NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

VOL. VII.

JULY—DECEMBER, 1895.

LONDON:

RAIT, HENDERSON & CO., LIMITED,

22 ST. ANDREW STREET, HOLBORN CIRCUS, E.C.

LONDON
PRINTED BY RAIT, HENDERSON & CO., LTD.,
22 ST. ANDREW STREET, E.C.

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No. 41. Vol VII. JULY, 1895.

NOTES AND COMMENTS.

Finis coronat Opus.

THE publication of the *Report* of the "Challenger" Expedition has been brought to a close with the issue of the two volumes reviewed in our May number. It is our English custom to accept our great deeds with equanimity, as no more than fitting, or even as inevitable. There is a merit in this peculiar form of pride, and yet it has its dangers. It is to be feared that Englishmen do not really appreciate this undertaking at its full value; they count the cost, but fail to see the profit. This is natural, for such explorations immediately appeal to only a limited class, however much their ultimate results may benefit the world at large. Moreover, in the present instance, the mere magnitude and duration of the performance remove it from the grasp of the individual; there are few who can form an adequate conception of all the results. We have, therefore, attempted to play the part of the philosophic historian, to show the "Challenger" Expedition in its true perspective, and to estimate the worth of its additions to science. We could not have made this attempt without the cordial assistance of the numerous eminent authorities, many of them the actual writers in the "Challenger" *Report*, who have so generously answered our call. Our heartiest thanks are here offered to them, and to many others whose names do not appear on our title page, but who have given help in revising, suggestions, and good-wishes. To our foreign friends we are specially grateful; it was only fitting that they, without whose help the "Challenger" collections could hardly yet have been worked through, should have the opportunity of personally appearing in this summary. We regret that obstacles of time and space have prevented yet more of them from contributing. Warm thanks are also due to the "Challenger" Office in Edinburgh for the loan of the wood-cuts that illustrate the present number.

The question proposed to our contributors was—How has the "Challenger" Expedition advanced science? And each was requested to answer this question for his special field of knowledge. One has answered the question on one line, another on another; the limits of space made it impossible to discuss all aspects of the subject, and by leaving the mode of treatment to the discretion of the different writers, greater variety has been obtained. In zoology, for instance, this writer has dealt with the facts of distribution, that one has plunged into pure morphology, yet another has detailed that increase in knowledge of genera and species upon which the broader results are based. But our readers must remember that there was advance in every direction, and that what is implied by any one of these writers is often as much and as valuable as that which is explicitly stated. There is one section which, though outside our usual scope, we are specially glad to publish, that, namely, written by the navigating officer of H.M.S. "Challenger," now Assistant-Hydrographer to the Admiralty, and discussing the results to hydrography and navigation. Here, at least, is something of which the man in the street can see the value; every addition to our knowledge of the ocean currents, the ocean floor, the ocean winds, is an addition to the safety of the sailor, to the ease and speed with which voyages may be accomplished, and to the intercourse of the nations. Every Briton is proud of Britannia's Navy; but let us remember that it is something more than our empire's fighting machine, that it has been in the past, and will be still more in the future, the servant of the world, and a most potent agent in the peaceful union and advance of all its peoples.

SOME LESSONS FROM THE "CHALLENGER."

IN every great undertaking of this kind, where so many interests are involved, and where so much depends on the accuracy and coördination of small details, there must necessarily be some failures, and this experience of failure is as valuable to future undertakings as is the experience of success. Some of our contributors have mentioned these weak points, in the hope that they will beguarded against by any forthcoming expedition. Already the lesson of the "Challenger" has led to great improvement in the methods of capture of oceanic animals. It was often impossible to tell from the old method at what depth an animal found in the net really lived; so that animals of markedly pelagic organisation were brought home labelled "2,000 fathoms" or thereabouts. By the introduction of nets that can be opened and closed while below the surface, these errors are now avoided. Again, the enormous advance that has been made in the technique of preparing organisms for microscopic examination cannot fail to render the results of a future exploration even more valuable than those of the "Challenger." Much histological work proved impossible owing to the somewhat crude method of preservation in force twenty-three years ago, and the length of time that many of the objects had to remain in unchanged spirit. Many of the reporters, too, had to do their work without the assistance of the elaborate appliances now found in every laboratory. Other suggestions for future explorations are given in the *Narrative*. There is, however, one other point that should not be overlooked. Those who originally planned the form that the "Challenger" *Report* should take can hardly have imagined the length to which it would run. Its size and cost are not such as to predispose "My Lords" to sanction future expenditure on a similar publication. No one questions that the results are worthy of the best paper, printing, and illustrations; but the promoters of any contemplated work of like nature would be wise in their generation if they were to adopt a less expensive scale and a *format* more convenient to the desk and book-shelf of the ordinary student.

Bathybius.

One of the earliest and most disappointing of the "Challenger" discoveries was that of the true nature of the "Bathybius." Professor Huxley, while examining deep-water dredgings, taken by Dayman, and preserved in strong spirit, found abundant traces of a grey gelatinous mass, resembling protoplasm in appearance, and containing embedded in it numerous minute structures which he called Coccoliths and Rhabdoliths. These were the early days of protoplasm, and Huxley, with a natural enthusiasm, suggested that what he found might be the remains of a primitive living slime, an amorphous mass stretching along the ocean bottom, as a continuous and almost unorganised beginning of life. As we all know now, the "Challenger" naturalists found that Bathybius was a flocculent precipitate formed when strong spirit was poured into sea-water, and that it was not and had not been alive. There was fierce exultation among the enemies of science, who were as delighted as if the whole theory of evolution had tumbled down with the collapse of Bathybius.

We need hardly point out that the reality or non-reality of Bathybius had no greater importance than that of any isolated zoological fact. So far as naked masses of protoplasm go, the plasmodia of many of the slime fungi, the naked masses of protoplasm that creep over tan-bark and decaying organic matter have a theoretical interest as great as a real Bathybius would have had. Moreover, it is at least probable that some Bathybius-like creatures do live on the floors of the oceans. The "Challenger" results have shown that vegetable life does not occur there, that bacteria (at least the bacteria of putrefaction) are absent. Theoretical considerations make it probable that simple organisms devoid of chlorophyll are more primitive than organisms with chlorophyll. It would surprise no zoologist were there brought up from the multitude of protozoa living at the bottom of the seas, naked amœboid creatures, devoid of chlorophyll, living on crumbs and fragments of organic matter, and at times cohering into plasmodia large or small; and such creatures would correspond nearly enough to Huxley's idea of Bathybius.

H. N. Moseley.

No reader of our article on the "Challenger" Expedition will fail to observe how large and important a share of the work was done by the late Professor Moseley. In that province of natural science which is regarded as specially his own, namely, the Morphology of the Invertebrata, his influence was prominent. Apart from his special report on some of the Alcyonaria and Madreporaria, we find some of the most important discoveries in many groups due to him: the true nature of *Peripatus*, and of the strange worm *Pelagonemertes*, the new Tunicate *Octacnemus*, the phosphorescent organs of deep-sea fish; these and many others will always be associated with his name.

But Moseley recognised that, while the deep-sea was not likely to change its character for many a day, the customs of savages and the flora of oceanic islands alike were disappearing or changing. He chose wisely and deliberately to lose no opportunity of observing these decaying aspects of life. The botanical work he did is fully referred to by Mr. Baron Clarke; to what Professor Haddon says of his anthropological labours we may add a few words.

Both in lectures and in private conversation, Moseley used to say that the "Challenger" Expedition saw nearly the last of the unsophisticated savage. The advent of missionaries and the spread of commerce, however important they may be from other standards, are wholly lamentable from the point of view of anthropology. Moseley devoted a large part of his time ashore to the investigation of the manners and customs of the natives. He brought back an anthropological collection of the greatest interest and importance, part of which is in the museum at Oxford, and part of which has been distributed to various private and public institutions. But the knowledge of primitive customs he had acquired is for the most part lost. He was able to assist in the arrangement of the Pitt Rivers collection, which was put under his control by the donor, and so far a certain amount of his information was not lost. But it was a hope of many of his intimates, a hope frustrated by his death, that one day he would be able to write a volume on the habits and customs of savages.

Irish Scientific Worthies.

We deeply regret to learn of the premature death of the Director of the Science and Art Museum at Dublin, Professor Valentine Ball.

A full notice of him must be deferred to our next number. One of his recent acts was to send the following letter to the *Irish Naturalist*:—

"For some time I have had it in contemplation to exhibit in a suitable part of the Museum a collection of portraits of persons identified with the progress of science in Ireland. Quite recently a number of portraits having become available for this purpose, and others, as the result of special correspondence, having been presented or promised, the time is now close at hand when the collection can be placed on view. I therefore desire to make known through the pages of the *Irish Naturalist*, that contributions and loans to this collection of portraits of eminent and acknowledged men of science belonging to the above denomination will be gratefully accepted. Circumstances have rendered it desirable that no restriction whatever should be put upon the style or nature of the portraits so contributed, no funds being available for securing uniformity. Hence we have decided to accept oil paintings, lithographs, etchings, or photographs, and to exhibit them as received, save that suitable frames will be supplied when needed. Portraits of mathematicians, astronomers, physicists, meteorologists, geologists, botanists, zoologists, antiquarians, and numismatists will be arranged in separate groups. In the cases of those who are deceased, short biographical notices will be attached to the portraits."

We trust that this application will have the desired effect, and at the same time we suggest to those who will now carry it out as a memorial of their departed chief, that they might include autograph letters or manuscripts, as such are found useful in the identification of labels and other memoranda associated with specimens.

Weights and Measures.

The American Metrological Society has the praiseworthy object of advocating a rational system of weights and measures. To that Society as well as to our readers, we commend a treatise upon measures, recently published in London by Mr. Wordsworth Donisthorpe. In that he traces the past history of our existing standards and advocates a new system based upon the metric scale, by which, of course, the measures of length, surface, and volume would be correlated. Incidentally in his book he mentions some ingenious comparisons that may be found useful by our readers. All of us who use the metric system in scientific work, unless we have a very extensive habit of measuring, find it more or less difficult to realise actual dimensions when the metric names are applied to them. We all know what an inch is; how many of us could draw on paper a line of a millimetre or of a decimetre?

The millimetre, Mr. Donisthorpe says, is the length of the letters a. c. e. m., etc., in nonpareil type. The centimetre is a trifle less than the diameter of the little red wafers used by lawyers as seals opposite the names of the signatures upon a deed. The decimetre is within a sixteenth of an inch of the hand used in measuring horses; that is to say it is nearly four inches, the width of an average man's hand. The cubic centimetre, the French millilitre, is about the size of French dice, which are a shade smaller than English dice. The litre is nearly a cube of four inches. It is about a pint and three-quarters, which Mr. Donisthorpe says is what we think of as a long drink.

The Distribution of Scale-Insects.

A recent note by Professor T. D. A. Cockerell (*Proc. U.S. Nat. Mus.*, vol. xvii., pp. 615-625) gives a summary of the numbers of genera and species of scale-insects (Coccidæ) known from various parts of the world. It appears that our ignorance of these creatures is as yet very great. A few areas have been well marked. Principally through the labours of Mr. Maskell, 108 species are recorded from Australia, and seventy-seven from New Zealand. Professor Cockerell thinks that the Coccidæ of the latter islands are better known than those of any European country. The recorded Palæarctic coccid fauna is believed to number about 200 species, while the Nearctic list numbers 127, the development of economic entomology in North America naturally accounting for attention to such a destructive family there. In our own country the group is being investigated by Messrs. J. W. Douglas and R. Newstead. Mr. Cockerell himself has paid much attention to scale-insects in the West Indies, whence come most of the 124 recorded Neotropical species, Brazil contributing some half-dozen to the total. From the entire Ethiopian and Oriental regions together fewer insects of the family are known than from the island of Jamaica. We see from this summary what an immense field for research lies open to naturalists who will pay attention to these minute insects. The sedentary habits of the females render inquiry into their distribution and means of dispersal of special interest, while no branch of zoology is more important to the gardener and the fruit grower.

Irish Freshwater Sponges.

In a recent number of the *Irish Naturalist* (vol. iv., pp. 122-131) Dr. R. Hanitsch enumerates six species of Spongillidæ from Ireland, the British fauna containing but four species. Three of these occur in Ireland, the other three sponges, all from the west coast of the latter country, being also North American species. Dr. Hanitsch would not solve this interesting distributional problem by supposing a former extension of the sponges over the whole northern hemisphere; he believes that their gemmules could readily have been carried across the Atlantic by winds, ocean currents, or birds. In some remarks on the European distribution of the Spongillidæ, Dr. Hanitsch notices their extreme rarity in Southern Europe. Only one species is known from the Iberian peninsula (N. Portugal), two from the Italian, while none at all have been found in the Balkan.

The Scientific Results of the "Challenger" Expedition.

INTRODUCTION.

IT is nearly twenty-three years since I went down to Portsmouth to bid "good-bye" to my dear old college friend, Moseley, when the "Challenger" steamed out of Portsmouth Harbour on her expedition for the investigation of the biological, chemical, and physical conditions of the great oceans of the world. The final volume recording the results of that memorable expedition has now been issued, and we may attempt to answer the question as to whether it was "well done"; whether the results have been worth the expenditure of public money; and whether the record of those results has been satisfactorily set forth without undue delay, and yet with necessary accuracy and fulness. There is unanimous testimony in the affirmative. Never did an expedition cost so little and produce such momentous results for human knowledge.[1] Over and above the normal expenditure involved in putting the ship in commission—an expenditure which is not to be reckoned to the special purpose of the expedition, since it would have been incurred in the usual course of activity of her Majesty's navy—there was the cost of some special fittings, and of apparatus for dredging and sounding, and of the means for preserving and transporting specimens. Besides this, there were the salaries of Wyville Thomson and his assistants—Moseley, John Murray, Buchanan and Willemoes-Suhm. The expenditure on the preparation and publication of the *Report* has been relatively greater; but the authorities of the Treasury may rest assured that the whole scientific

[1] The estimated cost of the "Challenger" Expedition while afloat was £30,000 per annum, but there is no means of knowing how much was actually spent on the expedition. Probably £90,000 is above the mark for the total naval expenditure. The "Challenger" was a man-of-war, in which nearly all the usual drill was carried on throughout the voyage, and the pay of the officers and blue-jackets, the most costly part of the expedition, cannot be regarded as an extra cost to the nation. The salaries of the civilian scientific staff while afloat amounted to £2,200 per annum. The total extra charge to the country for carrying out the scientific work on board the "Challenger" during the whole cruise may be put down at about £20,000.

The expenditure in connection with the care, examination, distribution, and description of the collections after the return of the expedition, together with the necessary researches and investigations and the preparation of the fifty volumes of the *Report* for the Press, was about £48,000—that is to say, the expenditure from public moneys; but many of the contributors have spent some of their own funds as well as their time in connection with their contributions to the publications.

world sets the very highest value on these volumes, and that, had it suited the dignity of an Imperial Government to treat the work on a commercial basis, instead of liberally presenting copies of it to scientific institutions throughout the world, the publication could have been made completely to pay its own expenses by sales.

Sir Wyville Thomson, on the return of the Expedition in 1876, was appointed to superintend the publication of the results, for which an annual sum was voted by Parliament. It was arranged that the Stationery Office should publish the work, and that all the collections, after they had been reported on, should be deposited in the Natural History Branch of the British Museum. Sir Wyville made some of the arrangements as to the distribution of the collections to experts for report, and decided upon the general form and style of the volumes to be issued; but his health broke down soon after his return home, and in 1882 he died. Suhm had died on the voyage, and eight years later another of the naturalists, Moseley, was taken from us, so that only John Murray and Buchanan now remain of the civilian staff of the "Challenger" Expedition.

On the death of Sir Wyville Thomson, Mr. John Murray was appointed to take his place as director of the collections and editor of the *Report*. It is not too much to say that it was a rare good fortune for science, and for the reputation of the "Challenger" Expedition, that a man who has proved to be so peculiarly fitted for the work which had to be done was at hand. The feat that Mr. John Murray (now "doctor" of many universities) has performed is remarkable on the mere face of it. He has, with the aid of a well-chosen staff, sorted and sent out to specialists in all parts of the world the treasures brought home by the "Challenger"; he has obtained from those specialists, whose zeal and promptitude is worthy of grateful recognition, richly illustrated reports of the highest value; and he has seen these through the press and issued them, together with a general *Narrative* and a *Summary* of the results, in fifty thick quarto volumes. The collections have been returned and safely deposited in the British Museum. To have obtained such a result within twenty years after the return of the expedition is evidence of unflagging energy, industry, and tact on the part of the director and editor. But this is not all; for Dr. John Murray has throughout these twenty years kept his mind bent on the great general problems to the solution of which all this work tends. He has himself, in conjunction with Professor Rénard, written one of the most important and original of the reports, that on Deep-Sea Deposits—and now has crowned the period of his labours with a marvellous index-summary of results preceded by the best historical account of the rise and progress of the science of Oceanography which exists, and followed by an extremely important essay containing far-reaching generalisations relative to the history of the earth's surface of land and water, entitled "General Remarks on the Distribution of Marine Organisms."

In the preparation of the "Challenger" *Report*, Dr. John Murray rightly made no distinction of nationality when selecting expert naturalists to do the work. When a British subject was the best man to deal with a given group, and was ready to undertake the work and put it through in a reasonable time, he was gladly welcomed by Dr. Murray; when a German, Belgian, Dutch, Scandinavian, or American naturalist seemed to be the fittest person to report on a group, he was enlisted. Thus the volumes contain some of the best work of the most distinguished naturalists of all countries. But there was enough material to occupy many men for many years in study, and not the least important service rendered by the editor has been in bringing forward young zoologists who have won their spurs under his auspices and fully justified his selection. Among such may be mentioned Messrs. S. O. Ridley and Dendy, who took up certain groups of sponges; Mr. Quelch, who dealt with reef-corals; Dr. Pelseneer, who had some of the most interesting mollusca intrusted to him; and Mr. Hoyle, who made himself an authority on the Cephalopoda. It is needless to say that the man who has thus "driven" the "Challenger" team to the successful close of its journey is, though energetic and determined, no ordinary taskmaster. He has gained the esteem, friendship—I may say the affection—of all who have worked with him, whether reverend professors, such as Renard, Häeckel, and Agassiz, or young men fresh from college who have been his assistants.

The actual results, their amount and importance, will be reported on by others in these pages. But I may be allowed to say what is the bare truth, and that is, that the "Challenger" volumes form a library of zoological literature of the highest kind of excellence, such as has never before been issued in one series, under one editorship, and in so brief a space of time. Our knowledge of the sponges absolutely dates from the great volumes here devoted to this difficult and multiform group. The same is true of the deep-sea fishes and of the crinoids and holothurians. The systematist has to refer first of all to the "Challenger" volume for knowledge of the Pycnogonida, and for complete revision of the various groups of Echinoderma, Crustacea, Hydrozoa, and corals. Nor must we forget the important contributions to botanical science, or the great advances made in our knowledge of the ocean floor and ocean physics, as well as the light thus thrown on some of the larger problems of geology.

Britons—I hardly like, since John Murray is a Scotsman, to say Englishmen, though that term really includes as much and perhaps more than the former—may fairly be proud of the whole conception, execution, and carrying through of the "Challenger" Expedition and its results. It was that fine old soldier of Natural Science, Dr. W. B. Carpenter, who thought out and proposed the expedition—all honour to him!—but honour also to our oft-abused representative Government and Legislature, which cordially voted the supplies for the Expedition when the Royal Society had endorsed Dr. Carpenter's suggestion. And, finally, congratulations to Dr. John Murray—and to all who have helped him—on the completion of his task, and on the honorary degrees showered on him by universities, and especially on the kindly and generous presentation to him, by the French Academy of Sciences, of the distinguished "Prix Cuvier."

The brilliant success of the "Challenger" Expedition and its *Report*, clearly point to the reasonableness of forthwith organising a similar enterprise by the aid of one of her Majesty's ships, for the purpose of filling up gaps and following out lines of inquiry which are patent to oceanographers and naturalists as the result of the consideration of the "Challenger's" work, and of that of other smaller but important expeditions which have followed it. There are now a large number of definite problems of the kind to which an immediate solution could be thus given. But, perhaps, the most interesting enterprise to British naturalists would be a biological and physical survey of the mud-line (of Murray) around the British Islands. E. Ray Lankester.

I.—HYDROGRAPHY AND NAVIGATION.

The combination of civilians with naval officers in the "Challenger" Expedition was most successful. Owing to the vessel being of a suitable size, each civilian not only had a cabin, but a work-room to himself; whilst the naval staff were also well accommodated. This enabled each member to work uninterruptedly at his own speciality, and to compare notes with the others in the smoking circle daily after dinner, a function always well attended, and one where the events and work of the day were freely and amicably discussed. To say that the civilians cheerfully endured the being cribbed, cabined, and confined to a movable prison with a chance of being drowned, hardly does justice to the alacrity they always exhibited, or to the constant interest they took in their work; whilst to the naval staff the close intercourse with men not brought up to a sea-life from a tender age, but educated in an entirely different school of thought, in the universities, had a charm which served to make the long voyages anything but tedious. That all were animated with the idea that it was their business to make the Expedition a success, is proved, not only by the evidence of the late Sir Wyville Thomson, in his letters to the Hydrographer of the Admiralty, but by the general results obtained, which are freely acknowledged to be worthy of the nation which equipped, and the members who accompanied, the Expedition.

The principal results of the "Challenger" Expedition from a naval point of view are:—

1. The proof that the variation of the compass can be determined as accurately in a ship, as on shore, if the ship is magnetically suitable.

2. The delineation for the first time of the contour lines of the great ocean basins.

3. The determination of oceanic temperatures, which subsequent observation has shown to be constant below the depth of 100 fathoms.

4. The proof of a constant bottom temperature over large areas in the ocean; found to be due to such areas being separated by submarine ridges from each other, and from the cold water of the polar basins.

5. The determination of the exact position of many islands and dangers, of which the longitude, especially, had been previously very uncertain.

6. The charting, as accurately as time permitted, of the various unsurveyed parts of the world sighted, or touched at, during the voyage.

7. The determination of the ocean currents both on the surface and at various depths.

1. With respect to the accurate determination of the variation of the magnetic needle on board ship, it is necessary to point out that before 1872 observations for variation taken by a vessel between any two ports were generally dependent for correction (for the direction of ship's head at the moment of observation) on the deviations obtained at these ports at the beginning and end of each voyage, corrected, of course, for the varying force of the magnetical elements. The usual method of obtaining a table of deviations, *i.e.*, of the errors of the compass due to local attraction of the ship itself, being to land one compass, and take reciprocal bearings on shore and on board, as the vessel was swung round laboriously by anchors and hawsers, with her head directed to each point of the compass in succession; in some cases, however, this had been done by bearings of the sun or of a distant object. It is evident that the correctness of the result, and of the variation curves, would be entirely dependent on there being no magnetic disturbance on the land.

Shortly after the "Challenger" left England a statement was made that the Admiralty chart of variations was considerably in error in the neighbourhood of the Bermudas, and instructions were given that this statement was to be investigated. On the arrival of the expedition at Bermuda observations were taken on shore, with the result that the needle in different parts of the island showed an extreme difference of 6° in the variation, viz., from 4° W. to 10° W.—a somewhat surprising result in a group of islands of coral formation. The difficulty then was to find what the true error of the needle was, and the following plan was adopted:—

It is shown by the late Archibald Smith in the "Admiralty Manual for Compasses" that if a table of deviations, or local errors in a ship, be obtained by swinging the ship on a number of equidistant points, if the resulting easterly deviations be called + and the westerly —, and that if the total of the easterly and westerly deviations be taken one from the other and the result divided by the total number of observations, this will give the constant error of the compass on each point. This co-efficient is named A. In a ship where the compass is placed exactly in the fore-and-aft line, and where the iron is evenly distributed, there will be no A. This was found to be practically the case in the "Challenger." By swinging the ship outside Bermuda by azimuths of the sun the total error of the compass, *i.e.*, variation + deviation, was obtained on each point. Taking the algebraical mean of all the observations, the constant error on each point is determined. This error is the variation + the A. In a ship, such as the "Challenger," with practically no A, the result is the variation.

This swinging in deep water proved so satisfactory that the system was adopted at many stations throughout the voyage, thus not only furnishing base-stations, independently of the land, for correcting the observations made between the base-stations, but also serving to ascertain whether there was any magnetic attraction on shore. Since the "Challenger's" voyage all vessels instructed to obtain magnetic observations have been ordered to adopt the system introduced by the Expedition at Bermuda.

2. Although, before the "Challenger" started, many ocean soundings had been obtained, especially in the North Atlantic between England and America, and in the Mediterranean, along the routes chosen for submarine cables, most of the earlier soundings were of somewhat doubtful value, as the means at the disposal of the first investigators were insufficient, and the method of obtaining accurate depths, when the soundings exceeded 2,000 fathoms, could only be ascertained after much experience. Depths of 7,000 to 10,000 fathoms were asserted to have been obtained, and certain text-books quoted these statements as facts.

By the investigations made in the "Challenger," the contour lines at each 1,000 fathoms of depth were for the first time drawn with some degree of accuracy, and it was shown that the great depths formerly reported had been much exaggerated. Soundings of upwards of 3,000 fathoms were seldom found, and the deepest cast was 4,475 fathoms in the neighbourhood of the Mariana Islands. The investigations undertaken at the same time by the United States confirmed the results obtained in the "Challenger," which the subsequent experience of twenty years has shown to be correct; the many soundings obtained by other vessels since the expedition returned to England have not altered in any material degree the contour lines originally drawn by the officers in 1876, or resulted in the discovery of any depth exceeding five statute miles. Consequently, 4,500 or 4,600 fathoms may be fairly accepted as the extreme oceanic depth.

3. The laborious work of obtaining ocean temperatures at a

depth of each 100 fathoms from the surface to the bottom, and at every 10 fathoms to a depth of 200 fathoms, enabled diagrams to be constructed showing the vertical distribution of temperature in all the great ocean basins. These determinations furnished a standard of reference for subsequent observations, which have confirmed, in a remarkable manner, the results of the "Challenger" Expedition, and have shown that, at depths exceeding 100 fathoms, the temperature is either constant, or the change is so small that it cannot be recorded in a period of twenty years.

4. Early in the voyage it was remarked that over certain areas the bottom temperature remained constant. Thus, in the eastern part of the North Atlantic the temperature at all depths exceeding 2,000 fathoms was constant at 36·8° Fahr., whilst in the western part it was 0·5° lower. Subsequent experience in the North Pacific showed that the bottom temperature was constant at 35°; in the China Sea it was 36·8°; in the Sulu Sea, 50·5°; in the Celebes Sea, 38·7°; and in the Arafura Sea, 38·6°; whilst in the south-western part of the South Atlantic the temperature at the bottom fell to 32·7°—and previous results obtained in the "Porcupine" gave a minimum of under 30° for the bottom temperature to the north-eastward of the Faeroe Islands in the North Atlantic. These results were finally shown to be caused by certain oceanic areas being separated from each other by submarine ridges, which prevent the spreading to low latitudes of the cold bottom water existing in, or near, the polar basins.

In connection with these results it is worth noticing that no bottom temperature was obtained as low as the freezing point of salt water, and that the only temperature hitherto recorded which is near the point of maximum density of sea-water (25·4°) is that obtained in the voyage of Sir John Ross to the Arctic in 1818. Also that the bottom temperature of the Red Sea is constant at 69°, and of the Mediterranean at 55½°.

5. The "Challenger" was provided with twelve chronometers, and careful observations were made at each place touched at, and the meridian distance between each place calculated. The longitude of some of the islands in the Southern Indian Ocean was proved to be twenty minutes or upwards in error. The total of the meridian distances round the world amounted to 360° 7′—an error of seven minutes in a voyage lasting three-and-a-half years, during which the chronometers had been exposed to great differences of temperature, and the length of time occupied between the ports had necessarily been much lengthened in order that the special work of ocean exploration might be properly performed.

6. Although the "Challenger" was not specially employed for surveying work, advantage was taken of the vessel's stay at any port to survey the anchorage, or add to the chart already existing. Thus, in the course of the voyage, an elaborate survey was made of the space enclosed by the mole at Gibraltar, plans were made of

Porto Grande, St. Vincent; of Ngaloa Bay in the Fiji Islands; and of Nares Harbour in the Admiralty Islands; Kerguelen Island was partially surveyed, and positions selected for the observations of the transit of Venus; Heard and MacDonald Islands were sketched in as the ship passed; the extent of the coral bank surrounding the Bermudas was determined, and a new coral bank to the south-westward of that group discovered; and so on.

7. Observations for the determination of the set of the currents in the ocean, when circumstances were favourable, were accurately obtained (1) by anchoring a boat by means of the dredge, or trawl, and (2) by lowering a drag to various depths, and determining the drift of this drag from the boat at anchor. This is the only way in which these observations can be accurately made, and, so far as is known, the "Challenger" Expedition alone has adopted these means.

T. H. TIZARD.

II.—OCEANIC CIRCULATION.

THE series of memoirs on the physics and chemistry of the voyage of H.M.S. "Challenger" is fitly concluded by an *Appendix* dealing with the circulation of waters in the great oceans, by Dr. Alexander Buchan. Since this has only just been published, we give a more detailed account than is required by the other memoirs. This report consists primarily of sixteen maps, on which are exhibited the distribution of temperature and salinity at various depths, so far as made known to us by the observations of the "Challenger" and of a number of subsequent deep-sea expeditions. Our information is unfortunately still insufficient to allow of the construction of maps showing salinity at any level except the surface; but Dr. Buchan has drawn very complete isothermal charts of the mean temperatures at the surface, at every hundred fathoms up to 1,000, and at 1,500 fathoms; and more isolated observations are charted for temperature at 2,200 fathoms, and for temperature and salinity at the bottom where the depth exceeds 1,000 fathoms. Some forty pages of letter-press are devoted to a general account of the temperature phenomena disclosed by the maps, and of the probable oceanic circulation suggested by them.

It is scarcely possible to over-estimate the scientific value of the information set forth in this report, which may be regarded as the first serious attempt to represent as a whole the distribution of temperature in the great water-masses of the globe. Nearly thirty years ago Dr. Buchan published his classical memoir on the distribution of atmospheric pressure over the earth's surface, and it cannot be doubted that the present work will take a place amongst oceanographers similar to that occupied by the former amongst meteorologists. As Dr. John Murray points out, the results as far as now ascertained show the urgent need for further exploration in the Southern Ocean, the western half of the South Atlantic, and the Pacific from about

150° W. long. to the American coasts, and there are elsewhere serious gaps in the observations both of temperature and salinity. But from the nature of the case we must expect the growth of our knowledge of the depths of the great oceans to be slow; and it is, therefore, all the more satisfactory that it is now possible to obtain such a general view of average conditions as will enable us to appreciate the bearings of detailed studies over restricted areas.

In meteorological work, where temperatures below freezing are of common occurrence, and where isobaric and isothermal charts are frequently used for purely practical and unscientific purposes, there is much to be said for the retention of the Fahrenheit scale; but in an inquiry of this kind, which appeals almost exclusively to scientific specialists, it seems, indeed, a pity that the Centigrade scale was not adopted. Not only is it impossible to compare or combine Dr. Buchan's results with the observations of the majority of oceanographers and marine zoologists, but the transformation to the Centigrade scale must be effected before a specific gravity calculation can be made with the tables published in another part of the "Challenger" *Report*. It is further to be regretted that specific gravities are calculated for a temperature of 60° Fahr., and referred to pure water at 39·2° Fahr., since, in this case, the temperature difficulty could have been altogether avoided by expressing salinities in "pro milles" in the usual way. In the chart of mean annual surface temperature, areas above 60° Fahr. are coloured red, while colder areas are coloured blue, and the land is filled in with black tints; the general distribution of temperature being thus made abundantly clear at a glance. At the depths down to 1,500 fathoms a different method is followed,—the sea area is tinted according to depth, and only the isothermal lines are drawn, these being blue or red in each map according as they represent a temperature below or above the average of all the observations employed in drawing them. We could have wished that it had been possible to combine the undoubted advantage of representing the relation of the temperature at any part of a horizontal plane to the mean for the whole of that plane, with a uniform scheme of colour like that given on the surface chart; for the change of colouring in each map makes it difficult to form a clear mental picture of the vertical distribution between one plane and another. Further, the fact that the contour-colouring in all the maps is identical leads to confusion between open areas and closed basins, especially as in many cases the lines are drawn freehand so as to show the temperature at a depth which, according to the contour map, does not exist. This difficulty could have been got over by representing, for example, the whole area within 500 fathoms of the surface *as land*, in the maps of planes below 500 fathoms, and so on.

Perhaps the most interesting feature of the map of mean specific gravity at the surface is the relation of the areas of highest salinity to the great ocean anticyclones. The maximum evaporation occurs, as has been shown by Krümmel and Schott, where the winds are strongest and steadiest, and we accordingly find the densest surface waters in the regions of the great permanent winds; the typical examples being those of the trade winds in the North and South Atlantic. Comparing this map with that of mean annual surface temperature, it appears at once that the areas of highest temperature do not in general coincide with those of greatest salinity, but that over the latter there is usually a considerable gradient of temperature from one side to the other. Hence, we derive the important result that the heaviest water occurs very much on the polar sides of the areas of maximum salinity, and that so far as gravity alone is concerned we must expect to find there the chief tendency for the water to sink below the surface, a fact which may come to be of vital interest in connection with the distribution of animals. Space does not permit us even to mention the many points of great interest suggested by Dr. Buchan's map of surface salinity; we may merely observe that in the case of the North Sea and the East Indian and Chinese waters it proposes a distribution markedly different from that hitherto accepted. With reference to the latter, great stress is laid on the influence of rainfall in lowering the salinity of the surface waters, and we must confess to some difficulty in following Dr. Buchan's explanation, especially in view of Schott's observations and experiments in this very region.

In constructing the temperature maps for the depths, Dr. Buchan states that after full investigation for intermediate depths down to 200 fathoms, the plane of 100 fathoms was recognised as being beyond the limit of seasonal variation; single observations are accordingly accepted as mean temperatures. We hope Dr. Buchan may be induced to publish the maps to which he refers; for a complete knowledge of seasonal variations, to the greatest depth at which they occur in the open ocean, is of first importance in discussing the circulation of waters in closed areas. We know, for example, that temperature in the Faeroe Channel is not constant even at a depth of 400 fathoms, and it is probable that variations in the strength of the current flowing over the Wyville-Thomson ridge are in part responsible for great changes of temperature and salinity in the North Sea and the Baltic.

The mean temperatures, for all the oceans, at the different levels, are given as follows, and show an average vertical curve of extreme interest:—

Depth in fathoms.		Temperature in degrees Fahrenheit.	Depth in fathoms.		Temperature in degrees Fahrenheit.
100	..	60·7	900	..	36·8
200	..	50·1	1000	..	36·5
300	..	44·7	1100	..	36·1
400	..	41·8	1200	..	35·8
500	..	40·1	1300	..	35·6
600	..	39·0	1400	..	35·4
700	..	38·1	1500	..	35·3
800	..	37·3	2200	..	35·2

In the Atlantic and Pacific Oceans the controlling influence of the great anticyclones of the lower latitudes is very clearly seen even at great depths. Circulation is, of course, most active in the Atlantic, partly because the belt of calms between the trades is at all seasons north of the equator, and the trades themselves blow with greater force and persistency than in the Pacific, and partly because the configuration of the land is such that the horizontal movements of water at and near the surface are suddenly arrested, and the increased pressure due to the heaping up of the waters is in part relieved by vertical movements downwards. One important effect of the position of the belt of calms is that immense quantities of warm surface water are transferred bodily from the South to the North Atlantic, with the result that so far as temperature is concerned the two oceans stand in strong contrast to each other even at great depths. A comparative study of the distribution of temperature in the Atlantic and Pacific Oceans strongly impresses upon us the truth of Mr. Buchanan's remark, recently emphasised by Admiral Wharton, as to the extreme slowness of the vertical movements of oceanic waters when the action of gravity is left to work alone. If we take a sea-water of average density, 1·0260 at 60° Fahr., its density at 45° Fahr. is 1·0275, and at 67° Fahr. 1·0250; so that the same water can cover the whole range of density found in the Atlantic by a temperature variation of 22° Fahr. Hence, even the saltest surface-waters can only penetrate the layers underlying them after having been cooled by a process of mixture, which has probably robbed them by dilution of the greater part of the extra salinity; and we are forced to the conclusion that when strongly-marked vertical movement occurs it must, in most cases, be ascribed to differences of pressure acting at the surface.

In the latter part of his discussion Dr. Buchan treats the Gulf of Mexico, the Mediterranean, the Red Sea, the Persian Gulf, the Indian Ocean, the Arctic Ocean and Norwegian Sea, and the Southern Ocean under separate headings. Outside the Atlantic and Pacific, interest naturally centres in the last-named, with which is inseparably bound up the Indian Ocean. The rigours of the unknown Antarctic are kept within bounds by the vast quantities of heat sent southward from the Brave West Winds and their following currents. At the surface the icy fingers are only visible here and there across the surface of the warm drifts, but underneath, 1,500 fathoms down, the creeping cold can be seen making its way northwards.

H. N. Dickson.

III.—GEOLOGY.

Geologists received from the "Challenger" a great mass of facts concerning the deposits now forming in the depths of the ocean; their interest was again markedly aroused in the problems of coral-reefs and the solution of limestone; while for the discussion of those wider problems of the permanence of ocean basins and general world-architecture, they have been provided with new and important documents. All these questions have already been fully discussed in Natural Science by persons competent to express an opinion. In our first number the Report on Deep-sea Deposits was reviewed at length by Mr. Harris Teall, and the exploration of coral-reefs was dealt with by Dr. J. W. Gregory. In August, 1892, Dr. Russel Wallace criticised the views as to the permanence of ocean basins that Mr. John Murray had based on the work of the "Challenger"; while Professor Edward Suess was so good as to give English readers his opinions on the same subject in our number for March, 1893. We have now asked Professor Judd to set forth the present answer of geologists to the questions concerning coral-reefs raised by the "Challenger" Expedition; and, as circumstances have unfortunately prevented the Abbé Renard from fulfilling his promise to contribute, two of Mr. Murray's fellow-workers have most kindly supplied notes on the deep-sea deposits and the problems they have raised.

Coral-Reefs.

Previously to the expedition of the "Challenger," two naturalists had expressed doubts as to the universal application of the "subsidence-theory" of coral-reefs—a theory first propounded by Darwin, and afterwards very ably supported by Dana. In 1863, Semper showed that, in the Pelew Islands, there are found in close proximity to one another upraised reefs and atolls; while J. J. Rein, in 1870, argued that the phenomena displayed in the Bermudas point to far more complex conditions than those postulated in the theory of subsidence.

It is an unquestionable fact, however, that it was mainly owing to the important observations made on board the "Challenger" with respect to the nature and mode of accumulation of the deep-sea organic deposits, that a wide-spread feeling of doubt as to the adequacy of the subsidence-theory of Darwin began to be manifested among zoologists, and to a less extent among geologists also. It is not necessary, here, to detail the various contributions to this important question made by Dr. John Murray, and subsequently by Prof. A. Agassiz and other zoologists. A very clear and impartial statement of the arguments adduced on either side of the question, down to the year 1889, will be found in the appendix drawn up by Professor Bonney for the third edition of Darwin's "Coral-Reefs." Since 1889 there have appeared two other very important works dealing with the whole question, namely, the third edition of Dana's "Corals and Coral-Islands," and Dr. Langenbeck's "Die Theorien über die Entstehung der Koralleninseln und Korallenriffe und ihre Bedeutung für Geophysischen Fragen."

The geological bearings of the observations made upon existing coral-reefs have been made the subject of several important memoirs, chief among which we may mention those of Sir Archibald Geikie (*Proc. Edinb. Roy. Phys. Soc.*, vol. viii., 1883, p. 1.) and of the late Professor James D. Dana (*Amer. Journ. Sci.*, 3rd ser., vol. xxx., 1885, pp. 89, 168; also in *Phil. Mag.*, ser. 5, vol. xx., 1885, pp. 144, 269). During the last few years additional interest has been added to the discussion upon coral-reefs, in their geological aspect, by the discovery of a number of undoubted deep-sea organic deposits, such as Globigerina ooze and Radiolarian ooze, among the rocks of the earth's crust, some of which, though of late Tertiary age, have been elevated several thousands of feet above the sea-level. These facts have, of course, tended to confirm the views of those geologists who maintain that great interchanges must have taken place in past times between the continental and oceanic areas of the globe.

Within the last two years two most important monographs on coral-reefs have made their appearance, Mr. W. Saville Kent's "The Great Barrier-Reef of Australia," and Professor Alexander Agassiz's admirable description of the Bahamas[1], the authors arriving at very opposite conclusions on the general question of the origin of coral-reefs, from their careful and detailed studies of these interesting examples.

In connection with the latter of these memoirs, a melancholy interest attaches to the circumstance that it was the perusal and notice of his friend's monograph that occupied the distinguished American naturalist, James Dwight Dana, during the last few days of his life. From the charming and judicious sketch of his father's life and career, written by Professor E. S. Dana, we learn that the notices of books in the May number of the *American Journal of Science* were the last literary work undertaken by the great naturalist, and the views that he enunciates as the final result of his wide experience and his latest reflections on these important questions deserve to be widely known. We shall not, therefore, apologise for transferring them to these pages.

"Professor Agassiz, in discussing the origin of coral-reef limestones, states objections to the subsidence-theory of Darwin. Without touching here on the special arguments in its favour, two or three general facts may be stated.

"In geological history, many limestones have been made exceeding 1,000 feet in thickness, which show by their fossils that they are not of deep-water origin. Whether derived from coral and shell sediment like coral-reef rock, or from shell sediment chiefly, makes no difference; subsidence was required.

"Subsidences of one or two scores of thousands of feet in depth have taken place in past times over the region of the Appalachians, Alps, and other mountain regions; and in the sinking trough, sediments were formed successively at the water's level, or not far

[1] "A Reconnaissance of the Bahamas and of the Elevated Reefs of Cuba, in the steam yacht 'Wild Duck,' January to April, 1893," with 47 plates. *Bull. Mus. Comp. Zool.* Vol. xxvi. Number 1; December, 1894.

below it, to the thickness of the depth of subsidence; and some of the sediments were calcareous, making now thick limestone strata.

"After the Cretaceous period, and in the Pliocene Tertiary chiefly, or the Tertiary and Glacial period, the whole region of the Rocky Mountains was elevated; the elevation was 16,000 feet in part of Colorado, 10,000 feet, at least, in the region of the Sierra Nevada, 10,000 feet in Mexico, and over 17,000 feet in British America, latitude 49° to 53°, and less to the north. The region of the Andes, at the same time, was raised to a maximum amount of 20,000 feet; the Alps, 12,000 feet; and the Himalayas, 20,000 feet. Moreover, at the close of the Champlain period there was another epoch of smaller elevation, introducing the recent period. These elevations, affecting a large part of the continental areas, could not have taken place without a counterpart subsidence of large areas over the oceanic basin; profound oceanic subsidence was hence in progress during the growth of coral-reefs. The subsidence cannot be questioned."

In these remarks Dana has forcibly dwelt on the facts which greatly weigh with geologists in inducing them to accept the "subsidence-theory" of coral-reefs. That the questions involved in the explanation of the numerous examples of coral-reefs in different oceans are much more complicated, than was at one time suspected, they freely admit; but with such clear evidence as they possess of subsidence and deposition having gone on concurrently, until deposits thousands of feet in thickness were piled up, geologists find it difficult to believe that coral growth was the one form of organic accumulation that did not conform to this common rule. Important and valuable, then, as were the observations made upon coral-reefs by the officers of the "Challenger," geologists still feel that many more exact studies of these wonderful structures require to be made, before the problems connected with their origin can be considered as finally settled.

John W. Judd.

Chemico-Biological Changes in the Ocean.

The investigations conducted by the "Challenger" Expedition with reference to the distribution and composition of oceanic deposits over the floor of the ocean have led directly to a number of interesting researches, undertaken with the view of throwing some light on the chemical changes now taking place in the ocean under the influence of organisms and organic matter. The results are contained in a series of papers by Murray, Irvine, Woodhead, Young, Gibson, and Anderson, published in the *Proceedings* and *Transactions* of the Royal Society of Edinburgh, from 1888 to 1894.

These researches appear to explain some of the phenomena connected with the distribution of calcareous and siliceous organisms in different depths and regions of the ocean, as well as certain peculiarities of the different varieties of deposits. The results of these investigations may be briefly summarised.

A series of experiments were carried out with hens and crabs in order to determine whether or not they were dependent on the actual presence of carbonate of lime for the formation of hard calcareous egg-shells and tests respectively; and it was found that, provided lime was present in their food, in such forms as phosphate, silicate, sulphate, or nitrate, the animals found no difficulty in forming a sufficiency of carbonate of lime for their shells and tests. No shells were formed when salts of strontium or magnesium were substituted for lime salts. The formation of carbonate of lime is presumably due to the influence of ammonium carbonate, one of the ultimate products of the decomposition of excreta. This was so far confirmed in that the addition of ammonium carbonate to sea-water resulted in a precipitate having the same composition as that of corals and shells.

The separation of such a precipitate took place much more rapidly at a high temperature (80° Fahr.) than at a low (as 35° to 40° Fahr.). This may explain why in tropical latitudes the secretion of carbonate of lime by organisms is much more abundant than in polar waters, as, for instance, by corals, molluscs, foraminifera and algæ.

Diatoms were experimentally shown to be capable of forming siliceous tests when grown in water in which fine clayey matter was suspended; and it is interesting to note in this connection that such siliceous organisms occur in greatest abundance in those regions of the ocean in which there is a large admixture of fresh water holding in suspension detrital matter from the land; for instance, near river mouths, the Polar regions, and the North-west Pacific, where the power of the water of holding matter in suspension is, from its low specific gravity, relatively great. It is thus probable that marine siliceous organisms do not depend, wholly at least, upon the silica in solution in the sea for their skeletal parts, as has been generally held.

The blue muds laid down in the proximity of the land are comparatively rich in organic matters, the decomposition of which initiates, in the circumambient sea-water, the reduction of the sulphates to sulphides and carbonates, thus increasing the alkalinity of the sea-water associated with the muds. This increased alkalinity lends to the water an additional power of decomposing the sedimentary material on the bottom, and in this way brings about numerous chemical changes, such as the formation of zeolites, phosphatic and manganese nodules, and glauconite. As iron is a constant constituent of these deposits, the ultimate result of the chemical changes is the formation of sulphide of iron, giving to these muds their characteristic bluish-black colour. In the same way sulphide of manganese is formed in these muds; but, unlike the sulphide of iron, it is decomposed by carbonic acid, forming soluble manganese bicarbonate, which remains in solution until it meets with an excess of oxygen, as in the water overlying the mud or on the surface of current-swept ridges. It is then precipitated as a higher oxide of manganese, which may again be reduced, go into solution, and be re-precipitated elsewhere. There will obviously tend to be an accumulation of manganese in any region which is peculiarly free from reducing matter, as over the red-clay areas of the great ocean basins. These phenomena have been adduced to explain the formation of manganese nodules and concretions. (Pl. xv. Figs. 1 and 2.)

Attempts have been made towards the explanation of the formation of dolomites. The fact that corals placed in a solution of copper sulphate become superficially converted into pseudo-morphic copper carbonate, hinted at a possible solution, viz., that the dolomites arise by the interchange of magnesium and calcium in lime formations when exposed to such a solution of magnesium salts as occurs in modern seas. To test this a *Tridacna* (Giant Clam) shell, whose great age was attested by its size, was examined chemically in various parts, with the result that the outside or oldest part was found to be much richer in magnesia than the inside or more recent formation.

ROBERT IRVINE.

MARINE DEPOSITS.

The researches of the "Challenger" gave the first definite information regarding the sediment now accumulating in various regions and depths on the ocean floor. A study of the "Challenger" collections, together with those made by subsequent deep-sea expeditions, has enabled Messrs. Murray and Renard to give a comprehensive sketch of the composition and distribution of these deposits, which has proved of the highest interest to geologists and physical geographers.

The marine accumulations are divided into two great classes—**Terrigenous Deposits** and **Pelagic Deposits.** (See Plate iii.)

The Terrigenous Deposits are those formed in shallow and deep-water close to the shore, and are mostly made up of mineral particles and detrital matters washed down from the dry land by rain, or torn from the coasts by the action of waves and currents. Their peculiarities are thus determined by the character of the adjacent land. Blue Muds prevail in enclosed seas and off the mouths of large rivers, while off bold coasts Green Sands and Muds with much glauconite are more abundant; off volcanic islands are Volcanic Sands and Muds, while off coral islands Coral Sands and Muds are found. The rock-fragments and mineral particles diminish in size and abundance with increasing distance from land, and it may be stated generally that, at an average distance of 200 miles from the shore, particles of quartz and other continental minerals exceeding ·1 mm. in diameter rarely make up any appreciable part of the deposit, except in those regions affected by floating ice. Thus, at their seaward margin, the terrigenous deposits pass gradually into pelagic deposits.

The character of the Pelagic Deposits is determined by the conditions prevailing at the surface of the ocean, since they are largely made up of the shells and skeletons of pelagic organisms. In tropical and sub-tropical regions, far removed from land, the deposits are, except when the depth is very great, chiefly composed of the shells of calcareous organisms, forming the Pteropod and Globigerina oozes. Towards the Antarctic regions, and in the Central and North-west Pacific, the deposits often largely consist of the remains of siliceous organisms, forming the Diatom and Radiolarian oozes. In the very greatest depths of the ocean the calcareous shells of the Pteropod and Globigerina oozes are sometimes entirely removed from the deposits by the solvent action of sea-water, and there is then found the peculiar Red Clay of the oceanic deeps.

The principal constituents of the Red Clay are silicate of alumina and the oxides of iron and manganese, which appear to be largely derived from the disintegration of pumice and volcanic dusts. These volcanic materials appear for the most part to have had their

FIG. 1.—SIFTING DEPOSITS.

origin in subaerial volcanic eruptions. Associated with these Red Clays the "Challenger" frequently procured, in a single haul, hundreds of sharks' teeth, some of them of gigantic size and apparently belonging to extinct species, dozens of ear-bones and other bones of whales, large numbers of manganese nodules, zeolitic minerals apparently formed *in situ*, and magnetic spherules containing native iron, nickel, and cobalt, and believed to be of cosmic origin. The remarkable association of these organic and inorganic materials in the Red Clays seems to indicate an extremely slow rate of accumulation, which is the more marked the further these deposits are removed from continental land.

Chemical changes take place in all the deposits, giving rise to secondary products, such as phosphatic and glauconitic concretions in the Green Muds, sulphide of iron in the Blue Muds, siliceous and calcareous concretions in the calcareous deposits, and manganese-iron nodules and zeolitic minerals (phillipsite) in the Red Clays.

The following table, given by Messrs. Murray and Renard, shows the mean depth, mean percentage of carbonate of lime, and the estimated area of the various deep-sea deposits.

——	Mean Depth in Fathoms.	Mean Percentage of $CaCO_3$.	Area, Square Miles.
Red Clay	2,727	6·70	51,500,000
Radiolarian Ooze	2,894	4·01	2,290,400
Diatom Ooze	1,477	22·96	10,880,000
Globigerina Ooze	1,996	64·53	49,520,000
Pteropod Ooze	1,118	79·26	400,000
Coral Sands and Muds	710	86·41	2,556,800
Other terrigenous deposits, Blue Muds, etc.	1,016	19·20	16,050,000

J. CHUMLEY.

IV.—BOTANY.

It is a pity that the "Challenger" staff did not, as was originally suggested, include a botanist, qualified to observe and collect, who might have devoted the whole of his time to his own subject. This is no disparagement of the excellent services rendered by Moseley, whose interesting notes supply some of the most readable and instructive pages to the ponderous vol. i. on *Botany*. As Mr. Clarke points out, this includes much more than the Botany of the "Challenger" Expedition. In it Mr. Hemsley has got together from many various sources the facts relating to the history of insular floras, while, in the lists of plants, the material of our national herbaria has been used, dating as far back as some of the collections acquired by Sir Hans Sloane, now one of the most cherished possessions of the British Museum. To the Keeper of the Botanical Department in that Museum we are indebted for the following notes on—

THE MARINE FLORA.

The shore Algæ collected by Moseley during the cruise of H.M.S. "Challenger" were worked out by the late Professor Dickie, and published in the *Journal of the Linnean Society* as he received the collections from different localities. Professor Dickie's herbarium, now in the British Museum, was a good one, but not quite good enough for the purpose of determining with accuracy collections from so wide an area as that covered by H.M.S. "Challenger," and the result is that a number of the names do not stand. It was, however, an excellent piece of work, and as well done as it could have been outside the herbaria of the British Museum, Kew, or Dublin. Not many new species were added, but we have learned from these collections all we know of the marine flora of the small islets of the Southern Ocean. The "Transit of Venus" Expedition to Kerguelen Island added to our knowledge in that particular case. Considering

Moseley's other duties on board and other interests, it is a remarkable collection—as good a collection as would have been made by most young botanists with nothing else to do. The other sources of the Algæ collected were not of so much geographical interest; but in all cases the results have been welcome.

The main interest, however, of the expedition to botanists is in the light shed on the Algæ of blue water—the plankton Algæ of the open sea, removed from the influence of coast and river waters. This expedition first taught us the great extent of this flora, though observations, such as those of Sir Joseph Hooker in the Southern Ocean, of Dr. Wallich, and others, had led botanists to expect the existence of a universal pelagic flora. Dr. John Murray's observations, published in the *Narrative* and in the *Summary*, are by far the most important contribution to our knowledge of the distribution of these forms; and the recent Hensen Expedition has added but little to it. However, all that has yet been done in the study of this flora is to advertise its existence, and to proclaim to botanists the urgent need for its exploration. The marine Peridinieæ, *Pyrocystis* (Fig. 2), the Coccospheres (Fig. 3) and Rhabdospheres, and other forms like *Halosphæra*—noted but not yet described — all need working out. The Cyanophyceæ and Diatoms are, perhaps, of less biological interest at present; but much has yet to be done with them too. Castracane's report on the Diatomaceæ (*Botany*, vol. ii.) has added a great number of new species to the overwhelming number already existing—and it has been criticised with some severity by experts—but it, together with Mr. Comber's hard work contributed to the *Summary*, forms a notable addition to our knowledge of these forms and their distribution.

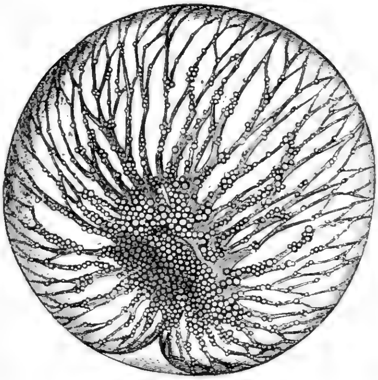

FIG. 2.—*Pyrocystis noctiluca*, Murray; 100 times nat. size.

FIG. 3.—A Coccosphere; 1,000 times nat. size.

The expedition has, then, not only made a great advance in our knowledge of the flora of the sea, but it has made exact and calculated work possible in the future. It has pointed out unmistakably what the next marine expedition has to do—whether it leave our shores for the Antarctic seas, or be a mere traverse of the Atlantic for biological purposes.

George Murray.

The Land Flora.

The object of the voyage of the "Challenger" was "to investigate scientifically the physical conditions and natural history of the deep sea all over the world." Among the scientific staff on board was no one specially set aside to collect plants and make botanic observations. H. N. Moseley was appointed as a zoologist, but he was more than a zoologist—he was a naturalist; indeed, though he did not profess botany, he had a considerable technical knowledge of the subject and an intense interest in the wider problems of geographic and geologic distribution on which botany throws special light. He took his own view of his duties from a study of the Naturalist of the "Beagle." At the end of his "Notes of the Voyage" he summarises in these words: "The deep sea, its physical features, and its fauna, will remain for an indefinite period in the condition in which they now exist, and as they have existed for ages past with little or no change, to be investigated at leisure at any future time. On the surface of the earth, however, animals and plants and races of men are perishing rapidly day by day, and will soon be, like the Dodo, things of the past. The history of these things once gone can never be recovered, but must remain for ever a gap in the knowledge of mankind. . . . Insular floras and faunas will soon pass away." With these views, Moseley worked his hardest while the "Challenger" was in harbour; out of the three-and-a-half years' cruise he got 520 days on shore. But a very large portion of this time was spent in well-inhabited ports, such as Funchal, Bahia, Melbourne, which afforded no specially favourable opportunity for study of the indigenous element of the flora. The Admiralty Islands he was the first to explore botanically, and he collected 69 species although he only got a week there; nor did he get a longer stay at the interesting Marion group, where he was also the earliest collector. In such short visits a botanist can only collect the plants of one season of the year found on a fraction of the area.

Moseley by no means confined his botanic work to collecting; in his Notes are recorded numerous observations, especially with reference to the transport of new species of plants to an oceanic island. He notes the arrival in the sea of the beans of *Guilandina Bonduc*, and their growing into shrubs on the sea-shore of West Indian islands. He also noted that large trees float in the sea laden with earth, so that some branches remain altogether in the air; on these fruits and seeds may be carried considerable distances by sea without any immersion in salt water; in this he advanced a step on Darwin.

The "Challenger" returned home in May, 1876; the zoologic collections were handed to specialists for study and description. Moseley's collections were sent to Kew and simply placed in the herbarium. Most of the islands at which he had collected had been previously visited by professed botanists: as St. Helena by Roxburgh and Burchell, the Falkand, Kerguelen, and many other islands in the Southern Ocean by Sir J. D. Hooker; and of these more complete floras already existed than the collections and notes of Moseley could furnish. The publication of Phanerogamic Botany in the *Report* of the voyage could hardly have been contemplated in the original official instructions; and it was only seven years after the collections had been stored at Kew that, on the recommendation of Sir J. D. Hooker, himself the leading authority on Insular floras, the task of preparing a report on the botany of the "Challenger" Expedition, *to be restricted to Insular Floras*, was entrusted to W. B. Hemsley. The reports on Algæ, Diatoms, etc., being largely on marine species, were made by specialists; Mr. Hemsley's work, with its inferences, is on the Phanerogams and Vascular Cryptogams of the islands visited; he drew up lists of these plants for Bermuda, Fernando-Noronha, Ascension, St. Helena, Trinidad, Tristan da Cunha, the Prince Edward group, Amsterdam and St. Paul, Juan Fernandez, Aru and Ke Isles, and Admiralty Isles; he tabulated these, showing their distribution in the nearest islands or continents, and discussed with numeric percentages and detail their affinities, indigenous character, or manner of introduction. In doing this work, Hemsley availed himself of all the previous collections and preceding writings, so that, in several cases, the collections and notes of Moseley supply but a fraction of the material worked up and discussed by Hemsley in the *Botany* of the "Challenger."

In restricting this report to insular floras, due regard was paid to the opinion which Moseley had himself expressed on the important deductions to be derived from them concerning the distribution of plants. This is especially true as regards the remoter islands little visited by man. In many islands, the indigenous vegetation has been almost wholly destroyed by him, and by the animals he has brought, while weeds have been plentifully introduced; where he has deserted his wasteful plantations, the weedy scrub, which has sprung up, in no wise resembling the primæval forest, is of no botanic interest. At the same time, it is highly instructive to discover exactly the route by which the new weeds arrived; there will too often remain a doubt as to many plants—whether they are indigenous or not. Islands lend themselves very kindly to Hemsley's tabulation in that they provide definite areas; if we begin to tabulate the "Cape Flora," our option where we choose to draw the boundary line of the "Cape" affects all our numeric results with large plus and minus possibilities of error.

The first and principal botanic gain, therefore, from the voyage of the "Challenger" has been the Report on Insular Floras, by W. B. Hemsley. It is not easy to epitomise his results shortly; one general result is the extent to which he has got rid of previously admitted anomalies. We find, for instance, in some large genus, a multitude of closely-allied species dotted about in the most "anomalous" manner in various oceanic islands and their nearest continents. But, as Mr. Hemsley observes, when all the material comes into the hands of one competent man, he unites some species, refers some specimens differently, and, finally, brings out a perfectly clear and consonant result. Mr. Wallace found the vegetable productions of Madagascar to be less like those of Africa than those of England are to those of Japan. The result of fuller knowledge is that the Madagascar flora is much more closely allied to that of Africa than to that of Asia or Australia; the ratio of similarity between the flora of Madagascar and that of any other continent follows the law of the inverse square pretty closely; if it did not we should have to look for prevalent winds or permanent oceanic currents to explain the anomaly. We may almost venture to write "human ignorance" in lieu of "anomalies in distribution." If we knew all the geologic history in addition to the causes at work, we ought to be able thereout to arrive at the existing distribution; the explaining away of an anomaly is the triumph of science. Hemsley has got rid of some formerly-received generalisations that formed very broad anomalies, and great obstacles to real progress. Thus it was believed that, in insular floras, the proportion of endemic species and of endemic genera was larger than in any continental areas. This it appears is not the case; in the flora of West Australia, or of the Cape, the endemic character of the flora is as strongly marked as in St. Helena or the Sandwich Isles.

One good step leads to another; Moseley's devoted labours led to Hemsley's Insular Floras. This has influenced numerous researches in the same field by H. O. Forbes, Guppy, Prain, Treub, J. Kirk, Cheeseman, Vasey, Rose, Christ, Bolle, Urban. The literature has already attained voluminous proportions.

One moral suggests itself, viz., that every future scientific expedition must have with it *either* a botanic specialist *or* a naturalist of the wide views and power of work of Moseley—such a man may be difficult always to find. But even Moseley could have given but a fraction of his mind to a subject more than sufficient to occupy completely a good all-round botanist. The investigation of insular floras has now advanced so far that it is no longer satisfactory to set one man to collect, and another man to work up, tabulate, discuss and infer in the herbarium at home; the man who stands on the shore of the oceanic island should be himself master of his subject—

acquainted well with its literature, able to draw his inferences on the spot, and proceed from those inferences then and there to intelligently directed, not hap-hazard, observation, inquiry, and collection.

C. B. Clarke.

V.—ZOOLOGY.

The greatest part of the innumerable discoveries with which the "Challenger" Expedition has enriched zoology concerns the Benthos, namely, those organisms which live fixed or creeping on the bottom of the ocean. But not less remarkable or important are the discoveries made on the Plankton, namely, those animals and plants which are free-swimming or suspended on the surface of the ocean, or at different depths (*c.f.* my "Plankton-Studien," 1890). With the exception of the Deep-sea Keratosa, my own contributions to the "Challenger" work concern the Plankton, and have proved that it is just the smallest pelagic animals which possess the greatest importance for oceanic life. As I wandered for ten years through this wonderful new empire, populated by more than 4,000 species of Radiolaria, for the most part previously unknown, and as I daily admired the incredible variety and elegance of their delicate forms, I had the happy and proud sensation of the explorer who is the first to travel through a new continent peopled by thousands of new and curious forms of animals and plants.

It is now universally admitted that the celebrated voyage of the "Challenger" is the most important and the most fruitful expedition that has set out since the times of Columbus and Magellan. No future expedition to elucidate the wonderful secrets of oceanic life can produce an equal number of new facts and important discoveries. The British nation may be proud to have executed this splendid standard work, and to have given to oceanography a fixed base for all future time. Many expeditions have been sent out for similar purposes during the last century; but no single one has reached similar results. To a great extent this was the consequence of the excellent preparation and the most practical equipment of the great undertaking, also of that combination of favourable circumstances, which we call "fortune." But it resulted far more, in my opinion, from the excellent men, both in the naval staff and in the civilian staff, who executed their great work with indefatigable energy and with rare intelligence. First of all must here be celebrated Sir Wyville Thomson, as the Director of the scientific staff, and after his lamentable and premature death in 1882, his successor, Dr. John Murray, who has proved himself "the right man in the right place."

During the twelve years that I was engaged upon the "Challenger" *Report*, I had to correct the proof of 3,000 pages of letterpress, and of 230 lithographic plates, and I had to exchange with Dr. Murray, as the Director and Editor of the whole work, some hundred letters. Throughout this long time and this difficult work, I came year by year more to admire the rare qualities of man united in Dr. Murray, which enabled him to accomplish this gigantic task; his general scientific knowledge and philosophic spirit, his practical skill and administrative capacity, and his admirable survey over all parts of his immense field. If, after eighteen years of labour, the fifty big volumes of the "Challenger" *Report*, with their thirty thousand pages of letterpress and their more than three thousand plates, have now really finished publication, the British nation may be proud of this "monumentum aere perennius," and it is in the first place indebted for its accomplishment to the singular genius of John Murray.

ERNST HAECKEL.

EXPECTATIONS AND RESULTS.

Scientific interest in the nature of the sea-bottom had been aroused by a series of earlier investigations. In 1819 Sir John Ross, dredging in the "Erebus," had brought up worms from a depth of 1,000 fathoms, and had suggested that life extended even to deeper recesses. But these results were little known to naturalists, and when Wyville Thomson, from the results of the "Lightning" Expedition, urged an extended exploration of the ocean-floor, he was unable to say certainly that life extended much below a depth of 650 fathoms. To determine the depth to which it extended and the nature of the fauna was the first zoological problem in the mind of those who organised the Expedition.

But hopes of a wider nature were entertained. It was generally believed that a large number of the sedimentary rocks had been formed at the bottom of deep oceans, and it was hoped that in the deeper parts of the existing oceans there would be found alive representatives of strange new types, and living forms corresponding to Tertiary fossils. Wyville Thomson specially insisted upon this, and there can be no doubt that it was a considerable disappointment to the naturalists to find few primitive types. No trilobites, blastoids or cystids, and no primitive vertebrates of any kind were discovered. In fact, from the point of view of connecting links, the voyage of the "Challenger" was almost barren. The most important linking animals, such as *Ornithorhynchus*, *Amphioxus*, *Balanoglossus*, *Peripatus*, and *Limulus*, are not inhabitants of the depths of the ocean.

The actual results of the Expedition were, in the first place, the discovery of a vast number of new forms, which, although they seldom added to our knowledge of the connections between existing groups, added vastly to our knowledge of the infinite variety of morphological structure among groups. As a simple extension of knowledge, the results of the "Challenger" were prodigious.

Next, the "Challenger" results laid the foundation for important conclusions as to the relative distributions of land and water at various times on the surface of the globe. The permanence of the great oceans and the enduring character of the great land masses are conclusions that have been at least partially the result of the Expedition.

Lastly, the Expedition conclusively established the existence of life down to the deepest abysses, and did much to catalogue the kinds of animals present in the different regions of the sea.

Combining the actual results of the "Challenger" with those of later investigations, most of which, indeed, were due to the stimulus given by the "Challenger" results, we are able to define the fauna of the sea. There are three great groups of marine inhabitants: a group that drifts, a group that swims, and a group that is anchored. The first group, or *Plankton*, consists of all those frail forms that float in the waters devoid of the power of movement or at the least of the power of movement against tide and current. The *Nekton* are those animals capable of swimming against currents, and so of migrating from place to place with or against the currents as they choose. The *Benthos* are those animals and plants that are fixed to the bottom, or that can crawl over the bottom only for short distances, and, therefore, neither migrate at will nor are carried about by the set of currents. The *Plankton*, *Nekton*, and *Benthos* form three well-marked communities of organisms, each having its own characteristic forms, and, naturally, its own seasonal variations. The *Benthos* and the *Plankton* can be studied more fully, as in their case the variable and elusive factor of "will" does not come into operation.

It is, of course, to be noted that both the *Nekton* and the *Benthos* contribute to the *Plankton*. The young forms of strongly swimming creatures like fishes or cephalopods are carried about by the currents, and, at certain seasons, compose a large part of the *Plankton*; while similarly the larval stages of *Benthos*, such as starfish, mollusks, and ascidians, are also *Plankton*.

The regional classification of marine life is more difficult. The simplest region is the Pelagic zone. This extends all over the seas, from the coasts to the great oceans: its limits are difficult to define, but may be taken as practically the depth to which strong sunlight penetrates. Its inhabitants are *Plankton* and *Nekton*, and the great character separating it from deeper waters is the presence of abundant plant life. The second great zone is the Neritic zone which extends from the coast to a depth of about five hundred fathoms, excluding the superficial *Plankton*, and including the region left bare by the tides. It corresponds to the littoral region of Moseley, with the addition of the shallow banks in seas far from coasts. Its inhabitants are chiefly *Benthos*, and the great character is dependence upon the coast. The creatures of the pelagic zone differ little all over the surface of the sea, and the inhabitants of the deeper waters vary still less from ocean to ocean, but the littoral zone of each coast has its own peculiar features. The Abysmal zone extends from a depth of 500 fathoms down to the bottom of the deepest oceans. Its inhabitants are chiefly, if not entirely, *Benthos* and *Nekton*.

As we have already said, a great result of the "Challenger" Expedition, was the disproving of the existence of living fossils in the recesses of the ocean. The inhabitants of the ocean-floor are strange enough, but their strangeness is that of novelty rather than of antiquity. The great depths of the ocean are poor in species and in genera, and the species and genera are often allied to existing littoral or pelagic forms. As Moseley was among the first to point out, migration to ocean depths is a migration to an abnormal environment and could have come about only slowly. Perhaps the great ocean depths were the last parts of the surface of the earth to be populated, and their inhabitants have reached them slowly from surrounding regions. The barriers to downward migration are numerous. First there is the scarcity of food, due to the absence of vegetable life. Next there is the absence, partial or complete, of light. Again, downward currents must be excessively slow and rare, so that there would be little chance of any but *Benthos* reaching the greater depths. Lastly there is the enormous barrier of the increasing pressure of the water, as the downward migration progresses. If the "Challenger" Expedition failed to find the living fossils zoologists hoped for, it found a still more extraordinary aspect of the kaleidoscope of life.

P. CHALMERS MITCHELL.

FORAMINIFERA.

No less than 814 pages and 115 quarto plates were devoted to the Foraminifera collected by the "Challenger." The monograph was the work of Dr. H. B. Brady, whose ripe knowledge had been early trained to a due regard for the simplification of nomenclature by his collaboration and friendship with Parker and Rupert Jones. The Report on the Foraminifera will always remain the great book of reference on all the recent forms of this group; it contained the basis of a bibliography and of an index to known forms, and paved the way for a surer and more definite classification. Perhaps the most valuable and at the same time the newest of Brady's work was the careful study and description of the previously little-known arenaceous forms, some ten genera and numerous "species" being described practically for the first time. The exact locality and depth of the gatherings rendered it possible to compare the geographical distribution of the Foraminifera. Brady was thus enabled to give detailed lists of those forms which form the mass of the Globigerina ooze (Pl. iii. Fig. 4), those which form the red clay, those of shallow water, and those of pelagic habits; lists of the greatest value to workers in the geological history of the group. He gave a detailed survey of the works of previous authors on the subject, compared the various classifications, and proposed his own view, redescribing every genus and carefully confining it more exactly than hitherto, thus smoothing the way for future workers to a remarkable degree. The elaborate and beautiful plates remain a lasting memorial to the talents of Mr. A. T. Hollick, and it is not too much to say that they have never been excelled, though the exquisite figures in the "Novara Reise," and in Vanden Broeck's little treatise on "Les Foraminifères de la Barbade," are quite equal to them.

The specimens of *Orbitolites* were entrusted to Dr. W. B. Carpenter, and enabled him to add largely to our knowledge of the structure and distribution of the four species, one of which his report describes for the first time.

C. Davies Sherborn.

Radiolaria.

When, in August, 1876, I attended the meeting of the British Association at Glasgow, and made the acquaintance of the naturalists of the "Challenger," the quantity and scientific value of the zoological collections there exhibited by them aroused my deepest interest. But none of the material astonished me so greatly as the wonderful Radiolarian ooze discovered by the "Challenger" in the depths of the Pacific. For I saw hundreds of microscopic preparations,

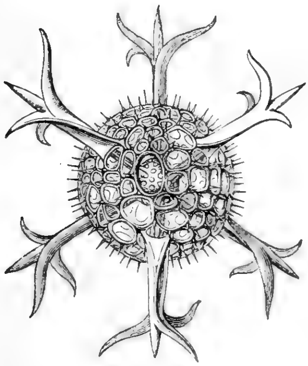

Fig. 4.—*Hexancistra quadricuspis*, Haeckel; one of the Spumellaria. Much enlarged.

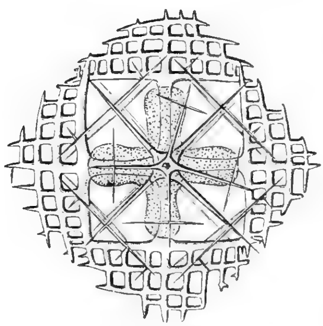

Fig. 5.—*Lithoptera darwini*, Haeckel; one of the Acantharia. Much enlarged.

each of which, in the narrow space of a square centimetre, displayed from twenty to fifty, or more, entirely new species of Radiolaria, those delicate forms of that class of siliceous-shelled Rhizopoda, of which, in my 1862 monograph, I had distinguished scarcely 200 living species. (Pl. iii., Fig. 1). Sir Wyville Thomson, who knew my work, offered me the whole collection of Radiolaria to study and report on for the "Challenger" volumes. In accepting this kind invitation, I hoped to be able to complete the work in three or four years, but the number of new and remarkable forms was so incredible, that their description occupied full ten years, and necessitated the diagnosing of over 3,500 new species. At the same time their enormous abundance as individuals in the plankton collection, proved that these minute rhizopods, quite unknown up to 1834, constituted the most important food supply of pelagic animals. In the variety and elegance of their different shells, as well as in their morphological and phylogenetic value, they surpass all other unicellular organisms that we know. This is the more astonishing as the whole class was formerly regarded as a rare curiosity: Huxley, in 1851, had given the first accurate description of a few species of *Thalassicolla*, and Johannes Müller in his last work, in 1858, united these with the polycystines and *Acanthometra* under the name Radiolaria, having observed fifty living species. The whole number of Radiolaria described in the 2,150 pages and 140 plates of my Report, is disposed in two sub-classes, four legions, twenty orders, eighty-five families, 739 genera, and 4,318 species. This great number might easily be augmented by a diligent observer who would employ another ten years in the study of the Radiolarian ooze. ERNST HAECKEL.

The three large volumes just referred to by Professor Haeckel are no less evidence of the industry and genius of that distinguished naturalist than of the vast field almost untouched before this expedition. It must not, however, be supposed that the cataloguing and arrangement of a great number of species is all that we owe to this section of the "Challenger" *Report*. There are also the details of geographical and bathymetrical distribution of the Radiolaria, and their part in the composition of deep-sea oozes: a mass of evidence bearing on the wider problems of physiography and geology.

More than this, we have gained greatly in our knowledge of the structure of the living animal. The demonstration of the complex nature of the central capsule in higher forms; of the parasitic, dark-green cells, which in one section take the place of the better-known Zooxanthellæ; of the peculiar chemical composition of the skeleton in the Phæodaria: these are all matters of the greatest interest and importance to the zoologist.

This increased knowledge of Radiolarian anatomy is especially useful as giving a basis for a new main classification into certain large groups, at once natural and convenient. Students of the older text-books—and, still more, teachers of zoological classification—will readily recognise the advantage of replacing the long lists of families usually given in such works by the two main sections, Porulosa and Osculosa; and the division of these into Spumellaria and Acantharia in the former case, and Nassellaria and Phæodaria in the latter.

A. VAUGHAN JENNINGS.

SPONGES.

As regards the Sponges, the results of the "Challenger" Expedition are of an importance which it would be difficult to overrate. The magnificent collection of well-preserved specimens was so large and various as to require the labours of no less than six naturalists, some of them working several years, for its investigation.

The Calcarea and the Keratosa were reported on by N. Poléjaeff; the Monaxonida by S. O. Ridley and A. Dendy; the Hexactinellida by F. E. Schulze; the Tetractinellida by W. J. Sollas; and the Deep-sea Keratosa by Ernst Haeckel. In all 1,736 pages of letterpress, and 226 plates were required for the elucidation of this interesting group.

It is a subject for congratulation that the eminent naturalist, Professor Haeckel, whose work on the Radiolaria would alone have proved exhaustive to most mortals, was able to spare some of his attention for the study of a class, with which his name must ever be indissolubly connected. The inspiration of the "Kalkschwämme" was still an influence genially working in the minds of all the colleagues associated with him in the study of the "Challenger" sponges.

We are indebted to Professor Haeckel for the following account of his work on **"The Deep-sea Keratosa"**:—

The twenty-six species which are comprised in this group, and which are all new, belong to eleven different genera and four families. These sponges are very remarkable by reason of their peculiar pseudo-skeleton and their symbiosis with hydroid polyps. The main mass of the body is composed either of siliceous Radiolaria shells or of calcareous Foraminifera shells. The place of an internal skeleton made by the animal itself is taken by the reticular hydrorhiza of the hydroids living in symbiosis with the sponges. Some of the larger species have the form of a broad flabelliform leaf, and their transverse diameter reaches 20 cm. or more (*Stannophyllum*); some other smaller forms (*Ammolynthus*) are simple urn-shaped utriculi, not longer than 6–12 mm., and 1–1·5 mm. broad; they are among the simplest and most primitive sponges that we know. The whole structure of these Deep-sea Keratosa is so peculiar that many experienced naturalists who had previously examined them expressed the most different opinions as to their true nature. It required a very careful study before I could confirm the view of Dr. John Murray (stated immediately after their capture) that they were undoubtedly true sponges.

Ernst Haeckel.

When Poléjaeff commenced the study of the **Calcarea**, some ten years had elapsed since the publication of the "Kalkschwämme" by Haeckel, and in this interval great improvements had been introduced into the methods of section-cutting, so that a means was provided by which Poléjaeff was enabled to undertake a critical revision of the calcareous sponges, a task which, in spite of the comparatively small amount of material at his disposal, he accomplished with the most transparent success. A re-modelling of the classification of the group was one result, an exact knowledge of its anatomy and histology another.

The transition which Poléjaeff was able to demonstrate as occurring between the *Sycon* and *Rhagon* type of chamber-systems within the limits of the Calcarea is a fact of great interest, and the knowledge which we now possess of the chamber-system in this and other groups of sponges affords evidence of a strict homoplasy between the successive stages of development of this system in the calcareous sponges on the one hand, and in the remaining sponges on the other. Nature, having presented to her the problem—how to obtain by means of flagellated cells a maximum current with minimum expenditure of energy—has solved it in two different groups of organisms in essentially the same way; and the method of solution is one which, on physical principles, appears to be inevitable.

The number of species of Calcarea, all described from "Challenger" material, is thirty, of which twenty-three were new; they are grouped in twelve genera, of which four were new. (Pl. vi., Fig. 2.)

Poléjaeff's work on the **Keratosa** contains a large amount of exact information on the anatomy and histology of these sponges, but the material at his command was in this case too limited to afford sufficient data for a satisfactory system of classification: indeed, to arrive at this, a study of the Keratosa alone is inadequate, they must be taken in connection with the Monaxonida, from which the majority of them have almost certainly been derived.

Thirty-four species of Keratosa were obtained by the "Challenger," of which twenty-one proved to be new; they are distributed among twelve genera, none new.

It is to the **Hexactinellida** that the greatest interest naturally attaches. The exquisite beauty of such forms as Venus' Flower-Basket, the marvellous symmetry of complicated spicules which many well-known members of the group afford to the microscope, and the long acquaintance which the palæontologist has had with these sponges in the fossil state previous to their revelation as living forms by the dredge, have rendered them remarkable in popular esteem. Till, however, Schulze undertook their investigation, they were still objects of mystery, for nothing was known of the structure of the sponge itself. It was a great opportunity when the "Challenger" collection was placed in Schulze's hands, and splendidly he employed it. By means of the microtome all the well-preserved specimens were laid open to precise observation, and on the exact knowledge of structure thus obtained was based the foundation of a natural system of classification. The arrangement of the soft parts and the character of the chamber-system were found to be singularly uniform; in the latter a syconate character prevailed and indicated the position of the Hexactinellida as the lowest of the siliceous sponges, a fact in harmony with their very early appearance in the stratified series of the earth's crust. The uniformity of the chamber-system and the persistence of a sexradiate form in the spicules, sharply mark off the Hexactinellida from all other siliceous sponges; they form a truly natural order—an enviable position amongst sponges, to which the Calcarea alone among the rest have like claim.

If the canal-system is uniform and thus of no use for classificatory purposes within the group, the spicules are just the reverse, and by their extreme diversity offer characters of the highest taxonomic importance. It is noteworthy that it is not so much the large as the minute spicules which were found to possess most significance in classification, and this is true not alone of the Hexactinellida, for Ridley and Dendy found it to hold good in the case of the Monaxonida, and Sollas in that of the Tetractinellida.

Schulze did not confine his studies to the material obtained by the "Challenger," but extended them to embrace all known material, so that the report on the Hexactinellida is at the same time a veritable monograph. The number of species obtained by the "Challenger" was ninety, of additional species thirty-six; of new species sixty-nine were described, of previously known forty-six, they were arranged in fifty genera, of which twenty-two were new. (Pl. v.)

Ridley and Dendy in their elaborate report on the **Monaxonida** describe 213 species of which 158 are new, and arrange them in fifty-four genera, of which five are new. They modify and improve existing classifications, and point out that the deep-sea members of the group are usually distinguished by a greater degree of symmetry than those which inhabit shallower waters. (Pl. vi., Fig. 1.)

The **Tetractinellida**, including the stony sponges (Lithistids) share some of the interest which attaches to the Hexactinellida, with which in the early days of spongology they were sometimes confused. Great use was made of the microtome in their investigation, every species being examined in thin slices: in contrast to the Hexactinellids the characters of the soft parts were found to differ considerably in different groups, and thus to furnish useful aid in classification. The chamber-system was found never to fall to the level of the syconate type, it is always rhagose, and presents two very different degrees of complexity, the simpler or eurypylous, and the more complex or aphodal. It is in the Tetractinellida that the sponges seem to culminate, some of their members attaining a degree of specialisation unknown in other groups.

In addition to the specimens brought home by the "Challenger," all previously described material was made a subject of study, and the results embodied in the Report. Of species obtained by the "Challenger," there were eighty-seven, of which seventy-three were new; they were arranged in thirty-eight genera, of which eighteen were new. Of additional species 221 were described, and of additional genera forty-five, of which fifteen were new.

The important question of distribution was fully considered in all the reports, the facts were tabulated, and in most cases subjected to very elaborate analysis.

During the preparation of the reports, advantage was taken of the fact that so many observers were simultaneously engaged in the study of sponges, to discuss together a scheme for the simplification of the nomenclature of spicular forms. Assistance was afforded by Stewart, von Lendenfeld, and Vosmaer in this work, and a consistent system proposed, which has since found very general adoption. In this system the distinction between axis and actine, first pointed out by Sollas, played a considerable part.

The outcome of the Expedition, in the case of the Sponges, was, briefly put, to reveal to us the existence of a vast number of previously unknown forms, some of them of extreme interest, to extend our knowledge of anatomy and histology throughout the group, to render more natural our systems of classification, and to lay the foundations of a knowledge of distribution, both geographical and bathymetrical. No doubt there remains plenty of room for addition and modification, but the more immediate need, in the study of sponges, is for further knowledge of their embryology, and still more of their comparative physiology.

W. J. SOLLAS.

COELENTERA.

Perhaps one of the most striking results of the "Challenger" Expedition, so far as the coelenterates are concerned, was the overthrow of the old group of the **Tabulata**. Doubt had, it is true, been already thrown upon the value of the tabulæ in corals as a character for classification by the discovery made by Nelson and Agassiz that the Milleporidæ are hydroid and not anthozoan corals. During the cruise of the "Challenger," Moseley was able to confirm this result, and to give a first-rate description of the dimorphism occurring in the family. The drawing which Moseley gave of the expanded polypes of *Millepora* has been copied into nearly all the standard works of zoology (Pl. vii., Figs. 1, 2). But Moseley was able to extend this discovery, and prove that all the genera belonging to the family Stylasteridæ are truly hydrocorallines. The volume of the "Challenger" *Report* which deals with this family is perhaps more full of valuable original results than any in the whole series. No memoir that has been published before or since contains so accurate and so detailed an account of the anatomy of any group of corals. It is, and will remain for many years to come, the only standard work on this family.

A great deal more might be written upon this result alone of Moseley's work, but reference must be made to the striking and unexpected discovery that the Tabulate coral *Heliopora* was not a Zoantharian, but an Alcyonarian. The relations of this genus to several fossil forms, such as *Syringopora*, *Favosites*, *Halysites*, etc., were pointed out by Moseley, and the result of his investigations and suggestions has been the final abandonment of the Tabulata as a natural group.

Another important investigation of Moseley's, made during the cruise of the "Challenger," and published in the *Results*, was the description of the anatomy of the interesting reef alcyonarian *Sarcophyton*, and the discovery of a dimorphism of the polypes in this genus similar in some respects to that which was known to occur in the Pennatulids. Moseley introduced in this memoir the terms "autozooids" and "siphonozooids" in place of "polypes" and "zooids," the words used by Kölliker for the tentaculate and non-tentaculate forms respectively, and these terms have since been used almost exclusively by writers on the anatomy of Alcyonaria.

S. J. Hickson.

In the special reports on the **Alcyonaria**, the Orders of the Alcyonacea and Gorgonacea were examined by Professors E. Perceval Wright and Th. Studer; that of the Pennatulacea by Professor A. Kölliker. Of the **Pennatulacea** thirty-eight species belonging to nineteen genera were found, amongst which seven genera and twenty-seven species were new to science; unfortunately most of the species were represented by but one or two specimens. With regard to the geographical distribution of this group, the new forms were of great interest, both extending and confirming the conclusions previously arrived at by Kölliker in his well-known Monograph (1872). As to their horizontal distribution, Kölliker thinks it proved that they are not distributed over all seas in a regular manner; taking the families, he shows that they seem to have fairly well defined centres from which they spread more or less widely; perhaps the distribution of the Umbellulidæ is the most remarkable. Known for over a century from only one locality, near the coast of Greenland, forms of it were found during the cruise between Portugal and Madeira, in the Atlantic under the Equator, west of Kerguelen Island, in the South Polar Sea, off the coasts of New Guinea and of Japan, and from the middle of the North Pacific Ocean. The knowledge of the vertical distribution of the group was greatly increased: when Kölliker published his Monograph he was justified in saying that the great majority of the species were shallow-water forms; but now the deep-sea forms are about as numerous as those living near shore; *Umbellula thomsoni*, Köll. (Pl. vi., Fig. 3), was found at a depth of 2,125 fathoms, and *U. leptocaulis*, Köll., at 2,440 fathoms, while several other species were found at depths exceeding 1,000 fathoms.

Among the **Alcyonacea**, owing to their being for the most part shallow-water forms, the species found were not very numerous, but some extremely interesting additions were made to the Siphonogorginæ, a group only described by Kölliker in 1874. The researches of Moseley on *Heliopora coerulea* and *Sarcophyton lobatum*, have already received due appreciation from Professor Hickson. The species of the genus *Spongodes* collected numbered twenty-two, of which eighteen were new; four new species of *Siphonogorgia* are described, while the new genera *Paranephthya*, *Scleronephthya* and *Chironephthya* are established for forms nearly related to this genus of Kölliker.

Perhaps the more remarkable species occurred among the **Gorgonacea**, an immense number of new genera and species being described, of which only the most remarkable can be referred to. *Callozostron mirabilis* was taken from a depth of 1,675 feet, and at the most southerly point attained during the cruise; the mass has the appearance of a large annelid worm, over three-fourths of the surface of which the beautiful primnoid polypes are attached; several species of the genera *Strophogorgia* and *Dasygorgia* are described. Numerous additions are made to the Isidæ, and one *Bathygorgia profunda* was dredged from a depth of 2,300 fathoms between Yokohama and the Sandwich Islands. Many new species of the genera *Stenella* and *Thouarella* were found. *Primnoides sertularoides* dredged off Prince Edward Island constitutes a peculiar type among the Primnoidæ. Several new genera of Muriceidæ, with numerous species, were found among the Gorgonidæ: two merit particular mention, *Platycaulos danielsseni* from shallow water at Banda, and *Callistephanus koreni* from a depth of 420 fathoms off the Island of Ascension. The genus *Scirpearella* is made for four new species from the Pacific. Among the Briareidæ, *Keroeides koreni*, is described as a new genus and species from Japan. Among the Melitodidæ many new species of *Melitodes* and *Parisis* are described.

From even such a hasty glance at the general results of these reports it will be seen that most important contributions to our knowledge of the structure and affinities of the Alcyonaria were made by Moseley, while our knowledge of the existing species has been extensively added to.

E. PERCEVAL WRIGHT.

The **Antipatharia** collected by the "Challenger" were fairly numerous, and formed the subject of a really brilliant memoir by the late George Brook. Before the appearance of this volume, the zoology of this group of zoantharians was in hopeless tangle, and it was practically impossible to obtain a satisfactory determination of any common species. Brook succeeded admirably in putting the group in order, and his monograph will doubtless serve as the standard work of reference for many years to come. But, apart from the value of this report to the systematic zoologist, the interest of the purely morphological results is undoubtedly very great. The occurrence of an interesting form of dimorphism in certain genera, and the presence of branched retractile tentacles in the new genus *Dendrobrachia* (the type of a new family), are two of the most important points which Brook's brilliant monograph described for the first time.

S. J. HICKSON.

The **Actiniaria.**—As the brothers Hertwig, in the first of their "Studies on the Theory of Germinal Layers," had written an exhaustive treatise upon the structure of sea-anemones, it was natural that the "Challenger" material should go to one of them. The report was published in vol. vi., but a supplement appeared in vol. xxvi. As the beautiful Naples monograph of Andres appeared before the supplement was written, R. Hertwig had the opportunity to discuss the scheme of classification and the systematic criteria adopted by that naturalist, and to suggest a scheme of classification of the whole group that later research has done little to modify.

Undoubtedly the most interesting individual anemones obtained by the "Challenger," were the forms called Corallimorphidæ by Moseley. In these, several features, usually present in anemones, are replaced by features more characteristic of corals. The tentacles are arranged in radial rows, so that several of them open into the same radial cavity; the disk is stiff and leathery, and has no sphincter muscle by which it may be drawn up like a bag closed by a string over the retracted tentacles; the nematocysts are peculiarly large. From examination of these and of some other peculiar forms, Hertwig reached the conclusion that the old distinction between the corals or sclerodermatous anemones, and the soft-skinned, or true anemones, is not morphological, and he inferred that as knowledge of the soft parts of the Sclerodermata is obtained they will gradually be distributed among the different groups of anemones.

The anemones he divided into six main groups, well-marked off by important structural features. These are the Edwardsiæ, Ceriantheæ, Zoantheæ, Paractiniæ, Monauleæ, and Hexactiniæ. The last group contains by far the largest number of forms.

In the hexactinians there is a great dichotomy between those like the Corallimorphidæ, with double or multiple wreaths of tentacles, and those in which the tentacles form a single wreath. The former group is the less known, and to it probably belong a number of the stinging anemones of tropical seas, the anatomy of which is imperfectly known. Hertwig showed that the old distinction between anemones with retractile, and anemones with non-retractile tentacles, should be replaced by distinctions based on the presence or absence and the character of the sphincter muscle.

The material at Hertwig's disposal was neither large enough nor sufficiently well-preserved to complete the working out of the group, but there is no question but that he has laid the foundation for future investigation. With his reports and the monograph of Andres, which however, deals chiefly with external characters, those who have an opportunity of studying actinians will find the way prepared for most interesting and valuable investigations.

P. Chalmers Mitchell.

In the group of the **Hydroidea** no very important results were obtained. A few interesting new genera were found, and some remarkable points in geographical distribution referred to; but the collection was not a large one, and the results obtained from its examination present no features of special interest. The Hydromedusæ and Scyphomedusæ, however, were the occasion of very beautiful reports from the pen and pencil of Professor Haeckel, to whom we are once more indebted for the following note:—

The report on the **Deep-Sea Medusæ** describes and figures (in thirty-two plates) only eighteen new forms, and among these about one-half may not be true inhabitants of the deep sea, but captured accidentally during the hauling in of the net. But of the other half, a part are certainly true deep-sea Medusæ, characterised by a quite peculiar organisation, viz., among the Craspedotæ (or Hydromedusæ), the Pertyllidæ; and among the Acraspedæ (or Scyphomedusæ), the Periphyllidæ (Pl. vii., Fig. 3), and the Atollidæ. As a general introduction to this report is given a short sketch of the comparative morphology of the Medusæ, based upon investigations of these beautiful Plankton-animals which I had carried on for twenty-five years.

The report on the **Siphonophoræ**, with its fifty plates, forms a complete though short monograph. Since in my numerous voyages during thirty years I had paid special attention to these most interesting pelagic Hydrozoa, I was prepared to elaborate the materials of the "Challenger," of which no naturalist to the Expedition had made a special study. Combining the results of this examination with my own observations made on living animals, I was able to fill up the numerous gaps between the older descriptions, to elucidate many errors, and to give a more complete and consistent idea of the whole organisation than was formerly possible. Among the new Siphonophoræ discovered by the "Challenger," special interest attaches to the Auronectidæ (with the two families Stephalidæ and Rhodalidæ), which constitute a new order of this class, adapted to deep-sea life in a very remarkable manner.

ERNST HAECKEL.

ECHINODERMA.

Crinoidea.—In connection with the "Challenger" Expedition the Stalked Crinoids have a special importance. For it was the discovery of *Rhizocrinus*, in 1864, by G. O. Sars, and its great interest as resembling extinct forms, which, through the intervention of Dr. W. B. Carpenter and Sir Wyville Thomson, led to the cruise of H.M.S. "Lightning," in 1868. The results of this cruise, notably among Echinoderma, were so remarkable, that it was immediately followed by the expeditions of the "Porcupine," and eventually by the great voyage we now commemorate. It was, moreover, these animals which the original head of the scientific staff wished to take under his particular care, regarding them as "the most remarkable of all the deep-sea groups, both on account of their extreme rarity and of the special interest of their palæontological relations." Formerly regarded as a group "on the verge of extinction," and as pre-eminently abyssal, the Stalked Crinoids have been proved by the dredge of the "Challenger" (nor must we forget that of the U.S. C.S. "Blake"), to be as widely distributed in depth as almost any other group (50 to 3,200 fathoms), while their numbers, in individuals if not in species, show scarcely any decrease from those of Jurassic and Cretaceous seas. Before 1869 only three genera, including five species, of Stalked Crinoids were known. The "Porcupine" added one genus and three species, and the "Challenger" added two genera and twenty species, which, with a species from the "Blake," brought the number up to the six genera and twenty-eight species discussed in P. H. Carpenter's Report.

If present seas compare unfavourably with those of Palæozoic periods in the number of species of Stalked Crinoids, they at least rival them when the Unstalked Crinoids are taken into account. Carpenter's second volume considers six genera collected by the "Challenger," of which two were new, and 180 species, of which 110, including 88 new forms, were dredged by the "Challenger." A less conscientious or less learned worker would have vastly increased the number; Carpenter himself at first estimated them as over 400.

The new genera discovered were of profound interest. Among stalked forms: *Bathycrinus* (Pl. viii., Fig. 1), with fused basals and remarkable arrangement of axial nerves; *Hyocrinus* (Pl. viii., Fig. 2), singularly archaic in its lofty basals and massive orals, and somewhat resembling certain Silurian crinoids in its lengthy pinnules; *Metacrinus*, with more brachials below the first main axillary than had been seen for many a geological period. Among unstalked forms: *Promachocrinus* (Pl. viii., Fig. 3) with twice as many radials as we were used to; *Thaumatocrinus* (Pl. viii., Fig. 4), that wonderful creature from the Southern Ocean, reminiscent of the Taxocrinidæ in its anal process (*a a*), of the Rhodocrinidæ in its interradials (*i*), and of the Larviformia in its orals, yet all the time with a centrodorsal (*cd*) like any *Antedon*.[1]

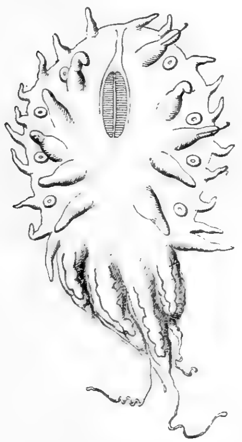

FIG. 6.—*Myzostoma quadrifilum*; parasitic on *Antedon bidentata*; from ventral surface; × 4 diam.

In distribution we note how the widest range, both geographical and bathymetrical, is possessed by those forms that we have reason to regard as geologically older or morphologically simpler, though so far as present knowledge goes, it does not appear that a wide range in depth is always correlated with wide horizontal distribution.

Such increase to our knowledge would have resulted from the voyage of the "Challenger," to whomsoever the collections had been entrusted. But the studies of Carpenter revealed to us far more. It was not in the region of histology that much was gleaned, for the specimens had unfortunately not been preserved to that end, and had moreover been many years in spirit before they reached

[1] Mention may here be made of the parasites of the crinoids, *Myzostoma* and *Stelechopus*, which have induced the formation of plated swellings on the exterior of recent and fossil forms. Von Graff, by his study of the "Challenger" specimens, threw great light on the structure and affinities of this obscure group, which the discovery of a setiferous larva now causes us to place among the Chætopoda. (Fig. 6.)

Carpenter. It was, first, in the enlightened comparison with extinct crinoids, in the elucidation of many palæontological problems, and in the true explanation of what to some might seem morphological anomalies. Secondly, it was in the foundation of an exact terminology, and the establishment of true systematic characters: the multitude of unstalked crinoids, which might have confused a less patient worker, enabled Carpenter to formulate certain laws with regard to the branching of the arms and the mode of union of the brachials, to adapt and improve the ingenious method of formulation employed by Bell, and finally, to sort the various species into ten groups for *Antedon* and eight for *Actinometra*, which have been of the greatest assistance to subsequent workers. Each fresh step that I take into the depths of my own ignorance enables me the better to appreciate the learning of my dead friend, and as I rise once more from the perusal of these magnificent volumes I feel that not the least result of the "Challenger" Expedition was the field it afforded to Herbert Carpenter for the exercise of his marvellous industry and clear insight.

The **Echinoidea**, though still abundant in both individuals, species, and genera, are, like the crinoids, of great palæontological importance, and it is fortunate that they, too, were placed in the hands of a zoologist who could illumine the study of both recent and fossil forms by his own knowledge in both departments.

When Professor Alexander Agassiz wrote his report, 297 recent species were known, of which forty-nine were due to the "Challenger." One-third of these species had been discovered since deep-sea dredging began, to which third the "Challenger" contributed more than a half, also adding fifteen new genera. Moreover, seven genera, previously known only from fossils, were found in the deep sea. In his "Revision of the Echini," Agassiz had subdivided the recent faunæ of sea-urchins into six realms—Atlantic, Circumpolar, Australian, Antarctic, Pacific, and American. The knowledge of distribution gained by the "Challenger" caused these subdivisions to lose some of their significance, but enhanced the importance of the bathymetrical zones, especially the Littoral, Continental, and Abyssal regions, on which Agassiz had already laid stress. It is not, however, the pressure varying with depth that appears the important factor, but rather the gradual spreading of life from the shore to the abyss; and so we find that those genera which extend from the Littoral to the Abyssal region are those which date back to the Cretaceous period, that those with more restricted range are not older than the Tertiary, while those which extend only slightly beyond the Littoral range are found only in the more recent Tertiary periods. A similar result was seen to follow in the crinoids. In the Littoral region temperature has some influence in separating the diverse faunæ, not, however, by its highest, but by its lowest limits.

The knowledge gained from the deep-sea forms has also caused some changes in the classification of the urchins. Though Agassiz retains the Palechinoidea as a sub-order, he points out that it can no longer be contrasted with all other types of Echinoidea. Carpenter in his reports, it will be remembered, emphasised the distinction between Palæocrinoids and Neocrinoids; and in that case it was reserved for palæontologists to show that such a division could not be maintained.

Most important among deep-sea urchins is the elongate *Pourtalesia* (Pl. ix., Fig. 3), first found by Count Pourtalès between Key West and Havana, and the subject of Lovén's classical study. To the family containing this and other strange shapes, twelve new species were added by the "Challenger." "It was" says Dr. J. W. Gregory, "the close resemblance of some of these to the Cretaceous Ananchytidæ that led to the well-known and oft refuted generalisation that we are still living in the age of the Chalk." Among these the genus *Cystechinus* with its thin flexible test (Pl. ix., Fig. 2) is of special interest, as presenting in the structure of its plates a surprising similarity to such Palæozoic fossils as *Palæechinus:* this genus was not a known fossil till Gregory described *Cystechinus crassus* from the Pliocene bed of Barbados. Here also are placed the slipper-shaped *Echinocrepis*, and the *Galerites*-like *Urechinus*. These and other deep-sea Spatangoids resemble the fossil, but differ from nearly all other recent Spatangoids, in the absence or slight development of the fascioles. "Interesting from an embryological point of view," says Agassiz, "are such novel and strange forms as *Aërope* (Pl. ix., Fig. 1) and *Aceste*, which have assumed a facies absolutely identical with that passed through by the young of the *Brissina* of to-day. In these two genera the odd anterior ambulacrum is immensely developed, its suckers are of a gigantic size, entirely out of proportion to the rudimentary ones of the paired ambulacra."

It was the dredgers on the "Porcupine" who were the first to be startled by the worm-like movements of the living Echinothuridæ, urchins whose flexible tests with imbricating plates were already known as Chalk fossils. To our knowledge of this family much was added by the "Challenger." The young of the group and such species as *Asthenosoma gracile*, *Phormosoma asterias*, and *P. rigidum* show that the lapping of the plates and the distinction between the actinal and abactinal surfaces are features of gradual development, and render it difficult to separate this family from the Diadematidæ. Some species of the family present peculiar modifications of the spines. Sometimes baggy envelopes with an irritating fluid surround the sharp spines, and add a numbing effect to their painful wounds. Sometimes the spines end in knobs or in broad conical shoes, as in *Phormosoma hoplacantha;* these serve as pattens to raise the animal from the ground. The Arbaciadæ have a similar cap on their spines, and in *Coelopleurus* it was shown by "Challenger" specimens to be developed to four or five times the length of the spine proper. It is suggested by Agassiz that "the immense triangular and curved spines thus formed served to raise the test, as it were on stilts, and enabled the sea-urchin to move with considerable rapidity."

Among other interesting discoveries may be mentioned *Porocidaris elegans*, with its curved actinal spines and its long, smooth, primary spines; and *Salenia hastigera*, the fourth recent species of a genus well known in the Jurassic and Cretaceous rocks, and always held of great morphological importance owing to the large size of the plates in its apical system. F. A. BATHER.

The collection of **Asteroidea** has been stated to be one of the most important made during the voyage of the "Challenger"; it was unquestionably the most important contribution to this group of animals that had ever been made. Representatives were obtained of more than three-fourths (77·5 per cent.) of the previously known types of starfishes; and, in addition to these, the collection contained 184 new species and twelve new varieties, which furnished the types of thirty-four new genera and four new sub-genera (five of the genera and two sub-genera being, however, based on types of which one or more representatives had been previously known).

The special interest of the collection may be said to centre in the large number of forms obtained from the Abyssal zone, which has practically opened a new chapter in the history of the Asteroidea. The archaic characters of many of these are highly remarkable, and throw important light not only on the relationship of numerous existing forms and upon the classification of the group as a whole, but upon the systematic position of many of the extinct members of the class.

One hundred and nine species and varieties were obtained from the Abyssal zone (*i.e.*, from depths greater than 500 fathoms), all except four of which were discovered by the "Challenger." These represented thirty-five genera, all but sixteen of which were discovered by the "Challenger." Twenty-six genera of starfishes were found living in depths greater than 1,000 fathoms, and all but eight of these were discovered by the "Challenger."

The Abyssal zone has furnished the following new genera:—*Pararchaster*, *Dytaster*, *Lonchotaster*, and *Aphroditaster*, in the Archasteridæ. *Porcellanaster*, *Styracaster*, *Hyphalaster*, and *Thoracaster*, constituting the Porcellanasteridæ, a family wholly due to the "Challenger." *Phoxaster*, in the Astropectinidæ. *Chitonaster*, *Nymphaster*, and *Paragonaster*, in the Pentagonasteridæ. *Cnemidaster*, in the Zoroasteridæ, and *Neomorphaster*, in the Stichasteridæ. *Marsipaster*, *Benthaster*, and *Pythonaster*, in the Pterasteridæ—the latter being, perhaps, one of the most remarkable types obtained during the expedition (Pl. x., Fig. 2). To the Brisingidæ the "Challenger" added a number of species, together with the new genus *Colpaster*.

By the discovery of this large series of forms, living under conditions of comparative isolation in abyssal depths, much light has been thrown upon the range and character of the morphological plasticity of many genera, as well as upon the probable archaic characters of a number of forms previously known only from shallow water.

Several novel points of structure are met with among deep-dwelling Asterids; but mention can only be made here of two or three. For instance, the Porcellanasteridæ, in addition to their archaic form, are remarkable for the presence of "cribriform organs,"—peculiar structures associated with the marginal plates, which probably serve as percolators (Pl. x., Fig. 3). Many of the members of this family possess a more or less elongate, epiproctal, tubular prolongation; and "segmental pits and papillæ"—organs whose functions are as yet unknown—occur in some forms.

The Pterasteridæ, which are now found to possess a world-wide distribution in deep water, are remarkable for the dorsal nidamental chamber in which the young are kept for a period, as in a marsupium (Pl. x., Fig. 1). Direct development is thus fostered, and the intervention of a locomotory pseudembryo avoided. A number of other Asterids belonging to different families have been discovered, in which the same result is attained by different means, and not only in starfishes but in other groups of the Echinodermata, *e.g.*, Holothurioidea, Echinoidea (see *Hemiaster cavernosus*, Pl. ix., Fig. 4), Ophiuroidea. The prevalence of forms in southern latitudes presenting this mode of development has been noticed as remarkable; it is probable, however, that it will be found on further research to be more widely distributed than has hitherto been suspected.

The abyssal Asterid-fauna brought to light by the "Challenger" is not the only interesting part of the collection. Many valuable additions have also been made to the fauna of the Littoral and Continental zones; and some of these increase our knowledge of the relationship of previously known deep-water forms, and add greatly to the solidarity of the group. Under this category may be mentioned the new genus, *Pholidaster*, which is perhaps the shallow-water representative of *Zoroaster;* and the interesting *Peribolaster*, which in like manner recalls, and is structurally related to, the abyssal *Korethraster*. *Pseudarchaster* is an interesting annectant genus between the Archasteridæ and Pentagonasteridæ; and not less important are the genera *Leptogonaster*, *Tarsaster*, *Rhipidaster*, *Perknaster*, and a large number of specific forms belonging to genera previously known.

It is needless to say that the knowledge of the geographical distribution of types has been largely extended.

W. Percy Sladen.

No better account of the **Ophiuroidea** collected by the "Challenger" can be desired than that furnished to the *Narrative* by Mr. Theodore Lyman, after the completion of his Report:—

"In no group, perhaps, was our knowledge more extended by the explorations of the "Challenger" than in that of the Ophiuroidea. The number of known living species was increased from 380 to about 550, or nearly by one half, while the corresponding increase of novel groups is indicated by the addition of twenty genera. By far the greater number of new species are of the deep-sea fauna; that is to say, they occur below the 100 fathom line, so that this Expedition has furnished the first opportunity of comparing the littoral and the deep faunæ over a wide extent of the oceans of the world. The result is that these Echinoderms are found to be animals which live very much in defiance of temperature, light, and water pressure. Something other than environment has determined their growth; or rather, their growth is not affected by an important part of their environment. To be sure there are some genera which are confined to the profound region of cold, darkness, and crushing weight; such are *Ophiotrochus*, *Ophioplinthus*, and *Ophiernus;* but there are others, for example *Amphiura* and *Ophiacantha*, which are found from the littoral zone down to the lowest points reached by the dredge. In the different zones these genera may present modifications; for instance, the *Amphiuræ*, below 1,000 fathoms, often have more numerous mouth papillæ, and the corresponding *Ophioglyphæ* usually have swollen arm-plates and a microscopically tuberculous surface. Such structural features, however, plainly have no connection with the conditions of life, nor have they any relation to the survival of specially favoured forms. From a depth of over 1,500 fathoms are found the strongly armoured *Ophiomusium pulchellum* (Pl. xi., fig. 2), the delicate *Amphilepis*, and the *Ophiomitra chelys* (Pl. xi., fig. 1), with its thorny spines and soft disk. At that great depth the peculiar conditions, apparently so unfavourable to a rich and varied growth, have not checked the development of widely differing forms.

"While, however, the Ophiuroidea yield little to the dictation of light, heat, or water pressure, they show well-marked laws of growth. Certain genera take the lead, like the larger clans of a barbarous nation. The collections of the 'Challenger,' when combined with those of the 'Blake,' show that the four genera *Ophioglypha*, *Amphiura*, *Ophiacantha*, and *Ophiothrix* contain more than two-fifths of the known species. There is a tendency also to elaboration and variety in structure. The naked and embryonic genera, like *Ophiomyxa* and *Ophiogeron*, have few representatives; while the finely constructed *Ophioglypha* has many species, and even the highest group, composed of the closely allied *Ophiura*, *Pectinura*, and *Ophiopeza*, is pretty strong in numbers.

"The dredgings of the 'Challenger' have further taught us that we must not look exclusively in the abysses for surprising shapes, or for those that connect us closely with geological times. If the singular *Ophiotholia* must be sought in 1,800 fathoms, its relative *Ophiohelus* may be found in less than 100 fathoms; and if *Ophiomastus* from the deep sea brings to mind the extinct *Aspidura*, *Pectinura* of the littoral zone recalls the so-called *Ophiura* of the Oolite. Nor must we forget that the extraordinary *Astrophiura*, apparently intermediate between the Brittlestars and Starfishes, lives in shallow water."

Before the "Challenger" Expedition our knowledge of the **Holothurians** was limited almost exclusively to littoral forms. By the Expedition our acquaintance with these was greatly increased, and an entirely novel fauna of the abyss discovered. The deep-sea

Holothurians are derived from two sources. Those that have comparatively recently migrated from shallower waters, even to depths of 2,900 fathoms, and that, like the *Cucumariæ*, still resemble their littoral ancestors, are few both in species and individuals. The great majority are Elasipoda, which must have originated long ago from a type very different to the present shallow-water fauna. From the three Elasipoda previously known, and all from the N. Atlantic and the Arctic Sea, the "Challenger" raised the number to fifty-two species, divided into nineteen genera, which were nearly all found at depths greater than 1,000 fathoms, and had a universal distribution, some species ranging almost from pole to pole. The answer to the question how our knowledge of the Holothurians was increased by the "Challenger," will, therefore, largely consist of a summary of elasipodan peculiarities.

The differentiation of an upper and lower surface, producing a bilateral symmetry, which may be seen in some of the ordinary Dendrochirotæ and Aspidochirotæ, is in the Elasipoda carried to a strange extreme, and is accompanied by an unusual symmetry in the arrangement of the pedicels and processes (Fig. 7). The ambulacral

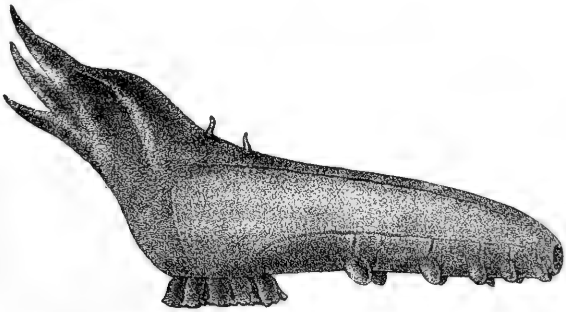

Fig. 7.—*Peniagone wyvillei*, Théel; 2,425 fms.; nat. size.

appendages of the under surface alone are intended for locomotion, these being particularly large in the typical Elasipoda, and arranged in a single row on each side of the body, forming distinct pairs of legs. They tend to appear in fixed places and in a fixed number, often a small one, in every species of the more typical Elasipoda. They usually lack a terminal plate, sometimes even a sucking disc; but they are stumpy and often have a firm external skeleton. They are probably used, not as the tube-feet of other echinoderms, but as the limbs of more highly organised animals, to move and to dig in the soft bottom-ooze. The appendages of the upper surfaces also tend to be fixed in position and definite in number; and their large nerve-supply indicates that they serve as organs of touch. The tentacles form a disc around the mouth, and as the animals move along the bottom of the ocean, help to fill the alimentary canal with the ooze, from which such nutriment as it contains is extracted. There is no trace of respiratory trees. Auditory organs, in the shape of small sacs containing otoliths, are often abundantly developed, but there are no eyes. The preceding characters appear to be those in which the Elasipoda have been modified for an abyssal existence, and they show that this family has had no connection with the others, at all events with the Synaptidæ, Molpadidæ or Dendrochirotæ, since a remote period.

The following characters appear to have been transmitted without change from their primitive ancestors. The calcareous deposits, both in the perisome and in the spicular ring surrounding the gullet, singularly resemble those of larval forms. The water-vascular system, as in the larvæ only of other holothurians, but as in the adults of other classes of Echinoderma, is often in persistent communication with the exterior, and that, too, not only by one pore, but sometimes by a number of pores closely crowded together so as to form a kind of external madreporic tubercle.

Despite the archaic and distinctive characters of the Elasipoda, one of their families, the Psychropotidæ, closely resembles some of the Aspidochirotæ, such as *Stichopus*, and especially *Pælopatides*—a genus first found by the "Challenger"; and this suggests that Aspidochirotæ and Elasipoda sprang from a common branch. Thus confirmation is lent to the view that the ancestors of the Holothurians were pedate, with an open stone-canal and a well-developed ambulacral system.

Considering the habitat of the Elasipoda, it can hardly be supposed that they undergo development with metamorphosis through a free larval stage. That direct development is possible, was shown by the interesting observations made during the "Challenger" Expedition on the development of some shallow-water Holothurians, viz., *Cladodactyla crocea*, from Stanley Harbour, and *Psolus ephippifer*, from Heard Island. In the females of the former the young were closely packed and adhering to the dorsal pedicels, while in the latter Pl. x., Fig. 4) the embryos were developed in a kind of marsupium formed by the plates of the upper surface. There is little doubt that the eggs are impregnated in the ovary, and that the free larval stage is omitted.

HJALMAR THÉEL.

ANNELIDA AND NEMERTEA.

The collection of **Annelida** made by the "Challenger" was by far the largest hitherto brought together as regards both individuals and species, no less than 330 different forms having been procured, and the majority, viz., about 220, were new to science. In comparison, the collection made by the American ship "Blake" contained only 102, and the extensive Philippine series of Semper about 160. Though no new family had to be constituted, yet in every one new species, and in many new genera, occur—some of them of a remarkable character. Further, this fine collection showed that the general classification adopted by Malmgren, the main features of which had been tested by anatomical inquiry, was fairly satisfactory, though the genera may require reduction. No links connecting the Annelida to other groups were found, so that the present boundaries remain. Into all the novelties it is impossible to enter, but such striking facts as the sexual differences of certain Polynoidæ, the curious modification that takes place in the ventral division of the foot in others—reducing the ventral bristles to one, and the further addition to our knowledge of commensal forms, are worthy of mention. Our knowledge of the visual organs of the Annelida was extended in a noteworthy manner, especially by the discovery of large complex eyes in the Phyllodocidæ, such a condition having hitherto been known only in the Alciopidæ. Ramose types of marine annelids, again, were unknown till the "Challenger" dredged a hexactinellid sponge off the Philippines containing a complexly-branched *Syllis*, an animal, indeed, which had a furor for budding and extending into all the ramifications of the canal-system of the sponge. A single example thus takes the place of a colony, and the reproductive elements are useful chiefly for spreading the species on fresh sites. Remarkable members of the Chloræmidæ from the abysses of the Atlantic and Pacific, *e.g.*, *Trophonia wyvillei* and *Buskiella*, show that closely allied forms range from tide-marks to great depths. The tubes of many of the sedentary forms were no less striking than the animals themselves—for the beauty and ingenuity of their formation.

The Expedition showed that some species were cosmopolitan. A large number occurred in the North Atlantic, and did not range to other areas, yet this may be due to the more or less unexplored condition of these areas. Thus the Amphinomidæ (with a single exception) are absent from the north-east part of the area, while they abound in the south-western; while the Euphrosynidæ appear between tide-marks in the southern parts, but are limited to the deeper water in the northern. The centres for specimens in the South Atlantic were Brazil and the Cape, and the peculiar types belonged chiefly to the Polynoidæ and Terebellidæ, the latter especially abounding in the mud of Kerguelen in the South-Indian area. The Australian region had for the most part unique types, comparatively few of which ranged into other areas. The Philippine or Japanese region was specially rich in novelties. The Expedition, further, emphasised the fact that in the warmer areas the Amphinomidæ, the Eunicidæ and the Alciopidæ were specially abundant, and that the distribution of most of the families was world-wide, *e.g.*, the Aphroditidæ of which one genus, *Lætmonice*, occurs in the deeps of the great oceans and ranges also to the British Isles.

The greater number of species appear to frequent shallow water (probably because this had been most effectively worked), yet annelids are found in the deepest dredgings, such as 2,500 and 3,125 fathoms. Moreover, the genera which occur there are well known; and for this reason it is probable that further exploration will enlarge the area of the new genera. Those procured from the profound abysses are mainly tube-dwellers, and thus are more or less protected, though at the same time this fact renders their presence in the trawl or dredge more frequent. The consideration of the annelidan inhabitants of the abysses of the Pacific and the Atlantic, affords no countenance to the view that primitive types have been gradually pressed by the more prolific and hardier shallow-water forms deeper and deeper into the ocean.

Again, the food of these deep-sea forms demonstrates that many of the lower organisms, such as Foraminifera, Radiolaria, and Infusoria dwell at the bottom, and are devoured in the living condition, a fact which at once disposes of the view that nourishment is absent there. The deepest abysses of the ocean are inhabited by Annelida, and thus, food for fishes especially is to be found. Moreover, in regard to development, the same series of phenomena appear to occur in the benthal types as in those of shallow water, and in those frequenting tropical oceans as well as those amidst the polar ice.

In the **Nemertea** collected by the "Challenger," which I had glanced at before handing over to my distinguished friend, Professor Hubrecht, it was found that no change was required to be made in the classification adopted by the reporter (Professor Hubrecht), which, after all, by the aid of new terms, only rings changes on that founded on anatomical features, and clearly set forth in the work for the Ray Society in 1873. The latter classification remains as satisfactory now as formerly, though, it is true, its quiet terms do not appeal to theory. Amongst the striking discoveries in this group—made by the lamented Moseley—is *Pelagonemertes* (Pl. xii., Fig. 1), a pelagic form, figured as a mollusc by former travellers, which falls under the sub-order Anopla and the family Amphiporidæ, even its branched alimentary canal being similar to that of *Nemertes gracilis*. Two important new genera were also discovered, viz., *Carinina* and *Eupolia*, the latter placed under a special family. This valuable collection enabled Professor Hubrecht to enrich his report by an elaborate anatomical appendix, in which the additions to our knowledge were incorporated with the leading features already ascertained.

W. C. McIntosh.

Arthropoda.

In the zoology of the "Challenger" the reports on **Crustacea** occupy between a fourth and a fifth part of the text, and more than a fourth part of the 2,536 plates by which that text is illustrated. They describe nearly a thousand new species, besides throwing a fresh light upon a multitude of old ones. That carcinology should have claimed so predominating a share in the "Challenger" record is, for more than one reason, remarkable. No one of the naturalists accompanying the expedition was a specialist in this subject. It is not one which excites any very general interest in this country. Its importance in the field of faunistic discovery was, perhaps, little foreseen. The extent of the collected material embraced within its province was not readily to be appreciated by any but those who had been engaged in collecting it. One ambitious and eminent worker volunteered to describe the whole, unweeting, that in many years of toil and moil, not without storm and stress, he should scarcely accomplish his allotted part. In truth, it was not wholly unreasonable to suppose that the Crustacea of the Expedition would, collectively, form a manageable group in the hands of a veteran expert. For, primarily, the voyage was made with the object of exploring the depths of the sea, whereas crustaceans are more at home in the shallows. Writing on the Ostracoda, Dr. Brady says, "The work of the 'Challenger' gave us no collections whatever from between tide-marks, nor from the laminarian zone, and these two zones usually swarm with microscopic life." Similarly, of another group, Dr. Hoek says, "As the exploration of the coasts of islands and continents was of secondary importance during the cruise of H.M.S. 'Challenger,' we need not wonder that the Cirripedia of these regions are badly represented in the collections made during the voyage. Only occasionally were specimens collected in the neighbourhood of the coasts." The Stomatopoda, as Professor Brooks observes, are restricted to shallow waters, or to waters comparatively shallow. Of the Anomura, Dr. Henderson remarks, that in the collection a few of the shallow-water groups are but poorly represented, "while many well-known and widely-distributed species are conspicuous by their absence." Above all, perhaps, it might be said of the Isopoda and Amphipoda, that they were out of the direct line of investigation, since so many of them frequent the land and fresh-water streams and lakes, burrow in the sand and mud of the shore, hide away in seaweed, under stones, in the crannies of rocks and rock-pools, in estuaries, in inconsiderable depths of the open sea, or in the narrow strips of shore rarely uncovered at the lowest ebb of a spring-tide. Yet, in both these groups, our knowledge has been wonderfully enriched by the "Challenger" collections.

Only at Kerguelen do the conditions of research seem to have been made decidedly favourable to the gathering of Crustacea, and the results obtained from that melancholy island were really surprising. For here, in a stay of twenty days, were found three new species of Schizopoda, five of Cumacea, seventeen of Isopoda, thirty-seven of Amphipoda, four of Copepoda, and nineteen of Ostracoda. Sixteen new genera were required for these accessions to the fauna of Kerguelen. Heard Island, not far off, yielded several other new forms of interest. But in spite of the large and unexpected acquisitions from these sullen regions, there is reason to believe that their crustacean fauna is still very imperfectly known. Not all the species observed were brought home. Not all that were brought home have yet been determined. Not all the localities most likely to be productive were searched with thoroughness or searched at all. Judging, then, from the general results of the "Challenger" explorations, and from the special result at one spot where the conditions of investigation were exceptionally favourable, it may be inferred that the new forms discovered, though so numerous, were few in comparison with those awaiting discovery. The inference is supported by the great number of species of Crustacea which have been brought to light by subsequent researches, in some cases avowedly or evidently instigated by the successes, or the equally suggestive failures, of the "Challenger" work.

In regard to the distribution, horizontal and bathymetrical, of Crustacea, not only were a large number of facts ascertained, but the problems demanding solution were brought into prominence, so that subsequent expeditions have known both what points needed special attention, and how they needed to be approached.

In regard to the Brachyura, Miers believes the depth of 1,875 fathoms, at which *Ethusa* (*Ethusina*) *challengeri* was taken, to be the greatest that had been recorded for any species of crab, and points out the coincidence that this genus, which supplies the deepest living species of the Brachyura, is also that of which the species "evince the greatest degree of degradation from the Brachyuran type." According to Dr. Henderson, any knowledge of the bathymetrical distribution of the Anomura was almost entirely wanting until furnished by the "Challenger." His *Tylaspis anomala* (Pl. xiii., Fig. 1) was taken at a depth of 2,375 fathoms. His genus *Latreillopsis* is an important link between *Homola* and *Latreillia*, corroborating the view that those genera, at one time widely separated, and very different in general appearance, ought to stand in the same family. About 2,000 specimens of Macrura were examined by Spence Bate, including many strange larval forms, as well as many fine and many remarkable adult species. Some members of this series came from below 3,000 fathoms. The next group was claimed by Spence Bate as belonging to the Macrura. It was, however, separately reported on by Professor G. O. Sars, who writes:—"The collection of Schizopoda procured during the long voyage of H.M.S. "Challenger" has turned out extremely rich and of very special interest, containing, as it does, several most remarkable new types, the examination of which has led to a much fuller comprehension of the morphology of the Schizopoda and their relation to other crustacea than was previously possessed. The various collections, having been made in widely-distant tracts of the ocean, an important contribution to the geographical distribution of species has likewise been acquired." Of the Squillidæ, though the number of adult specimens was small, the collection, according to Professor Brooks, "throws light upon many interesting problems, and furnishes the material for a more exhaustive and satisfactory discussion of the phylogenetic relationships and the natural classification of the various genera and species than has been possible hitherto." Further he remarks that "the collection of pelagic Stomatopod larvæ is very rich, and it has yielded the material for tracing the history of several of the larval types, and also for establishing, in every genus except one, the connection between the adults and their larval types." Of the Cumacea only fifteen species were obtained, but fourteen of them were new. Members of this group can descend to a depth of 2,000 fathoms. At a like depth were found nine species belonging to seven distinct genera of Isopoda. In the Amphipoda the wide range of the Hyperidæ was decisively made patent, these being especially pelagic animals, most of them probably passing a great part of their time at or near the surface, while those which descend to great depths seem capable of coming at least occasionally to the top of the water. Among the Gammaridæ, also, there are some wide-ranging species, since some are common, for example, to Kerguelen and Great Britain; but, however cosmopolitan some forms may be, every new locality explored seems to reveal some gammarids of its own. The "Challenger" collection of Amphipoda has helped to show that, notwithstanding the many striking differences among them (Pl. xii., Figs. 3, 4), they are at present an order as clearly and sharply defined as any in the animal kingdom. All the known species in zoology are either decidedly amphipods or decidedly not amphipods. Time and space, however, are not so poor but what the intermediate forms, alive or dead, may yet be discovered. In contrast to the Amphipoda, which at present are practically unknown to geology, the Phyllocarida have long been limited to palæozoic fossils, with the small exception of the living *Nebalia bipes*. But the "Challenger" Expedition tripled the extant contents of the group by adding two new species and two new genera. Metschnikoff considered *Nebalia* to be a "phyllopodiform decapod," but Sars, after a detailed consideration of the forms at his command, believes that its relationship to other crustaceans will be more correctly expressed by calling it "a copepodiform branchiopod." As for the Copepoda, Dr. John Murray says that they were rarely, if ever, absent from the tow-net gatherings when examined on board ship. That all these gatherings did not come into Dr. Brady's hands is easy to explain. As every collector knows, the most ardent desire for storing specimens is sometimes quenched by the prolific abundance, the obtrusive superabundance, of aquatic life. Little account is made of Crustacea by landsmen because they are so seldom in view. Insects are rare in the ocean. But what insects are on land, that crustaceans are at sea—sometimes remorselessly plentiful.

Thomas R. R. Stebbing.

The above general summary of the results in Crustacea pays regard to the fact that we have been favoured with special notes by the authors of the Reports on Isopoda and Cirripedia, as well as a short account of the Ostracoda by our veteran authority on that group.

In the number of new species and genera, the "Challenger" collection of **Isopoda** excels any yet formed. In certain genera, notably *Arcturus* and *Serolis*, the number of species collected double the existing lists. In the Asellidæ a great number of new shallow-water species were collected round the shores of Kerguelen, while the deep sea yielded numerous interesting forms.

Apart from additions to our faunal lists, the chief facts of interest derived from the study of the "Challenger" Isopoda, concern the modifications induced by life at great depths in the ocean. Many deep-sea animals are totally blind; yet many species found in the deepest hollows of the ocean, appear to have perfectly normal eyes. These discrepancies were partly accounted for by the theory of abyssal light. The histological study of the eyes of certain deep-sea Isopoda, particularly of *Serolis* and *Arcturus*, shows, however, that the appearance of well-developed eyes was often deceptive. Anyone, before having recourse to the microtome, would assert that the deep-sea *Serolis neæra* was as keen-eyed as any species of the genus. Yet sections through the eye show that it is in a condition of degeneration; apart from the faceted cornea there is but little of recognisable eye-structure left. In *S. bromleyana* the eyes are well marked but entirely devoid of pigment; no trace of optic tissue could be found by microscopical investigation. It seems, therefore, as if the external and less important portions of the optic organs were the last to go. Several species of *Arcturus* indicate similar degradation in the eyes; in some the crystalline lens had increased in size, become opaque and lost its clear-cut outline. It appears, therefore, that to explain the occasional persistence of well-developed eyes in this group, there is no need of any theory of abyssal light; it is more likely that the state of preservation of the eyes is an index of the length of time that the species in question has been an inhabitant of the deeper waters. The "Challenger" material also enabled me to describe a new type of eye, confined to the Serolidæ, and to the closely allied Cymothoidæ, and recently found in other species of *Serolis* by Watase.

Modifications due to the scarcity of oxygen at great depths were found in two remarkable new types. In all Isopoda (except certain parasitic forms) the last pair of abdominal appendages are swimming feet, not modified for breathing as are the pairs in front; but in *Anuropus*, a genus of Cymothoidæ, these appendages also entirely resemble the branchial abdominal appendages which lie in front of them. In *Munnopsis pellucida* the skin, instead of being thick and strongly calcified, as is the case with all other Isopoda, is thin and transparent; this, I imagine, would facilitate the absorption of greater quantites of oxygen from the water.

In the deep-sea forms of Isopoda as of other Crustacea, spines are often richly developed. In *Serolis bromleyana* (Pl. xiii., Fig. 2), *S. neæra* and

S. gracilis, the epimera are pulled out into long spines; but this is not the case in the fourth deep-sea *Serolis*, *S. antarctica*. It is, however, in the genus *Arcturus* that this peculiarity is most apparent. *A. glacialis* is almost dangerous to handle from the multitude and sharpness of the spines which deck its body; and other species possess almost equally effective *chevaux-de-frise*.

F. E. BEDDARD.

The definition of the generic and specific characters in the group of small Crustacea known as **Ostracoda**, is very important to naturalists, and the "Challenger" *Report* by so experienced a biologist as Dr. G. S. Brady is, therefore, a most valuable production. The material discussed in this *Report* is arranged as follows:—The Podocopa are represented by the Cypridæ, of which forty-six species placed in eight genera, two of them new, are described; the Darwinulidæ; and the Cytheridæ, which include one hundred and forty-nine species placed in thirteen genera: the Myodocopa are represented by the Cypridinidæ, including seven species in four genera, of which one is new; and a single genus of the Conchoeciadæ, comprising three species: the Cladocopa furnish only a single genus of Polycopidæ, represented by three species: the Platycopa number thirteen species of Cytherellidæ, all placed in one genus. Altogether two hundred and twenty-one species, of which one hundred and forty-four are new, are discussed.

Excepting, of course, the Myodocopa, Ostracoda were found to be living in very limited numbers, both as to species and individuals, at the greatest depths. Below 1,500 fathoms only seventeen species were recognised in thirteen dredgings; and below 50 fathoms, fifty-two species in twenty-three dredgings. Shallow waters, however, proved exceedingly prolific. The geographical, as well as bathymetrical distribution, and the biological history are fully dealt with in this valuable monograph, which has made one more leaf in the vast book of Nature fairly legible and useful for the advancement of knowledge.

T. RUPERT JONES.

The **Cirripedia** of the "Challenger" Expedition formed an extremely interesting collection of about eighty species, of which three-fourths proved new to science. Before then, the existence of Cirripedia in the great depths of the ocean was almost unknown, the species of *Scalpellum* dredged by the "Vöringen," and described by Professor G. O. Sars, being the only recorded instances. Sars met with six species of *Scalpellum* in the North Atlantic; more than forty species of this genus were collected during the cruise of H.M.S. "Challenger"; with one exception they were all new, and contained the largest forms of pedunculated Cirripedia observed up to that time. Equally interesting forms of Cirripedia inhabiting the deep sea are the representatives of the genus *Verruca*—sessile Cirripedia characterised by their unsymmetrical shape, by the "extraordinary unequal development of the two sides of the shell," as Darwin has called it. Six new species of *Verruca* were added to the four previously known. The shape of the deep-sea species of *Verruca* is very curious, and I found it rather difficult to resist the temptation of introducing a new genus in the system for their reception. *Scalpellum* (Pl. xiii., Fig. 3) and *Verruca* are the only genera of Cirripedia observed at depths greater than 1,000 fathoms. *Dichelaspis* ranges down to 1,000 fathoms; the "Challenger" took a new species of this genus at this depth, the depth at which the other species of this genus were taken being unknown. The genus *Balanus*, of which forty-five species are known, occurs from the shore down to 516 fathoms; one of the five new species of this genus collected by the "Challenger" was taken at that depth; another—the beautiful *Balanus corolliformis*—was found to inhabit a depth of 150 fathoms, the other four lived at less considerable depths. *Alepas* and *Poecilasma* have each of them a new species in the "Challenger" collection, living at 410 fathoms, and none of the other known genera of Cirripedia (twenty-eight of the thirty-four enumerated in 1883) was ever observed at a depth greater than 150 fathoms. In all, thirteen genera of Cirripedia are represented in the "Challenger" collections, and most of them by highly characteristic forms. For one of them, *Megalasma striatum*, the creation of a new genus was necessary (Pl. xiii., Fig. 4). It is nearly related to *Poecilasma*, but easily distinguished by the form of the scutum and the width of the carina. Of floating forms of Cirripedia a dozen different species were represented in the "Challenger" collections; most of them were well-known forms, but one of them was a new species of *Chthamalus* taken from the screw of H.M.S. "Challenger," and so really deserving the name of "*Chthamalus challengeri*."

A supplementary report dealt with certain points in the anatomy of the Cirripedia. The curious complemental males of the Cirripedia, the segmental organs, the cement apparatus, Darwin's "true ovaria," the eye of *Lepas*, and the female genital apparatus were treated separately, as so many *capita selecta* of the morphology of these very peculiar forms of animal life.

P. P. C. HOEK.

The grotesque and superficially spider-like creatures included under **Pycnogonida** form, perhaps, one of the most compact and homogeneous groups in the animal kingdom. Their true systematic position, however, has never been accurately determined; and although some embryological evidence has lately been adduced in favour of a possible but certainly remote connection between them and the Arachnida, the difficulties in the way of establishing the exact homology between the seven well-developed cephalothoracic appendages of a pycnogon and the six of a spider or scorpion are so grave, that the only course open to us is to follow Dr. Hoek in regarding the group as equivalent to the Arachnida or Crustacea, but perfectly distinct from both.

Unfortunately, no light was thrown upon the origin and affinities of the Pycnogonida by Dr. Hoek's researches in connection with the species obtained by the "Challenger." But in other respects considerable additions to our knowledge were made. Representatives of thirty-six species, belonging to nine genera, were collected, and of these thirty-three species and three genera had to be described as new. Moreover, a striking fact connected with the bathymetrical range of the genera was discovered, namely, that, with one exception, the genera dredged in deep water were represented also by littoral forms. In a few cases, indeed, specimens of the same species were obtained at very varying depths. For instance, *Nymphon grossipes* at 83 and 540 fathoms, *Colossendeis leptorhynchus* at 400 and 1,600 fathoms, and *Pallenopsis patagonica* at 45 and 175 fathoms. The genus *Oorhynchus* (Pl. xiv., Fig. 1) is the only one that has no representative in shallow water. Lastly, it was observed that the conditions of life in the deep sea have by no means had a dwarfing effect upon these animals. On the contrary, many of the deep-water species attain a size which is never equalled by those near the coast. The largest species procured was *Colossendeis gigas*, a specimen of which spanned nearly 2 feet from toe to toe.

Tracheata and **Malacopoda.**—Since marine biological research was the main object of the cruise of the "Challenger," and collecting excursions on land rarely possible for the naturalists on board, it is easy to understand why the scientific descriptions of the strictly terrestrial forms of life find no place among the formidable array of volumes in which the researches upon the pelagic species are so elaborately set forth. Seeing, nevertheless, that many of the localities visited are islands, isolated and out of the beat of the ordinary run of vessels, and for this reason rarely, if ever, explored by collectors, it is not surprising that many of the species obtained proved to be of considerable zoological importance.

From a morphological point of view, there is no doubt that the most valuable of all the land Arthropods was the genus *Peripatus*, which Professor Moseley came across on the slopes of Table Mountain. The existence of this curious animal, half annelid, half centipede, had been known for many years; but its true position in the animal kingdom had remained up to that time an unsolved problem. The dissection, however, of freshly-killed specimens of the Cape species and a study of some of the stages of its development, enabled this able zoologist to point out once and for all, by means of the discovery of the tracheal nature of its respiratory organs and the appendicular character of its jaws, that it must take rank as the most primitive of Tracheate Arthropoda.

Very interesting, too, was the collection of Centipedes and Millipedes, which, though small in numbers, was relatively rich in rare forms, no fewer than twenty-one species out of the forty-six that were obtained, being previously undescribed. Special mention may be made of the new species of millipede of the genus *Acanthiulus*, a genus previously only known from a single specimen in the Paris Museum, and one which in the spine-armature of its somites calls to mind some of the extinct Carboniferous members of the group. Touching the Myriopod fauna of Bermuda, an interesting point was revealed. This island lies within a stone's throw, so to speak, of the south-eastern coast of North America, and its plants, land-shells, and insects are known to be almost wholly Antillean or Nearctic in their affinities. But while forty per cent. of the Myriopoda are Antillean, none are certainly Nearctic, but there is, on the contrary, a strong and unmistakable infusion from the Mediterranean area of forms which occur also in the Azores and Madeira.

Of the Hexapoda, several new species of Butterflies, including some interesting cases of mimicry, and of flies, beetles, etc., have been described.

R. I. POCOCK.

Pelagic Hemiptera.—Several beetles, flies, and other insects are found on the surface of rock-pools, or under stones between tide-marks. One genus of bugs (*Halobates*) alone among insects, is truly oceanic in habit. The small extent of the field enabled Dr. F. Buchanan White to transcribe all the previous literature on the subject, and to supplement the "Challenger" material by a study of numerous museum specimens. He described eleven species, gave a thorough account of the external structure of the insects, and recorded all known of their habits, development, and distribution.

The species of *Halobates* are small, the largest known being only 6 mm. long (Pl. xiv., Fig. 2). They are entirely wingless, and the abdomen is extremely reduced in size relatively to the thorax, the second and third pairs of legs being inserted close together, near the hinder end of the insect. These limbs are very long and slender, the tibial and tarsal joints of the second pair being provided with a long fringe of hairs. The front legs are shorter and stronger and furnished with claws, by means of which the insect anchors itself to floating substances, which provide it with rest and food. Numbers of *Halobates* may be observed in tropical seas, in calm weather, skimming over the surface of the water; they are to be met with near the shore, and also hundreds of miles from land.

Dr. White regarded *Halobates* as a very archaic type of insect, believing it never to have possessed wings, and to be near the common ancestor, from which it and its freshwater relations (*Gerris*, the Pond-skater, etc.) have descended. This view is, however, controverted by Dr. E. Witlaczil, who has since studied the *Halobates* collected by the "Vettor Pisani" Expedition. He described two additional Italian species (*Wien. Ent. Zeit.*, 1886, pp. 178, 231), and, being able to make microscopic sections of some of the insects, published a short description (*Zool. Anz.*, x., 1877, p. 336) of their internal anatomy. Finding organs normally belonging to the abdomen situated in the thorax, and modifications for an aquatic life carried to the most extreme point, he naturally regards *Halobates* as a most aberrant type of bug.

Dr. F. Dahl has recently described "Die Halobatiden der Plankton Expedition" (Ergebnisse der . . . Plankton Expedition der Humboldt-Stiftung, ii. g., 1893), from the N. Atlantic, separating one specimen as the type of a new species. Other species of *Halobates* have been described by Mr. F. Skuse (*Rec. Austral. Mus.*, i., 1891, p. 174), Dr. E. Bergroth (*Revue d'Ent.*, xii., 1893, p. 204), and the writer of this note (*Sci. Proc. R. Dubl. Soc.*, vii., 1892, p. 144).

Observations on the habits of *Halobates* have been lately published (*Ent. Monthly Mag.*, 2, iv., 1893, pp. 227, 252) by Mr. J. J. Walker, R.N. He notes that while the insects remain on the surface during calm weather, or in a swell without wind, they disappear "with the ripple caused by the slightest breeze." Observing also, that specimens kept in a vessel of sea-water dive on the approach of a foreign body, and swim readily beneath the surface, he concludes that it is their habit to dive into still water whenever the surface is disturbed.

In the "Challenger" *Report*, Dr. White transferred several insects of doubtfully pelagic habit, referred by older authors to *Halobates*, to a new genus *Halobatodes*. Dr. F. Meinert (*Ent. Meddelelser*, i., 1887, p. 140) regards these as individuals of the freshwater genus *Metrocoris*, Mayr, in which the wings have not been developed. Mr. Walker found these insects in harbours and estuaries. They are of considerable interest, as representing a transition between the (usually) winged, freshwater Hydrometridæ and the wingless, oceanic *Halobates*. The ocean is believed to have been the original cradle of all animal life, but its most gigantic inhabitants, the "great whales," and these small and humble insects must be regarded as modified land-animals driven back from the crowded continents to find a home in its waters.

Geo. H. Carpenter.

Mollusca.

As regards the Molluscs, the "Challenger" Expedition has made known a very large number of new marine forms, both genera and species, belonging to the different classes. But, from the point of view of pure zoology, all these forms are not of equal interest. We must, therefore, limit ourselves here to the chief of those whose study has yielded results of morphological importance or led to notable conclusions in phylogeny. From this point of view the following facts may be indicated as the most important :—

1. Among the peculiarities of organisation in abyssal molluscs, in relation to the conditions of their existence, there has been described the disappearance of the cephalic eyes in various Gastropoda (a fair

number of Streptoneura, and a Nudibranch Euthyneur, *Bathydoris*), and of the pallial eyes in the Pectinidæ, at depths exceeding 1,000 fathoms. The study of *Guivillea* has shown how the degeneration of the eyes takes place in the streptoneurous gastropods: the surface of the retina becomes extremely reduced, the pigment has entirely disappeared, and the epithelium of the eyeball has become uniform over almost all its extent.

2. The organisation of a group of Lamellibranchia, supposed to be without gills, has been elucidated. It has been recognised that their gills have been transformed into a muscular septum, whence the name Septibranchia given to these organisms (*Poromya*, *Silenia*, *Cuspidaria*=*Neæra*). Respiration is effected by the internal surface of the mantle in the supra-septal chamber; the water enters therein by paired orifices pierced through the septum, and only opening from without into the chamber; the current of water is produced by the contraction of the septum.

3. The study of the Lamellibranchia has permitted the establishment of a phylogenetic classification based on the structure of the gills, and now more and more adopted. It has also put us in the way of recognising the general hermaphroditism of the Anatinacea (*Lyonsiella*, etc.), and the fact that, among the Mollusca, hermaphroditism is secondary and super-imposed on the female sex.

4. Among the Polyplacophora, the collections of the "Challenger" have given us a good acquaintance with forms that have but few pairs of gills—eight or even six—notably *Leptochiton benthus*, where all the gills are placed, with the smaller ones in front, at the sides of the anus, behind the foot, in a sort of branchial chamber. This fact, combined with others that we know, has led to the opinion that among the Amphineura, which are the most archaic molluscs, there originally existed numerous gills down the whole length of the body; then that, in certain forms, their number has diminished from front to back, only the posterior pairs persisting, and the last of all being the only one that is preserved in other molluscs (Pleurotomariidæ, Fissurellidæ, Haliotidæ, Lamellibranchs, and dibranchiate Cephalopods); in *Nautilus* the last two are preserved.

5. Among the surface organisms, the very numerous "Pteropods" collected have, by the facts of their organisation, enabled us to show that the class Pteropoda must disappear, and that we must, with Souleyet and Boas, place the animals so called in the Opisthobranchia. It has been possible to fix the precise position of the Gymnosomata, which come from the Aplysioidea, and to confirm that of the Thecosomata, which come from the Bulloidea. The special case of torsion recognised in the straight Thecosomata is one of the grounds for believing that the Opisthobranchs—indeed, all the Euthyneura—have undergone an untwisting, contrary to the twisting of the Streptoneura or Prosobranchia, and that they are derived from streptoneurous ancestors.

6. Among the Nudibranchia collected, a Doridian, *Bathydoris* (Pl. xiv., Fig. 3), possesses a respiratory apparatus composed of many separate "branchial" plumes. This structure, which occurs also in the Hexabranchidæ, permits us to affirm that the perianal branchia of the Doridians is formed by the union of many pallial appendages, and in no way corresponds to the ctenidial branchia of other molluscs.

7. Finally, among Cephalopoda (without trespassing on the special notice by Mr. Hoyle), the capture of a *Spirula*, one of the five complete individuals known, has been one of the most precious gains. The study of its structure has shown that this form has no relations with the "Calciphora" (*Sepia*, etc.), or with any Myopsid. *Spirula* is an Oigopsid, and among them the least removed from the parent stock of modern Dibranchiates.

PAUL PELSENEER.

The "Challenger" collection of **Cephalopoda** contained seventy-two species, disposed in thirty genera, of which thirty-two species and four genera were new; it was only found necessary, however, to create one new family (Amphitretidæ). The collection is as remarkable for its deficiencies as for the types represented in it. The rare capture of pelagic forms was probably due to the enormous activity of these animals, which is so great that they can only be captured when the vessel is moving rapidly, a condition unfavourable to the use of the tow-net. A more important means of obtaining them is by the examination of the stomachs of predaceous birds, fish, and cetaceans; one of the most remarkable items in the collection, a large pen referred to *Chiroteuthis*, was taken from the stomach of a shark. Science would be greatly advanced if whalers and those engaged in the capture of sea-fowl would preserve the contents of such stomachs in spirit. It is disappointing that not even a fragment of one of the giant squids was found: the largest specimen was the type of *Cirroteuthis magna*, which is more than a metre long, and is the largest individual of the genus yet obtained. Neither were the expectations fulfilled of those who hoped that forms hitherto known only as fossils would be among the spoils. Moseley tells us that "even to the last every cuttle-fish which came up in our deep-sea net was squeezed to see if it had a Belemnite's bone in its back"; but no such precious discovery was made.

All the specimens of *Sepia*, including ten new species and some previously known only by their shells, were obtained during the cruise from the Eastern coast of Australia, through the Malay Archipelago, to Japan; a confirmation of the idea that the Indo-Pacific region is the metropolis of this genus. Great additions were also made to the already large genera *Octopus* and *Loligo;* but these were of less interest than the unique specimens made the types of new genera, each of which presents some character either entirely novel or important as furnishing connecting links between previously known forms. *Amphitretus* (Pl. xv., Fig. 2), for instance, differs from all other cephalopods in that the mantle is firmly united to the siphon, leaving two openings into the branchial cavity, one on either side, immediately below the eyes. *Japetella* and *Eledônella* are two curious gelatinous and semi-transparent forms, allied to *Bolitæna*. *Bathyteuthis abyssicola* (Pl. xv., Fig. 1) is one of the few cephalopods that really does appear adapted for life at great depths: the small fins are in marked contrast to those of pelagic species, while the small suckers and delicate tentacles are equally little fitted for raptorial purposes; on the other hand, the large circumoral lip seems well-suited for collecting nutritive matters from an oozy bottom. *Promachoteuthis* has a small, round body with very large fins; it comes from the N. Pacific. *Histiopsis*, from the S. Atlantic, is closely related to *Histioteuthis*, *Chiroteuthis*, and *Calliteuthis*.

As regards their distribution, the Cephalopoda seem divisible into Pelagic, Littoral, and Abyssal; and all the species of any one genus, usually belong to the same group. The occasional occurrence of a species in two categories is probably due to the want of complete information. Exact localities and conditions should be carefully noted by future collectors. Meanwhile the "Challenger" collection has confirmed the general statement, that, while pelagic animals belong to but few types, each of which has a comparatively wide area of distribution, littoral forms belong to many species, each of which is confined within narrow limits. Deep-sea forms seem to be even more widely distributed than pelagic ones, owing to the uniformity of the conditions of life, especially temperature. The bathymetrical results are unsatisfactory, as there was no means of determining at what depth the animals found in the dredge or trawl were captured.

W. E. HOYLE.

BRACHIOPODA.

These animals live chiefly on coral-reefs and shallow rocky bottoms; the deep-sea species are small in size, and few both in species and individuals; moreover, they are not easily collected by dredge or trawl. Our knowledge was, therefore, confirmed rather than added to by the "Challenger." As in other groups, abyssal forms are less localised than those that occur in seas of moderate depth. As the three most interesting species brought home by the "Challenger," Davidson who reported on them, quotes the following:—*Terebratulina wyvillei*, the largest species of the genus, dredged in 390 fathoms, off Culebra Island, north-west of St. Thomas, in the West Indies. *Terebratula wyvillei* (Pl. xv., Fig. 3), which occurs over a wide area, at depths from 1,035 to 2,900 fathoms, the greatest depth whence any living brachiopod has been brought up; a small species, with a shell, as in all deep-sea brachiopods, smooth, glassy and semi-transparent. *Discina atlantica* (Pl. xv., Fig. 4), another of the widely spread abyssal forms; the cirri proceeding from the edges of the mantle are of great comparative length, equalling the diameter of the shell. Only a small number of the species brought home are positively known to occur in the upper Tertiaries, and none of the abyssal forms have yet been found in the fossil condition.

F. A. B.

Bryozoa.

The reports by Messrs. Geo. Busk and A. W. Waters added largely to our knowledge of the variety of form in this group, and acquainted us with the delicate and flexible deep-sea species, though only one could be regarded as belonging to a decidedly abyssal family —the Bifaxariadæ. The geographical distribution of the abyssal forms bears no evident relation to the bathymetrical. Still less is light thrown on the fossil species. In fact the chief interest possessed by the Bryozoa of the "Challenger" has now been removed from them by the transference of *Cephalodiscus* to the group next considered.

Hemichordata.

Cephalodiscus may fairly claim to be one of the most novel types which have been made known as the result of the voyage of the "Challenger." This extraordinary animal was dredged in the Straits of Magellan, at a depth of 245 fathoms. No special attention seems to have been paid to it on that occasion, and the first cursory examinations which were afterwards made gave no clue to its real affinities.

The animal (Pl. xv., Fig. 5) measures some 2 mm. in length, and is provided at its anterior end with six pairs of multipinnate tentacular arms. Near the other end the body is produced into a short stalk, from the tip of which buds are produced. These buds break off after reaching a certain stage of development, so that no "colony," in the ordinary zoological use of the term, is produced. The animal is, however, gregarious, and large numbers are found in the cavities of a semi-gelatinous "cœnoecium," which is the product of their joint activity. The analogy of *Rhabdopleura* suggested that the cœnoecium was in large part at least secreted by the "buccal shield" or proboscis.

Although the affinity of *Cephalodiscus* to *Rhabdopleura* was soon recognised, it was first shown in the "Challenger" *Report* that the former animal was unmistakably allied to *Balanoglossus*. No conclusion could have been more unexpected. The two genera are totally unlike at first sight; their internal structure is identical in all essential particulars.

The three main regions of *Balanoglossus*, the proboscis, the collar, and the body proper, are clearly marked in the immature buds (Fig. 8) of *Cephalodiscus*. The divisions of the body-cavity corresponding to these regions are distinct and separate even in the adult animal; and consist, as in *Balanoglossus*, of an unpaired proboscis-cavity (*b.c.*^{1}), and of paired cavities (*b.c.*^{2}, *b.c.*^{3}) belonging to the two succeeding regions. Two of the special peculiarities of *Cephalodiscus* are the position of the anus on the dorsal side, not far from the mouth, and the production of the collar-region into the twelve tentacular arms which have already been alluded to. The proboscis-cavity opens to the exterior by a pair of proboscis-pores, which perforate the nervous system. The collar-cavities communicate with the exterior by a pair of collar-pores, which are situated in the immediate neighbourhood of a pair of gill-slits. The central nervous system is situated in the dorsal region of the collar, and it is outside the basement-membrane of the epidermis. The narrow stalk of the proboscis is strengthened by a tubular notochord (*nch.*) extending forwards from the pharynx.

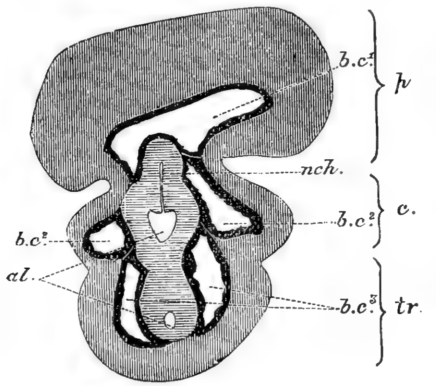

FIG. 8.—*p.* proboscis; *c.* collar; *tr.*, trunk or body; *al.*, alimentary canal.

If the above description is really accurate, there can be little doubt with regard to the affinity of *Cephalodiscus* to *Balanoglossus*, however dissimilar the two animals may at first appear. It is important to notice that confirmation of the account published in the "Challenger" *Report* has appeared from more than one side.

Should *Cephalodiscus* and *Rhabdopleura* be really related to *Balanoglossus*, the presumption is that they have nothing to do with the Bryozoa, a group in which they were temporarily placed. It might have been hoped that the study of **Phoronis** afforded by the "Challenger" material would have had some bearing on this question. But in spite of the anatomical account of *P. buski*, McIntosh, the new species described in the *Report*, and in spite of the more recent and fuller accounts of the anatomy of the genus, published by Benham and Cori, the affinities of *Phoronis* cannot be said to be at all clearly known. It is by no means impossible that this animal is related to *Cephalodiscus;* and some considerations suggesting an affinity between the two animals were brought forward in the "Challenger" *Report*. But the resemblances are too uncertain, and the differences too obvious to place the conclusion on the same level of probability with the conclusion that *Cephalodiscus* is related to *Balanoglossus*. It cannot be too strongly urged that *Cephalodiscus* and *Rhabdopleura* belong to Bateson's group of the Hemichordata, and that they have nothing to do with the Bryozoa. *Phoronis* may or may not come in the same group, but the question should not be obscured by the assumption, at present not sufficiently warranted, that it necessarily has affinities in the direction of the Bryozoa.

S. F. HARMER.

The Tunicata.

The large collection of Tunicata made during the Expedition has added greatly to our knowledge of this group, as regards both its morphology and its distribution. The pelagic tunicates (Salpidæ, Doliolidæ, and Pyrosomidæ), which form an important constituent of the surface fauna of the ocean, have, on account of their abundance and the comparative ease with which they may be obtained, attracted the attention of naturalists and voyagers in many parts of the world. Hence the "Challenger" collection of these forms contains comparatively few novelties; but it is of considerable value, since, from the constancy and care with which tow-net observations were conducted, and their results preserved, it affords much additional information as to the distribution of these pelagic Tunicates horizontally, and to a less degree vertically. One noteworthy form is the new species *Pyrosoma spinosum*, of which a magnificent specimen, over four feet in length, was obtained in the North Atlantic, but was unfortunately not preserved entire. The remarkable new genus, *Octacnemus*, described first by Moseley, of which two species are known, seems to be an abyssal and considerably modified ally of the pelagic Salpidæ. A new family, the Octacnemidæ, has been formed for its reception.

The collection is rich in **Ascidiæ Compositæ**, but although many of them are new species, the great majority belong to well-known genera. This can be accounted for by the fact clearly brought out by the "Challenger" collection, that the Ascidiæ Compositæ form essentially a shallow-water group, the bulk of the collection having been obtained close to land, or at localities, such as Kerguelen Island and Port Jackson, where the shore fauna was investigated. A few Compound Ascidians were, however, obtained from great depths, such as 1,600, 2,050, and 2,900 fathoms, but they show few notable morphological peculiarities. Perhaps the form most worthy of special mention is *Pharyngodictyon mirabile*, in which the branchial sac is in the curious simplified condition found in *Culeolus* amongst Simple Ascidians. The horizontal distribution of the group is very wide, representatives being found in all the great oceans and in almost all latitudes.

Among the **Ascidiæ Simplices**, the most important new forms constitute a small group of pedunculated Cynthiidæ, apparently confined to deep water, and characterised by several striking peculiarities. They are more nearly allied to *Boltenia* than to any other previously known genus, and have been placed in two closely related new genera *Culeolus* and *Fungulus*, the former containing seven species and the latter one. Their most important morphological feature is the very remarkable condition of the branchial sac, which is simplified, apparently, by the total absence of the system of fine interstigmatic vessels; the result being that the large meshes formed by the intersection of the transverse vessels, and the longitudinal bars, are not divided up into stigmata, as they are in the case of a typical Simple Ascidian. This peculiar condition of the branchial sac seems to be associated with the abyssal zone, as it has apparently been evolved independently in at least four different groups of deep-sea ascidians, viz., *Culeolus*, *Fungulus*, *Bathyoncus*, and *Pharyngodictyon*, while it has not been found in any forms from shallow water.

In *Culeolus* the branchial sac is strengthened by the development in the vessel-walls of a system of gracefully branched and curved calcareous spicules, marked internally by a series of "contour" lines. These are quite different in appearance from the fusiform echinated spicules found in some species of *Cynthia*.

Another noteworthy feature in the anatomy of the genus *Culeolus*, is the condition of the blood-vessels of the test in some of the species. In *C. murrayi* the terminal twigs of the vessels open into large vesicles placed just below the surface of the test, and only separated from the external medium by a very delicate membrane. In several of the species there are thin-walled hollow papillæ or projections from the surface of the test, and these are in free communication with either the large vesicles or the ends of the vessels. This is obviously an accessory respiratory apparatus, permitting the blood circulating in the test (which when the heart contracts dorso-ventrally is impure) to be brought into such close relations with the external water as to ensure a certain amount of oxidation.

A large number of other new species of Cynthiidæ were obtained, but the only others which cannot be referred to a known genus are *Bathyoncus mirabilis*, *B. discoideus*, and *B. minutus*, forms which agree with the typical Styelinæ in having simple tentacles, but differ from them in having a branchial sac of the skeleton type found in *Culeolus* and *Fungulus*. *Styela* is remarkable on account of its very extended bathymetrical range. Most of the species are found in shallow water, some few between tide-marks; while six species in the collection are from between 100 and 600 fathoms, and two, *S. bythia* and *S. squamosa*, both fairly typical members of the genus, were obtained at a depth of 2,600 fathoms. (Pl. xvi., Fig. 2.)

In the Molgulidæ, two gigantic pedunculated forms, destitute both of hair-like processes from the test and incrusting sand, have been placed in a new genus, *Ascopera*. In the Ascidiidæ there are three noteworthy new genera—*Corynascidia*, *Abyssascidia*, and *Hypobythius*, all from deep water. *Corynascidia suhmi* is, like so many other of the abyssal forms, supported upon a peduncle. The position and course of the intestine are peculiar, and the branchial sac is one of the most beautiful and delicate known. *Abyssascidia* is a connecting link between the well-known British genera *Ascidia* and *Corella*. It resembles *Corella* in the position and course of the intestine, while, in the structure of the branchial sac, it exhibits the simpler arrangement found in *Ascidia*, from which again it differs in the condition of the dorsal lamina, and in the large number of lobes surrounding the branchial and atrial apertures. A little group of three species, for which the new genus *Ecteinascidia* has been founded, forms a connecting link between the previously known Clavellinidæ and the Ascidiidæ, and shows that the group of Social Ascidians, established in 1828 by Milne Edwards, must now be merged in the Ascidiæ Simplices.

The geographical distribution of the Simple Ascidians is very wide; but it appears from the "Challenger" investigations that they are not specially abundant in the northern hemisphere, and are comparatively scarce in tropical latitudes, while they attain their greatest numerical development in southern temperate regions. The bathymetrical range is also wide, extending from the littoral zone down to 2,900 fathoms; still they are mainly a shallow-water group, and are found in greatest abundance immediately around the coast in a few fathoms of water.

Altogether the "Challenger" collection of Tunicata contained 184 new species (in addition to a number of marked varieties), and these have required the formation of twenty-one new genera, and three new families—the Cœlocormidæ, the Polystyelidæ, and the Octacnemidæ. Among the theoretical conclusions that have been deduced from their study are:—

1. That the Tunicata are to be regarded as a degenerate offshoot from the Protochordata, with some primitive Clavellinid as the ancestral form of the fixed Ascidians.

2. That *Pyrosoma*, although now a pelagic free-swimming organism, was derived from the fixed Compound Ascidians.

3. That Ascidiæ Compositæ are an unnatural or polyphyletic group, having probably been derived from the ancestral Simple Ascidians at three distinct points—the result being that the Compound Ascidians form three groups: (1) the Polystyelidæ; (2) the Botryllidæ; and (3) the remainder, which are more nearly related to particular groups of Simple Ascidians than they are to one another.

W. A. Herdman.

Vertebrata.

Fishes.—The great contribution to Ichthyology made by the "Challenger" Expedition, was the provision of a broad and sure foundation of our knowledge of the abyssal fish-fauna. In the introduction to his volume on the "Deep-sea Fishes," Dr. Albert Günther has already clearly stated the extent of this contribution and summarised previous knowledge of the subject, so that it is unnecessary to do more than quote from his observations. Risso, in 1826, was the first to distinguish an abyssal fish-fauna, and he not only assigned to it certain species, but also attempted to state the depths at which they habitually live. Between 1843 and 1860 the Rev. R. F. Lowe's researches among the fishes of the ocean round Madeira added the further important fact that some fishes live during their earliest stages at or near the surface, while they retire into comparatively great depths in the course of their growth. He also determined the precise depths at which certain species occur. Between 1862 and 1866 Mr. J. Y. Johnson continued Lowe's investigations, though not clearly perceiving the significance of the many deep-sea fishes he discovered. During the decade following 1860, Dr. Günther himself also discussed the bearing of these discoveries, with what is now proved to have been much foresight; and by 1870 the time had arrived for some definite and systematic attempt to solve the various problems that had arisen. The voyage of the "Challenger" was precisely opportune, and the naturalists in charge obtained no less than 610 specimens, all carefully localised, and many with an approximate record of the depth at which they were captured. It then became clear that the deep-sea fishes had a very wide distribution, and some were definitely proved to live at no less great a depth than 2,750 fathoms. Ample material was also furnished for an examination of the so-called "eye-spots" on these remarkable animals (Pl. xvi., Fig. 4); and the researches of Moseley and von Lendenfeld (forming a supplement to Dr. Günther's report) gave the first adequate idea of the structure of these organs. It is now certain that they produce light, and at least the more specialised of them appear to be directly under the control of the will of the fish. The most interesting general result of the "Challenger" work, however, was the proof that all the deep-sea fishes are modifications of forms still inhabiting the shallower waters. *Bathypterois*, for instance (Pl. xvi., Fig. 3), is a new Scopeloid genus which has retained much of the outward appearance of surface fishes, and might be thought equally well organised for life in some quiet dark water near to the surface. The chief modification is in the pectoral rays, which are much elongated, some of the upper ones being separated from the remainder of the fin. They are evidently organs of touch, enabling the fish to examine objects hidden in the ooze, which its imperfect eyes could not detect. The Palæontologist might have expected to find among the deep-sea fishes a few refugees from an older fauna; but none of them represent types earlier than those of the Cretaceous period. The few very antique fishes that remain have taken refuge in the fresh waters, or become adapted to the present conditions of the shore and open ocean.

The only report on **Reptiles** is a short memoir on the development of the Green Turtle, contributed by the late Dr. W. K. Parker to the first volume in 1880. This is based on a collection of embryos brought from Ascension by the Expedition, and on other specimens subsequently collected in the same place by Dr. Maclean, R.N. It is illustrated by no less than thirteen plates, and gives the first detailed account of the development of the skull in the Turtles. Some of the more striking embryos themselves are also briefly described, and Dr. Parker particularly emphasises the fact that they exhibit many more body-segments, especially in the neck and tail, than might be expected from the number of vertebræ in the adult.

A. Smith Woodward.

Considering that the principal function of the "Challenger" was to collect deep-sea creatures, the collection of **Birds** formed by the Expedition was highly creditable, especially to Mr. John Murray, who interested himself in the matter. The result was that 900 specimens were collected, and several new species were obtained. To work out these collections Dr. Sclater, who was entrusted with their description, called to his aid several well-known ornithological experts, such as Count Salvadori, the late Marquis of Tweeddale, Dr. Otto Frinsch, Mr. Osbert Salvin, and Mr. Howard Saunders.

The two most important collections were those made in the Philippine Islands, when several new species were discovered, and in the Admiralty Islands, which was untrodden ground to the naturalist, and here the bulk of the species procured were new to science. The other memoirs deal with more well-worn subjects, as all the localities visited by the "Challenger" had been, more or less, explored by previous naturalists and collectors, and no novelties were to be expected; but the thorough way in which Mr. Murray procured specimens of birds on every possible occasion resulted in the addition of an extremely fine series of Penguins and other sea-birds to the British Museum. The portion of vol. ii. devoted to the birds embraces an important series of memoirs, amounting to 180 pages, and is illustrated by thirty coloured plates by Smitt.

The two most important memoirs are, of course, those by the late W. A. Forbes, on the Petrels (Tubinares), and Dr. Morrison Watson on the Penguins (Spheniscidæ). The former of these reports is published in the fourth volume of the series, and the latter in the seventh. Both of these memoirs are of the highest importance to science, and have had a marked influence on the classification of the orders of which they treat. They are, moreover, excellently arranged as regards material and tabulation of results, and, though Dr. Watson's is the larger of the two reports, they are both very complete. If nothing besides these two contributions to the history of the Class Aves had been published in the "Challenger" *Report*, Mr. John Murray would have earned the gratitude of ornithologists for all time for the interest he displayed in collecting such a rich store of material.

R. Bowdler Sharpe.

Of the **Mammalia**, whether from land or sea, no great collections were obtained by the "Challenger." She was not fitted as a whaler, and the cetacean specimens obtained were mostly in the form of skulls and bones. The marine mammals could have yielded no richer results than were obtained by the accomplished anatomist, Sir William Turner, who has kindly sent us the following note:—

In the memoir on the **Cetacea** collected during the voyage, the skeleton of a young specimen of Layard's Whale, *Mesoplodon layardi*, from the Falkland Islands, is described for the first time, and is compared with the skull of an adult collected at the Cape of Good Hope. The minute structure of the teeth, both in the young and adult cranium, is specially examined and compared with that of the teeth in Sowerby's Whale. It is proved that, in the earlier stages of growth of the teeth in these Cetacea, the structure does not differ materially from the ordinary human or carnivorous tooth, the crown being invested by enamel, the fang by cement, whilst the great body of the tooth consists of dentine, in the core of which is a pulp-cavity. The exceptional character of the erupted teeth in the adult is due to the disappearance of the enamel from the crown, the cessation in the development of the dentine, the excessive formation of osteo-dentine, modified vaso-dentine and cement, through which the pulp-cavity becomes almost obliterated, and the fang assumes dimensions, which, in Layard's Whale, lead to the growth of the very remarkable strap-like tooth so characteristic of this cetacean.

The memoir also contains an account of a skull of a *Ziphius cavirostris* (Cuvier's Whale), from New Zealand, which is compared with a similar skull from the Shetland Islands. The author considers them to be of the same species, and regards the geographical distribution of Cuvier's Whale as equal to that possessed by the Sperm Whale.

In another chapter, the cetacean bones dredged from the floor of the ocean are described. These consisted mainly of the tympanic and petrous bones, more or less encrusted with manganese. They were all found south of the equator, and to a large extent belonged to the genus *Mesoplodon*, of the Ziphioid group of whales, though a few could not be referred to existing species. They were associated with large numbers of sharks' teeth, belonging to the genera *Lamna*, *Oxyrhina*, *Carcharodon*, but the species, so far as we know are extinct. Many of the specimens were dredged from a depth of from 2,000 to 3,000 fathoms (Pl. iii., Fig. 3, and Pl. xvi., Fig. 1).

The memoir on the **Seals** collected by the "Challenger" contains a description of the external characters and skeleton of the Elephant Seal, *Macrorhinus leoninus*, from Kerguelen Island; of the skeleton of Weddell's Seal, *Leptonychotes weddelli*, from Kerguelen, a comparison of the skull of a young and adult Lion Seal, *Otaria jubata*, and an account of the skeletons of Fur Seals collected on Kerguelen Island and in the Messier Channel off the west coast of South America. These latter specimens are referred to the genus *Arctocephalus*, sp. *gazella*, *australis*.

In another chapter the known species of seals and the walrus are classified according to their anatomical characters, based principally on a study of the skull. The distinguishing cranial characters of each species are believed to be worked out with more precision than in previous attempts at the classification of this interesting group of marine mammals. The author does not consider that there is sufficient anatomical evidence to warrant the division of the genus

Trichecus (walrus) into an Atlantic species differing from that frequenting the North Pacific Ocean, as has been proposed by Mr. J. A. Allen.

Another chapter describes the brain of the walrus and of the elephant seal, and compares the arrangement of the convolutions and fissures of the cerebrum with those present in the brains of carnivora, apes, and man. It concludes by giving, in a tabular form, the fissures and convolutions in the brain of a dog, which apparently have homologous arrangements in the ape's brain.

The memoir on the seals concludes with an appendix, containing a detailed description by Dr. W. C. Strettell Miller, of the myology of several species of seals from the author's collection. So far as the specimens permitted, the nerves which supply the muscles were dissected and described.

William Turner.

The collecting of **Land Mammals** had, as a matter of course, little place in the official programme of the voyage of the "Challenger"; but, nevertheless, when any specimens were by accident obtained, they were preserved, and, by the end of the cruise, amounted to about sixty in number.

Some few of these, such as a Thylacine, Armadillo, Platypus, were handed over to Professor D. J. Cunningham for dissection, and resulted in his valuable paper on "Some Points in the Anatomy of the Thylacine, Cuscus, and Phascogale," in vol. v., while the majority were sent direct to the British Museum, where they now are.

The value of these specimens lies not in their novelty or rarity (for being mostly obtained near seaport towns, and more or less by accident, without systematic trapping, they are almost wholly well-known species), but in the accurate particulars as to their localities and dates which accompany them. Thanks to these particulars, bats from Hawaii, shrews from Manilla, moles from Japan, and mice from Chili, all have their value to the specialist working at the several groups, even if not of sufficient importance to demand a general account of the collection.

It is hoped that another time, whether on a great expedition like that of the "Challenger," or during ordinary surveying voyages, a few traps, large and small, may be set out systematically whenever and wherever possible, for the results are sure to be of value sooner or later. Few but specialists are aware how incredibly ignorant we are of the exact distribution of mammals, not so much of the great groups, but of the species, while much of this knowledge will by degrees become more and more impossible to obtain, owing to the rapid spread over the earth's surface of Europeans, pigs, dogs, rabbits, rats, etc.

The visit of such a ship as the "Challenger" to all sorts of out-of-the-way islands, would, therefore, be an opportunity for gaining information about distribution, habits, etc., which could never be obtained by the ordinary mammal collector, who has to ignore known species and get enough rarities or novelties to make his trip pay commercially, and, therefore, would never think of visiting islands where a few known species would alone be found.

Oldfield Thomas.

VI.—ANTHROPOLOGY.

When one takes into consideration the length of the cruise and the interesting places visited by the "Challenger," regret can only be felt that more Anthropological work was not accomplished. Apart from the efforts of the late H. N. Moseley and R. von Willemoes-Suhm, it does not appear that anyone was interested in this science. A great opportunity, as is usual in our official expeditions, was almost neglected. Even the photographs were as a whole unsatisfactory. The general instructions were, however, wide enough, as the following extracts will show:—

"Every opportunity should be taken of obtaining photographs of native races to one scale; and of making such observations as are practicable with regard to their physical characteristics, language, habits, implements and antiquities. It would be advisable that specimens of hair of unmixed races should in all cases be obtained." And again, the "special interest" of the ethnology of New Britain and New Ireland was pointed out; but the "Challenger" did not go to either place, and spent only six days at the Admiralty Islands.

A small collection of skulls and bones was obtained, which in the able hands of Professor Sir William Turner has yielded interesting results; but this is due not so much to the material collected, valuable though it was, as to the fact that Sir William has made use of other data. Of the 153 crania of which measurements are given, only sixty-four were "Challenger" specimens. These consisted of the Bush Race (2), Fuegian and Patagonian (5), Australian (3), Admiralty Islands (13), Sandwich Islands (33), Chatham Island (4), and New Zealand (4). In addition, reference is made to the investigations of other craniologists, so that each collection of skulls forms an excuse for a little monograph of that particular people. Very few bones of the skeleton were collected; but by utilising that important series of human skeletons in the Museum of the University of Edinburgh, Sir William has written a very valuable essay on comparative osteology. These two Reports practically constitute the only text-book in the English language on these subjects, but it is necessarily extremely fragmentary. It will be seen that, with the exception of the Bush and Fuegian crania, all the specimens came from Oceania, and the "Comparison of the Crania of the Pacific Islands" is a masterly summary of the ethnology of that region of the globe. Even in some of the remote island groups there is a diversity in the cranial characters. "These variations can be sufficiently accounted for on the theory that two distinct races, a dolichocephalic Papuan [Melanesian] and a brachycephalic Maori

[Polynesian], are in some islands pure, in others mingled with each other, either in distinct colonies living side by side in the same island, or by intermarriage; though on the western side of the Pacific region the brachycephalic Malay and Negrito have without doubt exercised an influence in modifying the cranial and other characters of some of the islanders in that region." But Sir William thinks that "there are certain residual quantities of which it is not possible to give a satisfactory explanation, on the supposition that these are the only races which have ever occupied these islands." He refers more especially to the remarkable megalithic monuments in several of the islands.

Professor Turner writes, "there is sufficient information to enable me to say that racial differences are not confined to the skull, but occur also in other parts of the skeleton." He does not find "that any one race dominates, in all its characters, over all other races; or that any one race, in all its characters, is lower than all other races. There does not seem to be a graded arrangement, such as would lead one to say that the white races, which we will assume to be the most highly developed, have been derived, by successive stages of slow and gradual perfecting of structure, from the lowest existing black race, or, indeed, from any one of the existing black races."

In his charming book "Notes by a Naturalist on the Challenger," Professor Moseley gives numerous original anthropological observations, many of these are of great interest, and they indicate a keen eye and an appreciation of the points of real importance. There is, for example, a suggestive little essay on the metamorphosis of Hawaian gods into hook-like ornaments, and the chapter on the Admiralty Islands is of especial value; but Moseley has given a more detailed and admirable account of "The Inhabitants of the Admiralty Islands, etc.," in the *Journ. Anth. Inst.*, vi., 1877, p. 379. The skulls collected on the occasion of this visit were the first that have been described. A considerable part of Moseley's book is reprinted in First and Second Parts of vol. i. of the "Narrative of the Cruise," prepared by Dr. J. Murray. In these books there is some additional ethnographical information, which is illustrated by a few coloured plates, photographs, and woodcuts. Here, again, the section dealing with the Admiralty Islands is the most complete and the best illustrated (see Pl. xvii.); it is, in some respects, supplementary to Moseley's account.

A. C. Haddon

SOME NEW BOOKS.

Professor Prestwich on Some Geological Problems.

Collected Papers on some Controverted Questions of Geology. By Joseph Prestwich, D.C.L., F.R.S., etc. 8vo. Pp. xi.-279, with 13 plates and 8 figures. Macmillan & Co. 1895. Price 10s. net.

As Professor Prestwich is the acknowledged *doyen* of British geology, his opinions are entitled to the most respectful consideration. He always brings to any discussion a judgment resulting from an unusually long experience, and his writings have always shown that he is especially apt at preparing judicial statements of the arguments on both sides of the vexed questions of geology. One, therefore, turns to the volume expecting important help in defining and limiting the issues of current geological controversy. It is, therefore, rather a disappointment to find that the book consists of reprints. But as the articles have been revised and sometimes enlarged, a series of plates added, and the papers collected from scattered sources, the volume must be heartily welcomed, both as conveying fresh information and giving some of Professor Prestwich's latest conclusions in a convenient form.

The book contains six articles. These deal with "Uniformitarianism," "The Date and Duration of the Ice Age," "Plateau Man in Kent," "The Agency of Water in Volcanic Eruptions," "The Thickness of the Earth's Crust," and "The Rate of Rise of Underground Temperatures." The first of these is a reprint from the *Nineteenth Century*, and contains a protest against accepting the positive conclusions of physicists as to the rigidity of the earth, or the exaggerated estimates of geologists as to the length of time required for certain geological operations. Professor Prestwich strongly objects to what he calls "the *Fetich* of uniformity"; he states the views of some of the most devoted worshippers, as if they were those of the orthodox members of this school. He quotes Croll, and accepts him apparently as a typical representative of the Uniformitarians, although his theories have long since fallen from the prominent position which they once held. With Professor Prestwich's criticisms upon these views we heartily agree, though without in any way losing faith in the uniformity of geological phenomena. Professor Prestwich fully admits that the forces of erosion and the modes of sedimentation are "the same in kind as they have ever been; but we can never admit that they have always been the same in degree" (p. 14). With this probably every uniformitarian would agree: differences in degree must have happened; rainfalls vary, climates alter, and ocean currents gain or lose in erosive power by simple changes such as we can see going on around us at present. No one can set a limit to these changes; they appear to us to vitiate every attempt to calculate geological time in terms of years. And we are sorry to have to confess that, when Professor

Prestwich tells us that "there is every reason to believe . . . that Palæolithic Man and his companions came down to within some 10,000 to 12,000 years of our times" (p. 11), we regard his estimate as quite as unphilosophical as those, seven times as long, against which he argues. The second article attempts to estimate the date and duration of the Glacial Period; it seems open to the same objection, that the data are too inexact to repay the labour of using. The third article appears to us the most important in the volume, as it contains more new matter than the others, and is illustrated by a series of good plates. It describes the evidence for the supposed existence of man on the chalk plateaux of Kent in times earlier than the Palæolithic, and coincident or earlier than the gravels known as the "Southern drift." The implements are of a very primitive character, and many competent authorities have declined to accept them as of human workmanship. The specimens figured on the plates, however, seem convincing. There are, however, with these some of the normal Palæolithic implements, such as a spear head of the St. Acheul type (pl. xi., Fig. 38); and how the two series came into association, Professor Prestwich admits to be still uncertain.

The fourth article discusses the various theories that have been put forward to account for the water given off in volcanic eruptions. Professor Prestwich maintains that the old theory, that volcanic action is one of the results of contraction of the earth during cooling, is in fullest agreement with the facts, and further, that the steam given off is formed from water which works its way down from the surface, and is not occluded by the rocks of the interior. The article on the "Thickness and Mobility of the Earth's Crust" is that which is most likely to arouse energetic dissent, especially from its conclusion that volcanic action is incompatible with a thick crust. The final article discusses at length the data by which the rate of increase of underground temperatures can be determined. The numerous probable sources of error are described, and many of the most familiar measurements are dismissed for failure to allow for these. Professor Prestwich rejects a large number of records, and from those which he accepts he calculates the mean rate of increase of temperature as 1 degree Fahr. for every 48 feet.

J. W. G.

In our review of the four-handed text-book on Botany recently issued by Gustav Fischer, we asked how it was possible to issue so admirable and so copiously illustrated a work at so small a cost. The publisher writes to inform us that the cost of publication is not appreciably less in Germany than in England, less still has Bonn University anything to do with the matter. The explanation, he says, is due to the great pleasure he has had in bringing out as cheaply as possible a book which the four Bonn professors and teachers had done their best to make as valuable and original as possible.

Messrs. Dulau & Co., who have been appointed agents for the sale and distribution of the Royal Society's publications, have issued a complete price list of those that are still to be had.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments have recently been made :—

Dr. E. Knoblauch, to be Assistant in the Botanical Institute at Tübingen University; Dr. P. Dangeard, Professor of Botany to the Faculty of Sciences at Poictiers; Dr. H. Fischer, to be Assistant in the Botanical Institute at Heidelberg University; Dr. F. Saccardo, to be Assistant in the Botanical Division of the Royal "Weinbauschule" at Avellino; Dr. Günther, Ritter Beck von Mannagetta, to be Extraordinary Professor of Systematic Botany at Vienna University; Dr. F. Schütt, to be Ordinary Professor of Botany at Greifswald University; Dr. Karl Futterer, to be Professor of Geology and Mineralogy at the Technical High School of Karlsruhe in Briesgau; Mr. Frank Finn, to be Deputy Superintendent of the India Museum, Calcutta, in the room of Mr. E. C. Cotes, resigned. Dr. N. V. Ussing succeeds the late Professor Johnstrup in the Chair of Mineralogy, at Copenhagen; Dr. F. Karsch, becomes Extraordinary Professor of Zoology at Berlin University. Professors E. Du Bois Reymond, K. Weierstrass, and Eduard Suess have been elected honorary members of the Royal Irish Academy; Professor W. Dames and Dr. P. Groth have been elected Foreign Correspondents of the Geological Society of London; Professor G. B. Howes succeeds Mr. W. P. Sladen as Secretary of the Linnean Society.

THE Linnean Gold Medal has been awarded to Dr. Ferdinand Cohn, the eminent botanist; the "Prix de Candolle" of the Geneva Physical and Natural History Society has been divided between Dr. O. Warburg, of Berlin, for his monograph on the Myristicaceæ, and Professor R. von Wettstein, of Prague, for his monograph on the genus *Euphrasia*. Dr. John Murray has received the honorary degree of Doctor of Science from Cambridge University, he has also been awarded the Founder's Medal by the Royal Geographical Society. Both awards are in recognition of his work in connection with the "Challenger" Expedition. The other awards of the Geographical Society have been adjudged as follows:—Patron's Medal to the Hon. George N. Curzon for his travels and publications on Persia, Northern India, and French Indo-China; Murchison grant to Eivind Astrup for his journey in Greenland with Peary; Back grant to Captain Larsen for his Antarctic researches; Gill memorial to Captain Pringle; Cuthbert Peck grant to G. F. Scott Elliot for exploration of Ruwenzori and the west of Victoria Nyanza. At Commemoration honorary D.C.L.'s were conferred by Oxford University on Sir William Flower and Professor Michael Foster.

THE Statute establishing a final honour examination in Anthropology in the Honour School of Natural Science at Oxford University was (*proh pudor!*) rejected by sixty-eight votes to sixty. During his retention of the Readership in Anthropology, Dr. E. B. Tylor may, however, solace himself with the title Professor.

CANADA is to have a National Park. The Algonquin Park, for so it is called, will be a large reservation in the province of Ontario. The *American Naturalist* states that no hunting, trapping, or destruction of animal life will be permitted within its boundaries.

THE collection of birds' skins forwarded to England recently by Dr. Donaldson Smith, as a result of his explorations in Somaliland, has now been examined and described by Dr. R. Bowdler Sharpe, who read a paper on the subject at a meeting of the Zoological Society on May 21. Dr. Sharpe considers the collection to be a most important one, and to contain no less than twenty-two species new to science. One of these, a very handsome goatsucker (*Caprimulgus donaldsoni*) was actually procured on board ship before the expedition started on its long journey to Lake Rudolph, and if the young explorer had but known that he had begun with a new species at the outset, he might have taken it as an omen of the good luck, which has undoubtedly followed his expedition. The most striking novelties were obtained by Dr. Smith on the Darro Mountains, and near Sheik Husein and Sheik Mohammed in Western Somaliland. The finest of these new species is a Touracou (*Turacus donaldsoni*), and a Hornbill (*Lophoceros sibbensis*), as well as two new seed-eating Finches (*Crithagra donaldsoni* and *C. maculicollis*). In the lower country and in the district of the Webi Shebeyli Dr. Smith also met with some very interesting new forms, among them three new species of Larks, and a new Bulbul (*Pycnonotus dodsoni*).

A MOST successful expedition to the Salvage Islands, Canaries, Madeira, and Porto Santo has just been accomplished by Mr. Ogilvie Grant and Mr. Cecil Baring, who were accompanied by Mr. Grönvold, the taxidermist at the British Museum. Three weeks were available for collecting purposes, nine days of which were devoted to the Salvage Islands. A large collection of bird-skins and eggs was secured, and included a fine series of the White-breasted Petrel (*Pelagodroma marina*) and the White-rumped Storm Petrel (*Thalassidroma cryptoleucura*), with many eggs of the former, and one of the latter. *Puffinus assimilis*, in all stages of growth, was collected, together with eggs, and an egg of Bulwer's Petrel was also obtained. Of Madeira birds, the chief captures included a splendid pair of *Columba trocaz*, and large series of the Robin, Goldcrest, and Chaffinch peculiar to the island. Of the other vertebrates, the most interesting forms are the peculiar Great Salvage Mouse, and a large series (seventy-two species) of fish preserved in spirit. Four hundred and fifty land and freshwater molluscs, 400 arthropods, 700 insects, and a few echinoderms and worms, besides numerous plants and a small collection of rock specimens, bear striking witness to the value of these small expeditions when conducted by competent and energetic leaders.

IN addition to the support already noted by us as promised to the International Bibliographic Bureau, we learn that the Swiss Government has now made itself financially responsible for the headquarters of the undertaking, which will be at Zurich. A thousand francs is already contributed to the preliminary expenses by French institutions. The *Zoologischer Anzeiger*, the *Anatomischer Anzeiger*, and the *Bibliographie Anatomique* are all making arrangements to co-operate with the new scheme, the success of which must now be held assured.

WE learn from Captain Marshall Hall that Professor Torquato Taramelli, of the University of Pavia, has been nominated to represent Italy on the International Commission on Glaciers.

THE BRISTOL GEOLOGISTS' ASSOCIATION has arranged excursions to Portishead (July 21), Stroud Valley (August 11), and Dundry (September 15). The National Home-Reading Union holds its summer assembly at Leamington Spa, June 29–July 8. Mr. J. E. Marr will deliver four lectures on the geology, and Mr. Scott Elliot four lectures on the botany of the district. The first conference and excursion under the Irish Field-Club Union will take place on July 11–17. The programme is briefly as follows:—July 10, evening reception by Dublin Club; July 11, proceed to Galway and inspect town and neighbourhood; July 12, excursion to the Twelve Bens, Connemara; July 13, excursion to Ballyvaughan and Burren district; July 14, being Sunday, members make their own arrangements; July 15, excursion to the Aran Islands; July 16, excursion to Oughterard and Lough Corrib.

CORRESPONDENCE.

The Teeth of the Horse.

In the article on "The Teeth of the Horse," in the April number of this journal, it was stated, with reference to the preparations at the Natural History Museum, that the skulls were collected and presented by Mr. Goodall. It is, however, only fair to him to add that in most cases the teeth had already been exposed in the skulls, and that the skulls were not simply collected, but were carefully selected from a much larger series in his possession, with a view to showing the salient features of the dentition at each particular stage. There is, unfortunately, no indication in the paper of the amount of labour and thought which Mr. Goodall had already expended on the series; and, in justice to him, I wish to be allowed to rectify the omission.

W. G. Ridewood.

Change of Habit in Wild Birds.

When visiting the upper parts of Natal lately I came across what appear to be two instances of recently-acquired change of habits in wild birds. The first is that the common Griffon Vulture, Aasvogel of the Dutch (*Gyps kolbii*) has, of quite late years, commenced in this district (the watershed between the Upper Movi and Bushman's rivers) to kill living animals, not confining itself to carrion. I am aware that this habit is noted from the Cape Colony; but it would appear that in the part of Natal I visited the farmers only commenced to suffer during the last six to eight years. These birds breed in the steep cliffs of Mount Erskine, an outlier of the Drakensberg range, in large numbers, and thence scour the country. Authentic cases are given in which farmers have seen the living, healthy sheep attacked and killed, generally when at some little distance from the main body of the flock. They appear, however, generally to attack ewes when with very young lambs; first killing the mother, and then the lamb or lambs. I am also informed that, in one instance at least, they have attacked a cow, and killed her; but, although probable, I would like verification for this statement. At all events, it is quite certain that below and near Mount Erskine this habit has been quite recently developed.

Last year I was in the bush in the valley of the Upper Umkomanzi river. Parrots (*Psittacus*, sp.) are common in the bush; but, until then, had not foraged in the gardens and orchards. For the first time since the place had been settled by Europeans—a matter of twenty-five years—they attacked the fruit. Their somewhat timid disposition seemed quite altered, and they flew into the orchards in large numbers. They seemed unable to carry off the fruit, which consisted principally of apples, alone, so broke the small branches below the joint, and I saw them flying off with branches in their bills with apples attached. The excitement among them seemed intense; the discovery of such an abundant and new food-supply apparently much agitating the parrot world. No doubt, in both these cases, the change of habit will be permanent, and I thought the fact of the date of change being thus known was worth recording.

Durban, Natal, Maurice S. Evans.

March 29, 1895.

NOTICE.

To Contributors.—*All communications to be addressed to the* Editor *of* Natural Science, *at* 22, St. Andrew Street, Holborn Circus, London, E.C. *Correspondence and notes intended for any particular month should be sent in not later than the* 10*th of the preceding month.*

To the Trade.—Natural Science *is published on the* 25*th of each month; all advertisements should be in the Publisher's hands not later than the* 20*th.*

NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

No. 42. Vol VII. AUGUST, 1895.

NOTES AND COMMENTS.

The New London University.

BY the time this is in the hands of our readers the fate of the new Government will be practically decided. We hope, whichever party come into power, that time will be found to set going a real university for London. The delay in the matter is already preposterous. After long and arduous conflicts a reasonable scheme has been prepared, and is contained in the report of the "Gresham Commissioners." All the institutions concerned have approved the scheme; the majority of educated opinion regards it as a reasonable and practicable scheme. It contains enough compromise to satisfy even the most timid about the rights of minorities, and it must come into operation.

Here is our great London, the home of the chief scientific societies in Great Britain, containing a population that would provide innumerable students, the centre of the wealth and of the intellect of the country, provided only with some dozen inchoate institutions full of activity that is wasted because of senseless rivalry and complete want of co-operation. Here is a scheme waiting that shall breathe into them some corporate life: a scheme that has become possible only by many generous and long-sighted concessions on the part of bodies that have been building themselves up with much self-sacrifice and vast unrecognised expenditure of energy. Factious opposition and the exigencies of party conflict must now be overborne by strong and swift action. There lies to the hand of the successful political party a clamant opportunity, the embracing of which will be applauded on all hands.

Culture and Biology.

One hears it said everywhere that Huxley was an example of the cultured man of science, and that such an instance is conspicuous by its rarity. Similarly it is frequently asserted that he was a man naturally inclined to letters and culture, who had become a man of science by the accident of events. We believe this to be a misapprehension. We do not dispute that Huxley was a man of unusual and commanding ability, who, in whatsoever environment he had chanced to live, would have been conspicuous among his fellows. But a considerable part of his culture arose from a necessary consequence of his scientific pursuits. Most scientific men, like most educated people, have an acquaintance with Latin and Greek. But it is also necessary that they should make themselves familiar with French and German. There are very few who do not in addition acquire a working knowledge of Italian: a large number can read Russian and a Scandinavian language in addition. We venture to think that among the educated classes generally, among parsons, journalists, lawyers, bankers, and even men of letters, there are very few possessed of this ordinary equipment of scientific men. Although the languages are acquired as a professional necessity, often as a distasteful task, there are few who confine their reading to foreign scientific memoirs. Speaking of our own acquaintances among men living in London occupied in one branch of science, we know one who has amused himself by translating into English verse German and Norwegian poetry; another Russian and French; another who is an authority upon Spanish dramatic literature; yet another whose daily companion is Machiavelli. And if it came to a contest in Continental light literature, we could make up a scientific eleven in whom we should have every confidence.

Huxley and Agnosticism.

To a large section of the public, Huxley was most conspicuous as what it thought a militant scientific infidel, who had invented for himself the euphemistic appellation "agnostic." We cannot enter into religious controversy here; but one or two things may be worth pointing out. Huxley's religious views had no direct connection with his acceptance of Darwinism. He himself states that before 1859 he had abandoned belief in the Christian traditions; and he also insisted that there was no logical difficulty in the "reconciliation" of Christian theology with an evolutionary view of creation. With so rigid a theologian as the late Canon Aubrey Moore and with Paley himself, he held that the argument from design lost nothing of its logical force, although the organic world had come into existence slowly as a result of variation, inheritance, and selection. It was only the literal acceptance of Genesis as an inspired account of actual events that was overthrown by evolution.

Huxley's agnosticism was the lineal descendant of Descartes' philosophy. Descartes in 1619, as Huxley recalls in his preface to "Hume," made the famous resolution to "take nothing for truth without clear knowledge that it is such." This was Huxley's attitude to religious dogma, as indeed to every other dogma, scientific, political, or philosophical. It led him to decide against the authenticity of the Christian revelation. It led him to an absolutely open view as to the existence of the Deity. But these opinions, important as the opinions of any able man on any serious subject which he has considered seriously may be, are the individual opinions of Huxley; they are not the formulated and inevitable view of science. Philosophically, Huxley was not a materialist, even in the limited popular sense in which Tyndall was a materialist. He was a pure idealist in the sense of Berkeley.

Sunday Opening.

It is to be hoped that the Select Committee of the House of Lords, which is now inquiring into the working of the Lord's Day Act of 1781, will lead to some much needed amendments in the law. We, as scientific people, are chiefly concerned with the Sunday opening of Museums. We are glad to learn, from the evidence of Mr. Shaw Maxwell, chairman of the Glasgow Sunday Society, that public opinion, even in that city, is now in favour of the movement, although some time ago the good citizens of Glasgow were greatly scandalised by Professor Blackie's getting on the platform to sing "Let us haste to Kelvin Grove," on the Sabbath. Meanwhile the various Sunday societies are taking the opportunity to display more than usual energy. They held a congress at Prince's Hall, London, on July 1, and passed the following resolutions: "That the Lord's Day Act should not apply to any society or other body established and maintained for the public advantage and not for pecuniary profit." "That all authorities of museums, art galleries, and other institutions open on Sundays should provide for at least one day's rest in seven for the whole of their servants." So far, indeed, as museums that are open free are concerned, we are not aware that they require any more legislation than do tobacconists and sweet-shops; all that they need is the support of public opinion, which will no doubt become more healthy under the double influence of such meetings as these and the attacks of the Lord's Day Society. But example is better than precept, and if the new Government can succeed in opening the British Museum and the South Kensington Museum on Sundays, as has before been attempted, then other museums are likely to follow suit. Till then, the great public of week-day workers must be grateful to such enlightened private individuals as Mr. Horniman, whose museum at Forest Hill was visited on Sunday, June 2, by 2,976 persons. We may recall here the facts that Professor Huxley gave the first lecture for the Sunday Evenings for the People in 1866, and was President of the Sunday Lecture Society. This year's President of the Sunday Society is Canon Barnett, whose long experience of the true needs of the people in the east of London, lent peculiar weight to his eloquent address in favour of the Sunday opening of something other than public-houses.

Sexual Characters in Nautilus.

This question seems to be settled at last. Just a month after our publication of Mr. Willey's important paper, with its illustrations of the differences between the shells of the male and female *Nautilus pompilius*, there appeared in the *Comptes rendus* of the French Academy (vol. cxx., p. 1,431) a note by Dr. A. Vayssière, of Marseilles, "Sur le dimorphisme sexuel des Nautiles," which confirms and extends the observations of Willey. In both *N. pompilius* and *N. macromphalus* the opening of the female shell tends to be laterally compressed, while that of the male shell tends to be wide, especially towards the inner side of the whorl. The shell of the female has also a slight tendency to be keeled, and its margin is more sinuous than in the male, which is the opposite of Van der Hoeven's statement. The difference of width is clearly due to the size of the spadix, or copulatory arm of the male, which is on the right of the buccal bulb, and thrusts the bulb a little to the left; thus this portion of the body becomes nearly as wide as that at the level of the eyes. In an adult male the width of the hood equals its length, so that it is two centimetres wider than in the female; its lateral margins almost entirely hide the eyes and tentacles in the male, but in the female the eyes and first two pair of tentacles are exposed. Dr. Vayssière states that the mantle is not shorter in the male than in the female, and supposes that Van der Hoeven said it was. We have been unable to find any such statement in Van der Hoeven's paper; what he referred to was the hood, as correctly quoted by Buckman and Bather in our own pages (vol. iv., p. 431), and he was merely saying the same as Vayssière, though in a different manner. Buckman and Bather, while admitting the existence of differences between shells of *Nautilus*, pointed out that the characters of width and of sinuosity in the margin increased with age; this is confirmed by Vayssière, who is, however, now able to show, with Willey, that these differences are actually sexual characters.

Applying these observations to the ammonites, Vayssière shows, as Buckman and Bather had already pointed out, that they are totally opposed to the views of A. d'Orbigny, P. Reynès, and H. Douvillé, and that they lend no support to the more complicated theories of Munier-Chalmas. Here, too, our English authors have received confirmation from Dr. J. F. Pompeckj in his study of Rhaetic ammonites (*Neues Jahrbuch für Mineralogie*, 1895, Bd. II., p. 42). His own observations "completely agree" with their conclusion that "the so-called males are in reality the final expressions of the various races to which they belong."

The Origin of the Cephalopods.

It was an interesting paper that Mr. J. Graham Kerr read before the Zoological Society on June 18. It emphasised the paired and metameric character of the organs in *Nautilus*. Willey had already shown, in the paper referred to above, that the post-anal papilla represented the two posterior osphradia, or sensory organs at the base of the two hinder gills. Mr. Kerr suggested that the nerve-branches to this papilla represented the supra-anal commissure of the Amphineura. He supposed that the genital ducts of the female were homologous with the viscero-pericardial pores, so that there would be two pair of openings from the viscero-pericardial chamber to the exterior, just as there are two pair of renal openings. There is, however, nothing gained by homologising the viscero-pericardial pores with nephridia, for surely their position and opening into the nephridia in other molluscs is not so primitive as their direct opening to the exterior in *Nautilus*. It is recognised that the generative ducts are paired right and left, but that the left duct is rudimentary. It is therefore probable that, as Mr. Kerr suggested, the penis is a paired structure derived from the outer skin, with the left half rudimentary and having lost its connection with the duct.

It is generally held that the arms of the Cephalopoda are processes of the fore-part of the foot that have grown up round the head, and this view is based on the facts of development and on the circumstance that the arms receive their nerve-supply from the pedal ganglion or from a small ganglion connected therewith. Mr. Kerr apparently did not think any of the evidence worth discussing except that relating to the nerve-supply, and here he boldly denied that the pedal ganglion was the pedal ganglion, in other words, that it was homologous with the ganglia in the foot of gastropods. He believes that the ganglia of gastropods and cephalopods have been independently derived from a condition of continuous nerve-strands, such as occurs in *Chiton*. This is most probable, but it does not prevent the ganglion in question having been a pedal ganglion in the early days of its development. Mr. Kerr's conclusion is that "the Amphineura, and especially the Chitons, are of all living Mollusca those which most nearly approximate to the ancestral form of the time when the cephalopods diverged from the main molluscan stem." In the condition of the nephridia, however, *Nautilus* is even more metameric than *Chiton*, and it is surely possible that the various organs may have been affected by metamerism independently in those Cephalopoda that took to coiling their shells, while remaining simple in those whose shells remained straight and eventually became enveloped by the mantle. We look forward with considerable interest to the publication of the complete paper.

The Cultivated Cineraria.

It is a pretty quarrel, conducted with an agreeable virulence; and the beginning and the end leave us where we were. This was the fashion of it. Professor Weldon introduced a discussion on variation at the Royal Society by giving an account of his investigations on variation in the shore-crab. To this discussion Mr. Thiselton-Dyer, in the fulness of his heart, brought down from Kew a modern cultivated cineraria and an example of the feral *Cineraria cruenta* recently brought from the Canaries by one of his assistants. It was an object-lesson of great beauty and interest, and the Director of the Royal Gardens pointed out the identity of the foliage and the striking dissimilarity of the blossoms in the two forms. Undoubtedly, as he stated, the cultivated form has come into existence by human selection, and so far "as is known it has been accomplished by the gradual accumulation of small variations." Thus, the Director at the Royal Society, and subsequently in a letter to *Nature*, so far as it is possible to judge from the evidence, brought forward the case of change as a simple contrast to the ordinary stability of plants in an unaltered environment.

But he was reckoning without his Bateson. Mr. Bateson has the belief, and has shown considerable ground for it, that slow variations and slow selection are not the chief factors in the modification of organic forms. We have repeatedly given reasons why we are unable to accept Mr. Bateson's alternative; but apart from the ultimate value of his theory, at least the expression of it had the result of bringing into prominence some defects of Mr. Thiselton-Dyer's position. Mr. Bateson roundly asserted that there was no ground for the inference that the cultivated cineraria had been produced by slow modification (*i.e.*, selection of small variations) of the feral *C. cruenta*. He was inclined to dispute even the identity of the foliage of the two, and he produced copious historical evidence tending to show that the cultivated form was a result of numerous artificial rearings of hybrids, and of sudden sportings subsequent to hybridising. Professor Weldon intervened with a pungent criticism of Mr. Bateson's interpretation of his authorities, bringing out the fact that little reliance could be placed on the evidence for the hybridising origin, and that evidence did exist as to the variation of *C. cruenta*, independently of, and before the existence of the so-called hybrids. Mr. Botting Hemsley wrote sorrowful words, which it is not unfair to paraphrase into some such as these:—"You know that, if I could, I would be on the side of anyone disputing Darwinism, but it is a sad truth that I don't believe in this hybrid origin business." Mr. Thiselton-Dyer accentuated the error of attaching importance to the use of the term "hybrid" by horticulturists. He established the fact that the foliage of the cultivated form is identical with that of *C. cruenta*, unlike that of other species, and that anatomical evidence shows affinities between the cultivated form and *C. cruenta*, but not between it and other species. Mr. Bateson, Professor Weldon, and Mr. Thiselton-Dyer, all returned again to the charge. Apparently Mr. Bateson remains of his original mind, but most who study the controversy carefully will conclude that there is no good evidence for the hypothesis of hybrid origin; that there is good evidence for the origin of the cultivated form from *C. cruenta;* that Mr. Thiselton-Dyer was expressing a pious opinion rather than an elaborated judgment when he stated that "it had been accomplished by the gradual accumulation of small variations." We are inclined to share his belief; but we think that Mr. Bateson's polemic has been of service in that it has led to distinction between inference and known fact. We shall await with great interest the results of the work in progress at Kew on variation. It would be of inestimable advantage to science if we had the result of a series of experiments made under such competent guidance, on the relative possibilities of raising varieties from "sports," and by the selection of small variations. Perhaps the truth may lie between Mr. Bateson's theory of "sports" and the more orthodox view. Gradual selection may lead to the fixation of "forms of organic stability," which occasionally appear as "sports."

Fossil Plants of the Coal-Measures.

The last of a long series of papers in which the organisation of the Coal-Measure plants has been patiently worked out, and which forms one of the most valuable contributions to Palæontology issued by the Royal Society, is that on *Lyginodendron* and *Heterangium*. It is the joint production of the late Professor Williamson and Dr. Scott. The former, active to the last, has just left us, at a good old age; to the latter we look for a continuation of the researches to which the late Professor gave so strong an impulse. The paper deals with the vegetative structure of the two genera, which are described as among the most interesting and, at the same time, the most puzzling representatives of the Carboniferous flora. Nothing is certainly known of the reproductive organs, but their morphology and anatomy point to a position between ferns and cycads. The leaves of *Lyginodendron* are so like fern-leaves in form, venation, and minute structure, that they would, if our knowledge ended here, be referred at once to Filices. But the stem-structure suggests a cycad, the vascular bundles exactly resembling those in the leaves of existing Cycadeæ. One of the authors has, however, recently found that the peculiar mode of development of the bundles associated with the latter may extend to stem-structures, namely, in the genus *Stangeria*. The foliage of *Heterangium*, though less well preserved, is of the same type, while the primary structure of the stem recalls that of a fern like *Gleichenia;* the bundles continued from the leaves, on the contrary, closely resemble the foliar bundles of a cycad. In both genera secondary growth in thickness occurs, but, as the authors point out, this is no argument against a fern alliance, as the same happens in the modern genera, *Botrychium* and *Helminthostachys*. In conclusion it is suggested that they are derivatives of an ancient generalised race of ferns, from which they have already diverged considerably in the cycadean direction. *Heterangium* seems the more ancient, and is certainly nearer the fern stock, while *Lyginodendron* "has advanced much further on cycadean lines," retaining at the same time conspicuous fern-like characters. "This view by no means involves the improbable assumption that these plants were the actual ancestors of existing Cycadeæ."

PLANT NOMENCLATURE AGAIN.

SEVENTY-FOUR botanists across the Atlantic have risen in revolt against the new American system of plant nomenclature to which we have already several times referred. In their manifesto they strongly urge postponement of any radical measures of reform which are based on purely theoretical grounds. It is easy enough to alter old and well-known plant names to suit this or that modern code of regulations, but impossible to set aside the old books which must always remain the historic basis of classification. What with the extremely diffuse literature, frequent insufficiency of description, and want of types or of authorised specimens, the poor systematist has enough to bear without the additional burden of remembering as many sets of names as there are codes of nomenclature; for about these matters there is no finality. There will always be the smooth-handed agitator who has a soul above or a capacity beneath honest work. Some of these gentlemen have lately been revising ordinal names on principles laid down by themselves. We are glad to note that the first suggestion in the circular in question is that "ordinal names, having been established by long usage, should not be subjected to revision upon theoretical grounds." The other rules provide for the retention of long-established and well-known generic names, and the use of the first correct combination in specific nomenclature, and refuse to allow the competition of varietal with specific names, and the retrospective use of the principle "once a synonym always a synonym." The length to which some folk will go is well exemplified in a recent number of *Erythea*, in which a writer takes exception to certain names proposed for some new species. Several are Latin and Greek hybrids, and one is a latinised form of a Mexican place-name. It is possible to imagine more euphonious combinations; but, apart from the mere name, were they the worst sounding conceivable, or constructed in violation of every rule of orthography, no one is justified in replacing them off-hand without examining the plants and ascertaining in the first place whether a new name be required. No botanist, with any self-respect, would thus become responsible for species in a critical genus.

A NOMINALIST!

THE following precious note appears on p. 498 of *The American Naturalist* for May, 1895:—

The Name of the Southern or Splenic Cattle-Fever Parasite.—The generic name given by Drs. Smith and Kilborne, having been previously used in Zoology, must be dropped. I propose the name *Piroplasma* to replace it.

Piroplasma bigeminum (S. & K.)

Syn. *Pyrosoma bigeminum* Smith and Kilborne, Repts. Bn. An. Ind. '91-'92 (1893), p. 212, plts. IV-IX.—Wm. Hampton Patton, Hartford, Conn.

Mr. Wm. Hampton Patton is another of those that love to reap where they have not sown. The next time that a desire for fame leads him to irritate zoologists by the publication of a new name in this hugger-mugger fashion, we trust he will give the evidence on which the name due to the original author is stated to be pre-occupied, and that he will see more carefully to his own names. *Piroplasma* is either a solecism or a mongrel, but as its etymology is not given, we are unable to decide which.

Botany and the American Government.

Under the title of "The Botanical Work of the Government," Mr. J. M. Coulter gives in the *Botanical Gazette* for June, a brief sketch of the work of the U.S. Department of Agriculture. There are four divisions. That of Botany, under Mr. F. V. Coville and seven assistants, includes, besides more purely scientific work, the investigations of weeds, of poisonous and medicinal plants, and the testing of seeds; 38,600 dols. was appropriated for its use in the past year. The division of Vegetable Physiology and Pathology, with Mr. B. T. Galloway as chief, finds work for as many as ten assistants. Potato disease, diseases of fruits and cereals, and the anatomy of galls, are among the subjects to which attention is now being given. The appropriation for the year ending June 30, 1895, was 26,100 dols. The division of Agrostology comes into existence with the first of July, as separate from the division of Botany. It deals with forage plants and grasses, its function being to instruct and familiarise the people with the habits and uses of these plants, to investigate their natural history and adaptability to different soils and climates, to introduce promising native and foreign kinds into cultivation, and to identify all grasses and forage plants which may be sent in for the purpose. Professor Lamson Scribner, its chief, is preparing a handbook of the United States grasses. He has two assistants, and the appropriation amounts to 15,000 dols. The Forestry division is under Mr. B. E. Fernow, with four assistants. Its main work during the past three years has been the study of the character and value of the woods of "merchantable species." Mr. Fernow has, however, a much more difficult task in hand, namely, the arousing and organising public sentiment in favour of a rational forest policy. Mr. Coulter's article brings home the fact that in some things our American cousins have got a long way ahead of us.

SCIENCE IN MEXICO.

WE have received *La Naturaleza*, the publication of the Mexican Society of Natural History, for 1893–95. This consists of five parts, being nos. 5–9 of vol. ii. of the second series, and gives one a good idea of the activity of naturalists in Mexico.

In zoology, Dr. A. Duges has an interesting paper on the colour variation of the lizard *Gerrhonotus imbricatus*, and illustrates his observations with a coloured plate. In another paper he describes the footprints of a mammal of the genus *Felis* from the Upper Pliocene or Pleistocene deposits of Verdolaga. The impressions correspond closely with those made by the recent *F. concolor*. Some footprints of birds found with the *Felis* are referred to *Oxyechus vociferus*. Professor Herrera concludes his valuable memoir on the climate of the Mexican Valley and the biology of vertebrates, and gives a chart showing the range in height of mammals, birds, reptiles, and batrachians. The paper is of considerable value to the student of geographical distribution.

In geology, Dr. J. N. Rovirosa writes on the structure of the Teapa Valley, and gives some notes on the Cocona Cave, which has a length of 492 metres. Messrs. J. G. Aguilera and E. Ordoñez contribute an explanation of a new geological sketch-map of the Mexican Republic, which has been prepared under the direction of Dr. Antonio del Castillo. The map accompanying the paper shows Quaternary deposits round the greater part of the coast, and extending over a large area of the country, especially to the north. Starting from the Gulf of Mexico, and going west, we cross successively a narrow band of Tertiary deposits, a broad area of Cretaceous, with here and there a little Jurassic or Liassic, and reach the western half of the country which is almost wholly composed of eruptive rock. A few patches of cretaceous deposits occur, and some metamorphosed (Palæozoic ?) masses. Volcanoes, solfataras, and supposed extinct volcanoes are shown. Ordoñez has a note also on the composition of the Aztec Calendar or Sun Stone of the City of Mexico. He finds it to be a mass of Olivine Basalt (olivine, augite, labradorite, and magnetite), and considers that the labradorite was the first to crystallise. A micro-section of the rock is given.

In botany, Mocino and Sesse continue the Flora Mexicana; Dr. J. Ramirez describes a new species of *P. terostemon* (*P. rotundifolia*); while Mr. P. Maurey describes *Sebastiania ramirezii*, a new Euphorbia. Dr. J. N. Rovirosa writes a sketch of the life of E. P. Johnson, one of the pioneer botanists in Mexico, and contributes a note on the Flora of Tabasco. A list of ferns collected by Hugo Finck in the Cordoba district, and sent to the World's Fair at Chicago, shows 149 species.

ILLINOIS AND ITS STATE GEOLOGIST.

IT is our occasional misfortune to have to call attention to the eccentricities of writers, who, because they deal with scientific subjects, come within the cognisance of a scientific journal. A year ago, with reference to *Bulletin* No. 3 of the Illinois State Museum of Natural History, we pointed out that fifty-eight new species were "described in a State publication, under the name of a State official; but that only four of the type-specimens were in the State museum, the remaining fifty-four being in the private cabinets of the two authors." *Bulletin*, No. 4, described thirteen new species, the type-specimens all being in the cabinets of the authors. *Bulletin*, No. 5, described thirty-six new species, none of which were in the State museum, and of which the types of thirty-four were in the cabinets of the authors. The 6th *Bulletin*, published on April 5th and now before us, describes forty-two new species, and all the type-specimens are in the private collection of the State geologist and curator of the State museum of Illinois, Mr. Wm. F. E. Gurley, who with Mr. S. A. Miller, is the joint author of the *Bulletin*.

From the scientific point of view, type-specimens in private collections are in the most useless places. All museums, worthy of the name of scientific collections, endeavour to secure as many type-specimens as possible, especially when these specimens come from the localities in which the museums are situated.

Now, consider the delightful nature of the state of affairs at the Illinois museum. The State geologist has amassed a private collection; by describing his specimens in the State publication he has turned a large number of them into valuable type-specimens; as curator of the State museum he has to recognise that the museum is, alas! destitute of these valuable types, and it is his duty to secure them as speedily as may be for the museum, by purchase or otherwise. It is a situation charming in its simplicity; but, English institutions, please do not copy!

Natural History at the Indian Exhibition.

At the Empire of India Exhibition, Mr. Rowland Ward again has an exhibit of Indian animal life in the jungle and on the mountain. It is admitted that the amount of space at Mr. Ward's disposal does not permit of a representation very satisfactory either to the sportsman or the naturalist. The impressive solitude of the jungle is replaced by scenes that remind one rather of the stage of Drury Lane at pantomime time. The crowding of bears, antelopes, leopards, and goats on a few canvas rocks, with heads of *Ovis ammon* stuck in the background like those of Bluebeard's wives, does not constitute a particularly impressive picture. Another single tableau shows the crocodile, buffalo, gaur bison, rhinoceros, black Himalayan bear, black buck, pythons, adjutants, hornbills, tragopans, rose-headed parrakeets, flying foxes, and some dozen other species of mammals and birds. Some sort of excuse for this medley is supposed to be afforded by a muddy pool, but Mr. Ward knows quite as well as we do that this is absurd. Still, the naturalist may be interested to see many of these animals set up with Mr. Ward's well-known taxidermic skill; and no exception can be taken to the fight between an elephant and two tigers, or to the "frightfully thrilling" situation of a native asleep in his hut while a man-eating panther creeps in at the door. These two tableaux are satisfying to the artist, and it is plain that they are none the less attractive to the public. We hope that Mr. Ward will be able to give many more such exhibitions, and we believe that a little more attention to Nature and less subservience to the "Olympian" style of art would bring him in quite as many sixpences.

Albatross and Penguin Islands.

In the *Victorian Naturalist* for January a photograph is given of the nests and young of the Pelican, taken on Penguin Island by Mr. H. P. C. Ashworth. The paper accompanying it deals also with a visit to Albatross Island, and describes the curious "caves," formed, apparently, by the disintegration of soft dykes, which cut vertically through the quartz conglomerate, of which the island is composed. It is to be hoped that Messrs. Ashworth and Le Souef will publish the series of ornithological photographs taken by them while visiting this group of islands.

Object Teaching in Town and Country.

Decidedly things are moving. Constantly, some say too constantly, we urge the necessity of a return to nature in our methods of elementary education. The art of printing has done much for man, but the printed page too often inserts itself between our eyes and the realities of the world. Our cry, therefore, has always been—less book-teaching, less giving of information, let children learn for themselves by the old way of the five senses, let science be learned by the individual as it is learned by the race, through observation and experiment. But, as we said, things are moving, and soon there will be little left for us to urge.

In our April Number we mentioned the addition to the Educational Code that permits the time spent in visits to museums under proper guidance to be counted to the children as time spent in school-work. The account of a meeting at the Whitechapel Museum, reported in our News pages, shows that the teachers are taking this permission in earnest, and that there are at least some curators thoroughly in sympathy with the aims of modern educationalists. But, like the text-book, the museum is only a substitute, and in our editorial of April, we put forward the claims of the hedgerow and the quarry to a place in our system of teaching. We rejoice to see that the prophecy on which we ventured is even now being fulfilled.

A remarkable and inspiring circular (No. 369) has just been issued from the Education Department to H.M. Inspectors of Schools.

It is entitled "Object Teaching," and is prefaced with some admirable remarks by Sir George Kekewich. First, he draws the distinction we have so often emphasised between observation of the object itself and information about the object. "It should be always remembered," he says, "that in Object Lessons the imparting of information is secondary to the cultivation of the faculty of observation." He distinguishes object teaching from instruction in natural science: "It is Elementary Science only in so far as it aids the child to observe some of the facts of nature upon which Natural Science is founded; but as it deals with such topics without formal arrangement, it differs widely from the systematic study of a particular science." Science teaching belongs to a later stage of mental discipline. "In Object Teaching the chief interest in the lesson should centre in the Object itself." Summing up the uses of object teaching, Sir George says: "The first and most important is to teach the children to observe, compare, and contrast; the second is to impart information; and the third is to reinforce the other two by making the results of them the basis for instruction in Language, Drawing, Number, Modelling, and other Hand-work. There are, however, other important uses of good Object Teaching. It makes the lives of the children more happy and interesting by opening up an easily accessible and attractive field for the exercise of brain, hand, and eye. It gives the children an opportunity of learning the simplest natural facts and directs their attention to external Objects, making their education less bookish. It further develops a love of nature and an interest in living things, and corrects the tendency which exists in many children to destructiveness and thoughtless unkindness to animals, and shows the ignorance and cruelty of such conduct."

But the chief point in the circular that has attracted our attention is one that may easily be overlooked. After speaking of visits to museums as advantageous in connection with object teaching, it proceeds, "Occasional class excursions out of school hours (or, if the instruction be in accordance with Art. 12 (*f.*) of the Code, in school hours), under proper guidance, will enable teachers both to provide suitable Objects and to confirm previous impressions. It should be borne in mind that Objects, when they are brought into the classroom, cannot be there studied under their ordinary conditions; and therefore it is important by a proper use of such expeditions to let the children see what part the Object plays in its usual surroundings." When we turn to the list of objects suggested as appropriate to these lessons, we find among them "Caves by the sea formed by the waves; caves inland formed by rain dissolving limestone. Springs and running water. Study of flow of a stream. Study of seashore"; while for children in towns are suggested "River or canal, according to circumstances. Atlantic liners. The park or public garden." It is pretty obvious that seashores and Atlantic liners cannot conveniently be brought into the ordinary class-room ; so that outdoor excursions are a necessary corollary of Circular 369. We sincerely hope that the teachers, with whom after all the initiative must lie, will not be afraid of laying on themselves too great a burden, and we trust that they will not be prevented from putting these ideas in force by the apprehension, far too common among them, that a day in the country, or an hour of school time spent anywhere but in the school house, means a loss of marks and a consequent reduction of grant.

Science and Art Department.

The examinations of the Science and Art Department have done good service in setting a high standard for elementary science teaching, especially in evening classes. This is evident from the syllabus published under authority, and becomes still more so from the examination papers and the list of passes. When we consider the hard work, and frequent self-denial, which an approach to the required standards must often mean to students of that class which the whole arrangement is supposed primarily to benefit, it is only fair that an honourable observance of the syllabus should be rigidly adhered to by those to whom the work of examining is entrusted. A correspondent seems, however, to have just reason for dissatisfaction with the botany papers of recent years.

"I write," he says, "as one who has heard many complaints from candidates with regard to the advanced stage of this examination, and also as one who, knowing their opportunities, can sympathise with them. In the first place, they say that it is hardly fair to send a plant for description belonging to an uncommon British order (Apocynaceæ), especially when the only species that has the slightest claim to be indigenous is classed by Watson as a denizen. I have consulted several well-known field botanists resident north of the Midlands, and they—as well as myself—have never met with a plant of this order after rambling over the country for a score of years, and observing nearly all our native plants in a growing condition ; we are, in fact, compelled to steal a flower for dissection from some public park when a favourable opportunity offers, as it is never on sale at the florists.

"In the elementary stage a knowledge of only fourteen orders is required, while in the advanced stage an acquaintance with more than ninety is demanded, besides a fair knowledge of physiology and morphology, as well as an acquaintance with a dozen cryptogamic types.

"When a student who (after passing the elementary stage) has been doing his utmost by collecting and examining all the plants he can meet with, to make himself conversant with the greater number of our native orders, finds that his endeavour to get a pass in the first class is entirely frustrated by having handed out to him from the corner of a box a pinch of pinkish fragments between three fingers and a thumb of a superintendent, he certainly feels that the advanced stage in any other subject is much easier and certainly safer. The pinkish fragments in question were such as one can pick up under a vase of cut flowers ; and belonged to a cultivated plant of a foreign genus—*Dicentra*. In the following year a specimen from another foreign genus—*Weigelia*—was sent at the time when *Viburnum Lantana* was in flower, and could easily have been procured. However, he perseveres for three years more, and then presents himself again, when he receives a few withered fragments of what may once have been tiny white flowers; he asks for more, and gets a morsel of an apparently etiolated stem added to his specimen. This turns out to be withered fragments of the inflorescence of a third foreign genus—*Rheum* (garden rhubarb). After two more years he tries again, and is supplied with a maritime plant—*Armeria maritima*; he does not know it, as he has always resided in the heart of an inland town. As the questions are supposed to relate to the indigenous flora only, the candidate naturally avoids gardens when specimens are procurable in the field. The following year he is confronted with *Vinca*. The specimens sent are too meagre, and are in a dilapidated condition; moreover, they are distributed by a person who does not understand the requirements of the case. Small tin boxes are now so cheap that the additional expense of packing each specimen separately would do away with this cause of complaint, and give every candidate the same chance.

"If it is necessary to send botanical puzzles like the above, there should also be sent a representative of some other order, of which a knowledge might reasonably be expected; the candidate might be allowed to describe both specimens. For elementary students, *Delphinium* was certainly not a proper plant to send as a representative of the Ranunculaceæ.

"In twenty-eight or thirty lessons of an hour's duration a teacher is expected to prepare students for the advanced stage, and if he devotes half the lessons to general morphology and physiology, including the gymnosperms and twelve cryptogamic types, he is then expected to impart a practical knowledge of above ninety orders and their 'largest genera' during the remaining fourteen or fifteen lessons; and this largely in the winter—from September to May.

"Could not a summer course for descriptive work be encouraged? In organised science schools this should be insisted on, a record of the plants dissected should also be required, and the written descriptions should be filed and kept for examination by the inspector."

Our "Challenger" Number.

The kind manner in which the public and the Press have welcomed our attempt to furnish a convenient summary of the scientific results of the "Challenger" Expedition is most gratifying to us, especially as one of its results was to exhaust our first issue, though a larger one than usual, within a week of publication. Our second edition was in the hands of the public on July 6th. In it the opportunity was taken to correct one or two slight misprints. One alteration was the change of the word Bryozoa, in Mr. Harmer's contribution, to Polyzoa. Mr. Harmer had written Polyzoa, which he believes to be the correct name to use, and we, not knowing that he attached importance to the word, had altered it for the sake of consistency. We offer Mr. Harmer our apologies. Unfortunately it was not noticed in time that, in Mr. Carpenter's account of the

Pelagic Hemiptera (p. 60, second line from bottom), the word "Italian" was misplaced. It refers to the Expedition and not to the species.

Of the many kind letters that we have received, we will only quote the following:—"Mr. Gladstone offers his very best thanks to the Editor, for the singularly interesting number of NATURAL SCIENCE which he has been good enough to forward to Hawarden. Jul 1, 95."

We learn that a few people have complained that we did not pay enough attention to the chemical and physical results of the Expedition. Our regular readers will understand that those branches of the subject are outside our usual scope, and were, therefore, only dealt with so far as they seemed to appeal directly to biologists or geologists. Another reason might be found in the fact that their inclusion would have swollen our already enlarged number to a size that would have necessitated the raising of its price. Since, however, there may have been some purchasers of the number who suffered disappointment, we make them the best amends we can by offering them, in the present number, an article on the chemical and physical results of the "Challenger" Expedition, for which we are indebted to the kindness of Mr. Ritchie Scott, who, from his long connection with the "Challenger" Office and from his own special studies, is peculiarly fitted to deal with those questions.

One correspondent, who thinks that we treated the Hydroidea somewhat scantly, reminds us of "the gigantic Tubularian, by far the largest of all known Hydroid-polypes." He writes further, "The specimens of *Idia* brought home enabled the structure of this remarkable hydroid to be worked out in a way which would have been impossible with the dried specimens hitherto in the hands of zoologists, and have given occasion to the establishment, not only of a new family, but of an entirely new section of Calyptoblastic Hydroids. The determination of the true and hitherto misunderstood structure of *Grammaria*, and the establishment of the remarkable family of the Perisiphonidæ, afford sufficient evidence that the work of the "Challenger" in this department was not without results which have, to some extent at least, advanced the progress of Hydroid morphology."

We thank our kind correspondent, but we must remind the others, doubtless not few, who have found some sections less fully treated than they could have wished, that a summary of so gigantic a work, that is to be both short and interesting, must inevitably have "the defects of its qualities." It cannot mete out strictly proportionate justice to every subdivision of the natural sciences.

I.

Some Casual Thoughts on Museums.

Part I.

NO question has been more debated recently, and none deserves to be ventilated more in your pages, than the best arrangement of our museums, and especially of our great museums like the one in Cromwell Road. The problem, of course, depends upon the purpose and aim of museums. The old-fashioned notion that they form a kind of dustbin, where all the useless, ugly, eccentric, and curious productions of art and Nature are to be shown together and labelled with fantastic information, is obsolete. This kind of museum is now rapidly disappearing everywhere, and a theory (conceded as a theory by everyone) prevails that every object exhibited should teach something in a definite and precise way, and should be arranged with other objects so that a continuous lesson can be conveyed, and should not include a series of epileptic jumps from Cathay to Peru and from a mermaid to a mouse.

This theory is sound enough as a theory. Its difficulty is in its concrete application. In provincial museums a great many subjects have to be taught with only a limited collection of objects and a limited space. Stratigraphical geology has to be taught as well as the various problems of life, and an object lesson has to be given in the manifold operations of Nature. This involves an entirely different method of arrangement to that convenient in large museums. It can only be carried out by rigidly excluding all kinds of mere "curios," which, having been remitted very often to the stable or the garret, are passed on by some generous patron of science and art to the unfortunate local museum. All this rubbish should be declined or passed on again to where it ceases to be rubbish because it can form part of a series. It should not be difficult to arrange for every local museum a small stratigraphical collection like the one arranged by Mr. Etheridge at the Natural History Museum, only on a smaller scale, with some of the types of fossils ear-marking particular horizons, also a series of typical generic forms from different parts of the animal and vegetable kingdom. This should not attempt too much and not be too large, but every specimen should be as well mounted as possible, so that the fact that these skins really once belonged to living animals should not need a special label to teach us. There should also be on a small scale a collection to show the anatomy and physiology of life, as displayed in Professor Flower's Index Collections. This might be well done in every provincial museum by making the extent of any one series dependent on the accommodation. A clear, easy handbook should explain the whole collection, written in English and not in that bastard speech, a kind of Tartar jargon, in which every other word is a technical term requiring a dictionary to explain it, and which schoolboys call "beastly dull"—as a matter of fact, all dull men in museums should be pensioned off.

One-half of every provincial museum at least, unless the museum is a very big one, should be devoted to a local collection. It is local collections which ought to form the staple of local museums, the rest being subsidiary. What really interest and are most useful in teaching the greater number of country yokels, are the things they can find about home and know something of at home, and what they should be taught is the vast interest and importance of this kind of knowledge at their elbow when coördinated and arranged. Every object in such a collection should be the best obtainable, and set up as much like Nature as possible, with its natural surroundings and food shown.

What a number of facts and what a mass of knowledge have been accumulated by our workmen's societies in Lancashire and Yorkshire, on the life history of the plants, of the insects, and the land and fresh-water shells of those counties; and what a number of busy people there would be ready and willing to breed obscure moths and beetles, and thus to trace the life stages of many forms where they are still unknown, and to do similar work!

It seems to me that Lord Walsingham's exhibition of butterflies and moths in the British room at the Museum has already made more genuine real naturalists among London boys than all the hideous shows of some of the older parts of the great Museum put together. Such a local collection should also be most accurately labelled by the very best men, and not left to any amateur with two or three books on his shelves. For such collections are not merely intended to amuse the casual crowd, but to help school-boys and other collectors to name their own collections. There should, if possible, be also provided a guide, instructing these inexperienced collectors how to preserve objects, how to detach fossils from their matrix, how to dry plants, etc.; in fact, how to make use of the little knowledge which boys can acquire in the few minutes a day their parents and masters allow them to spare from trying to kill each other at football.

Again, it seems to me very proper that the great museum in Cromwell Road, in addition to its general collections, should contain a special collection of local objects kept together and shown together. This ought to be the type and model for all provincial museums to follow. The great museum is, in fact, the local museum for London—this great empire of London, with a million boys and girls, the great mass of whom are very poor and forlorn, and have no chance of seeing and knowing what Nature is like, what country flowers and butterflies and birds are like, and who crowd the museum at times quite delighted with what they see. Still more delighted if some casual Philistine, like myself, takes a party of them round and tries to convey to them some rags and tatters of dislocated knowledge. This is one class for which "the British room" provides. There is, however, another class—the great army of London public schoolboys—who come with their specimens to label and to identify, and who also come to patronise and to teach their sisters that crabs are not a kind of fish, and that shells are not half so interesting as their nasty, slimy contents which "the girls" habitually throw away.

The only difference between this particular department of the British Museum and of a provincial museum is that, London being so big and so cosmopolitan, this part of the collection ought to be conterminous with Britain itself instead of with some particular county, and the British collection there ought to be a model for the local collections elsewhere. Is it such a model now? Who can truly say so? If we exclude the butterflies and moths arranged by Lord Walsingham, which are incomparable, the birds' eggs arranged by Mr. Seebohm, and some of the crustaceans and echinoderms, do the rest of the collections fulfil any purpose whatever, except to arouse astonishment and disgust? The mammals are grotesque; they give one the impression that English wild beasts are nearly all suffering from the mange, and that they have habitually a grin on their faces suggesting their living continually with a dentist, while their protruding eyes and misshapen bodies are too grotesque for anything. The Chillingham ox is assuredly unmatched in any show in the world. Nor does one of the specimens show how the animals live, or what food they feed upon. They are merely bad furriers' specimens, and they ought to be carted away.

The birds are almost as bad—for the most part old worn-out specimens, badly stuffed, dirty and dusty, and suggestive of a lumber room. The real collection of English birds, than which nothing could be better and more attractive in every way, is not in the British room at all, but distributed partially upstairs and partially in the room containing the general ornithological collection, where it is quite out of place. The unrivalled series ought to be brought together into a British room, with adequate accommodation, and supplemented by a series of mammals similarly mounted, and all the present specimens in the British room moved off to any limbo whatever.

If we turn from these to the fish and reptiles the case is worse. Such horrors as the fish and reptiles in our museums are, were never contemplated in any scheme of nature. After Frank Buckland, and especially Mr. Else at Torquay, have shown us how to preserve fish so that they look something like fish and not like the properties of a pantomime, it is shameful to have passed off for so many years on unsophisticated innocent people these goggle-eyed, discoloured, parchmenty denizens of some necromancer's study, as the Almighty's handiwork. The same with the reptiles. If we are to have a show of British natural history, let it be a real show, and not something which the British fisherman, the British game-keeper, and British country children fail to recognize as old friends and old enemies, and which they are obliged to study in the works of Kircher and his friends. There is something to be said for not showing the public any specimens at all, and reserving them for superior people whose book of Nature is not the one whose leaves are found open in the woods and fields, but in drawers and cabinets reeking with arsenic and camphor; I believe they call themselves "systematists." But if we do show specimens, let the best artists we can find make up for what is inevitably gone, by in some fashion simulating the look of living things. Why should we not have some of those realistic plaster casts that they have at the National Museum in Washington, some of which were illustrated in Natural Science for August of last year? They would be an antidote to "the herald's horrors" which are carved in stone all over the Museum walls, and make one wish that a specimen of an architect could be exhibited in the same room with other eccentricities of Nature.

I should like to prolong this homily in another paper or two.

Henry H. Howorth.

II.

Waltzing Mice.[1]

WHATEVER the late war may have done towards increasing our knowledge of Japan and things Japanese, it was the means of introducing to me an interesting domestic animal, the subject of this article.

The mice were obtained from Mr. Haley, of this city, who received them from Japan. The original pair and nearly all the offspring for several generations are white, variegated with black, disposed about the head, nape, and root of the tail. The exceptions are reversions to the colour of the wild brown mouse, and two instances in which the black is replaced by faint buff; the irides of these are pink, whereas those of the other mice are dark.

At first, a visitor probably regards the mice as mere colour varieties of the common white race. A moment's observation reveals the peculiarities of the breed, and attention is rivetted by their strange performances. Early in life they exhibit the tendency which has earned for them the name above applied. When a mouseling leaves the nest its gait consists of an evident attempt to proceed in a straight line; this is frustrated by a tremulous movement of the head, which is nervously shaken from side to side. Shortly, a tendency is exhibited to turn; this develops into a rotatory motion, performed with extraordinary rapidity, which constitutes the peculiarity of the waltzing mouse.

The ordinary routine of daily life is constantly interrupted by this mad disposition to whirl, frequently indulged in for several minutes, and, with an occasional stoppage of a few seconds, continued for hours. The floor of one of Mr. Haley's cages being somewhat rough, the mice actually reduced their feet to stumps

[1] In August, 1894 (vol. v., p. 91), we referred to a paper by Dr. C. Schlumberger, published in the Memoirs of the Zoological Society of France (vol. vii., p. 63), and giving an account of a Japanese *netsuké*, or ivory carving, which represented a family of dancing mice. In his paper, Dr. Schlumberger referred to another by himself on these curious little animals, in *Feuille des Jeunes Naturalistes*, no. 271, p. 110, and a second by Remy Saint-Loup, in *Bulletin de la Société Zoologique de France*, 1893, p. 85. The following note was posted to us by Mr. E. R. Waite before Dr. Schlumberger's paper reached Australia. Since, however, it is an independent account by a trained zoologist, it will doubtless interest English readers, and may throw further light on this peculiar pathological breed.—EDITOR NATURAL SCIENCE.

before it was noticed. Like ordinary mice they sleep during the day, but apparently waltz the whole night long. If, however, they are disturbed during daylight, they leave their bed and work off some surplus energy.

The rotation is so rapid that all individuality of head and tail is lost to the eye, only a confused ball of black and white being recognisable. Very often they spin in couples, revolving head to tail at such a speed that an unbroken ring only is perceived. It is remarkable that they keep perfectly together; this may be attributed to their similarity in size and not to any special faculty they may possess. An upright peg forms a favorite pivot, but even without this guide they would not, in several minutes, cover an area larger than a dinner plate, and they easily spin under a tumbler. Sometimes three or four mice run together, the extra ones then form an outer circle, but as the evident desire is to rotate rather than revolve, more than two seldom work well. An individual generally spins in one direction only, and the majority turn to the left, only a small proportion going "with the clock."

A waltzing mouse may be placed on the ground without fear of it escaping. Should it attempt to do so, it will not proceed far before being seized with a paroxysm, which it will be necessary to work off before further progress can be attempted. These mice may also be kept in a paper box, which would not detain a wild mouse an hour; the process of gnawing the walls of their prison will be so frequently interrupted by the necessity of practising their infirmity that little damage can be done. As with all truly domestic mice, however, no determined effort to escape, such as characterises the wild mouse, is ever attempted, and at most such efforts are to be regarded as an inherited habit rather than a real desire for liberty, for domestic mice do not readily leave when their cages are left open.

The feature of the breed may be due to cerebral derangement, but that the trait is, at the present day, purely hereditary and not acquired by the individual, is shown by the fact that as soon as they arrive at an age when other mice begin to run, these begin to waltz.

They may be compared to tumbler pigeons, and the analogy is close, allowing for differences between an aërial and a terrestrial performance. The plane of motion is, however, quite different, as exemplified by Indian ground tumblers, which, when placed on the ground, turn head over heels.[1] In both cases the affection is the result of perpetuation by heredity of an affliction which would have insured the destruction of a wild race.

EDGAR R. WAITE.

Australian Museum, Sydney,
27th March, 1895.

[1] Darwin. "Plants and Animals, etc.," i., p. 150.

III.

Bud-Variation and Evolution.

MR. L. H. BAILEY has lately published an interesting paper on this subject,[1] treating the well-known phenomenon of bud-variation from rather a novel point of view. He observes that the evolution of the higher animals, at least, has proceeded in accordance with a different law from that of plants, and it is the object of his paper to emphasise the recognition of the fact of asexual evolution in the vegetable kingdom. When we remember that, on the ascending scale of life, the whole of the vegetable kingdom has never risen much above the level of corals, inasmuch as well nigh any portion of the highest plant is capable of reproducing all the phenomena of the entire plant, his contention seems feasible. He observes: "The mere fact that the phyton [or assumed plant unit] may reproduce itself is not the most important point, but rather, that each part of the plant may respond in a different manner or degree to the effects of environment." As no two peas are precisely alike, so no two branches on the same tree are identically the same in every point of structure; for, "variation among the sisterhood or colony of branches is determined by very much the same conditions which determine variation in independent plants growing in the soil. I believe that the primary and most important determinant of this variation is the variation in food supply." Hence follows a struggle for existence among the developing buds of a tree, strictly parallel to that among a number of individuals growing thickly together. There are weakly developing branches and strong branches, and "the survival of the fittest [*i.e.*, the constitutionally strongest] is Nature's method of pruning."

With regard to bud-variation, properly so called, which involves not merely vigour—even if it have that—but some change in form and appearance of the organs it may bear, Mr. Bailey shows that there is abundant asexual variation, and that this variation takes place as readily when the phyton is growing upon a plant as when growing in the soil. Now, every branch or phyton is in an incipient degree, a bud-variety; *i.e.*, as a rule, only in minute or inconspicuous features. Nevertheless, even in these, the practical horticulturist

[1] "The Plant Individual in the Light of Evolution." Address before the Biological Society of Washington, January 12, 1895. (*Science*, new series, vol. i., p. 281, March 15, 1895.)

recognises important differences, for "he instructs his budders to cut buds only from the topmost shoots of the nursery rows in order that he may grow straight, vigorous trees; and every farmer's boy knows that the reddest and earliest apples grow on the uppermost branches, and his father will always tell him that he should never select scions from the centre or lower part of a tree." This practice rests on the principle of acquired characters being hereditary in plants, expressed by M. Carrière, thirty years ago, in the following words[1] :—" Faisons aussi remarquer que les diverses combinaisons faites pour perpétuer les variétés, ou pour en obtenir de nouvelles, reposent sur cette loi générale que, dans la nature, tout tend à se reproduire et même à s'étendre, que par conséquent les modifications peuvent non-seulement devenir héréditaires, mais qu'elles peuvent encore servir de moyen pour arriver à d'autres modifications, à étendre et à multiplier de plus en plus les séries typiques."

Bud-variation, however, as ordinarily understood, consists of only the more extreme and readily noticeable forms of variations, as when a nectarine is borne on a peach tree, or laciniate or variegated leaves appear on a tree that ordinarily has entire, or green leaves, respectively, and the like.

The important point which Mr. Bailey proves is, that bud-variation and seed-variation are not only strictly parallel phenomena, but are really of one kind; for horticulturists can bring selection to bear on plants raised from bud-variation, or plants propagated by buds, and so "improve" them and fix varieties, just as they do with seedlings. The author quotes the following passage of Darwin's[2] : "To my surprise I hear from Mr. Salter that he brings the great principle of selection to bear on variegated plants propagated by buds, and has thus greatly improved and fixed several varieties. He informs me that at first a branch often produces variegated leaves on one side alone, and that the leaves are marked only with an irregular edging, or with a few lines of white and yellow. To improve and fix such varieties, he finds it necessary to encourage the buds at the bases of the most distinctly marked leaves, and to propagate from them alone. By following with perseverance this plan during three or four successive seasons, a distinct and fixed variety can generally be secured."

As another parallel between bud- and seed-variation, Mr. Bailey says: "It is well known that the seedlings of plants become more variable as the species is cultivated; and it is also true that bud-varieties are more frequent and more marked in cultivated plants," many plants having great "sporting" tendencies, as in certain sections of roses, chrysanthemums, etc. The general cause is the same for both kinds of variation, namely, the environment; or in the words of Darwin:

[1] *Production et Fixation des Variétés dans les Végétaux*, p. 9. Paris, 1865.

[2] "Animals and Plants under Domestication," i., p. 411.

" When we ask ourselves what is the cause of any particular bud-variation, we are lost in doubt, being driven in some [all ?] cases to look to the direct [or indirect] action of the external conditions of life as sufficient."

Again, as crossing is common among flowers, so graft-hybrids are possible. One stock or scion may so influence the other as to cause it to produce buds partially or greatly like itself. Seeds of a cultivated scion when grafted on a wild stock may be so affected as to reproduce the wild form. Other instances are well known.

Mr. Bailey next draws attention to the seminal reproduction of bud-varieties, as, *e.g.*, the moss-rose. On the other hand, as " some seed-varieties will not 'come true' by cuttings, so also there are some bud-sports which will not."

Lastly, "in proof of the further similarity of bud- and seed-variations, each class follows the incidental laws of external resemblance which pertain to the other class. For instance, there are analogous variations in each, giving rise to the same kinds of variegation, the same anomalies of cut and coloured foliage, of creeping branches, parti-coloured fruit, and the like . . . The most expert observer is not able to distinguish between bud-varieties and seed-varieties ; the only way of distinguishing the two is by means of the records of their origins."

Mr. Bailey next discusses more fully the most important point of truly asexual variation as a source of the origin of species. He enumerates several plants which have produced, under cultivation, many varieties, but have never been known to bear seed—such as the pine-apple, banana, bread-fruit, weeping willow, "top" onion, and horse-radish. Of fruit-trees, he describes the interesting case of the Newtown pippin apple, which has been widely spread by grafting. He tells us that it originated upon Long Island, New York. In Virginia it varied into the " Albemarle Pippin," an inferior kind. It has varied again in the extreme North-Western States, " being much longer, and bearing distinct ridges about the apex."

This last form has varied again in New South Wales, the ridges becoming more marked, and is called the " Five-crowned Pippin." That the causes are attributable to the environment, such as climate, etc., is obvious, from the fact that " most north-eastern varieties of apples tend to take on the elongated form in the Pacific North-West, to become heavy-grained and coarse-striped in the Mississippi Valley and the Plains, and to take other characteristic forms in the higher lands of the South Atlantic States."

He notes the rapidity with which the asexual changes are sometimes brought about : " Within two years the Chilian strawberry varied or departed from its wild type so widely as to be indistinguishable from the common garden strawberry ; so that we have here a most interesting case of sexless evolution, but one in which the subsequent generations reproduce these characters of sexless origin by means of seeds."

Mr. Bailey further observes that, since evolution by asexual variation can take place under cultivation, it will be able to do so in nature, whenever plants can be multiplied and distributed by detachments from their vegetative system, as many water plants are (*Hydrocharis*, *Elodea*, etc.), and numerous land plants, by bulbils, runners, offsets, etc.

Darwin has collected a number of instances of "bud-variation by suckers, tubers, and bulbs,"[1] as among potatoes, dahlias, phlox, tulips, etc. Since, therefore, new varieties and races can be established by bud-variation alone, there is ample evidence to prove that "a progressive evolution of plants can take place without the aid of sex."

The rationale of all this is, that variation in plants is always due, directly or indirectly, to the influence of the environment; and it matters not whether the plant be raised from seed or from the vegetative system, the new surroundings can act on both precisely in the same way. This, I have proved, *e.g.*, taking slips and seed from the wild spiny rest-harrow, in two years I have converted both into a spineless form not distinguishable from the so-called species *Ononis repens*, L, by growing them in a constantly saturated atmosphere.

Mr. Bailey concludes his article by refuting Dr. Weismann's theory and observes: "I should bring in rebuttal the result of direct observation and experiment to show that given hereditable asexual variations are often the direct result of climate, soil, or other impinging conditions. As a matter of fact, we know that acquired characters may be hereditary in plants; if the facts do not agree with the hypothesis, so much the worse for the hypothesis."

Now it is in this power of evolution, in the vegetable kingdom, by wholly sexless means, that Mr. Bailey sees a fundamental difference between the evolution of plants and that of the higher animals at least.

George Henslow.

[1] *Op. cit.*, i., p. 384.

IV.

Chemistry and Physics in the "Challenger" Report.

ALTHOUGH the interest of zoologists in the "Challenger" Expedition and its results, as embodied in the fifty volumes of *Report*, chiefly centres upon the zoological section and its revelations of life in the great oceans, yet it should not be forgotten that the unique services rendered by the Expedition to oceanography, in its chemical and physical aspects, are not only valuable in themselves, but have a profound bearing on marine zoology. The fundamental conditions of an animal's existence are expressible as physical data: what is the average temperature of its habitat, and to what range of temperature is it subjected? how much oxygen can it have? how much sunlight? and, in the case of marine organisms, the amount of salinity and pressure may become questions of importance. All these questions are for the physicist and the chemist to answer, and to him must the naturalist apply if he would render a full account of marine life, especially in the consideration of such general questions as the distribution of species and the like.

On board the "Challenger" the chief physical work was the determination of the specific gravity of samples of water collected from the surface every day; from the bottom at sounding-stations by means of a slip bottle attached to the line; and, wherever practicable, from intermediate depths of 25, 50, 100, 200, 300, 400, and 800 fathoms from the surface. A characteristic feature of the Expedition's work was the determination of the temperature of these water samples *in situ*, as was also the collection of samples from various depths all over the great oceans.

The chemical work of the ship-laboratory consisted in extracting the gases from, and determining the carbonic acid in, as many samples as possible. Besides this, a very large number of samples of sea-water from the surface, the bottom, and intermediate depths were carefully stored in glass bottles for more detailed examination at home. This was the daily programme for some three and a half years. "It is difficult," writes Dr. Murray, "for anyone, except those who actually witnessed the daily work at sea, to form an adequate idea of the labour, skill, and continuous effort required to carry on these observations in all sorts of weather, and to form, and bring home successfully, collections and observations like those which have resulted from Mr. Buchanan's exertions."

After the return of the Expedition to England, Mr. Buchanan proceeded to analyse the gas samples which had been brought home; but he being unable to proceed with the chemical work of the Expedition, all the material was handed over to the late Professor Dittmar for completion of the work. The resulting volume, published six years after, in 1884, besides being a valuable addition to oceanography, contributed not a little to the art of chemical analysis, in which Professor Dittmar was a recognised master; and as a piece of scientific work it is a monument of painstaking and unwearied search after accuracy, doubly instructive in its mathematical habit of thought and its simple record of persistent trial and failure until the desired result was accomplished.

The first really great work on the chemistry of ocean-water was that of Georg Forchhammer, who, in 1864, just twenty years before the appearance of Dittmar's Report, published his paper, "On the Composition of Sea-water in different parts of the Ocean." Beyond his demonstration of the existence in sea-water of constituents hitherto unsuspected, his great service to science consisted in showing that the proportions of the cardinal constituents of sea-water salts, the chlorine, sulphuric acid, lime, and magnesia, vary very little throughout the great oceans. After Forchhammer's work no analysis of sea-water was of any value unless executed with the highest attainable precision, and it was in full consciousness of this that the late Professor Dittmar entered upon the complete analysis of his seventy-seven samples of ocean-water, and endeavoured to furnish, as he says, "if nothing more, at least a valuable extension of Forchhammer's great work."

The small quantity of each sample at his disposal (from one to two litres) rendered impossible the determination of the minor constituents (some twenty-two in number) enumerated by Forchhammer, so he restricted himself to the determination with great accuracy of the chief components, sodium, potassium, magnesium, calcium, and sulphuric and hydrochloric acids. This direct determination of the sodium, which had been omitted by Forchhammer for want of an accurate method, was a great advance, and led to a very valuable result, viz., that the equivalents of base were always in excess of the sum of the equivalents of sulphuric and hydrochloric acids, thus establishing beyond doubt the presence of considerable quantities of carbonates in sea-water.

Combining acids and bases in an arbitrary way, we may state Dittmar's final results as follows:—

	Average Composition of Ocean-water Salts.	Average Composition of 1 litre of Ocean-water.
Sodium chloride	77·758	28·9980 grms.
Magnesium chloride	10·878	4·0568 ,,
Magnesium sulphate	4·737	1·7665 ,,
Calcium sulphate	3·600	1·3425 ,,
Potassium sulphate	2·465	0·9193 ,,
Magnesium bromide	0·217	0·0809 ,,
Calcium carbonate	0·345	0·1287 ,,
Total salts	100·000	37·2927 ,,
Water		989·7073 ,,
Weight of litre in grammes		1027·0000

The last column gives the average composition of a sample of ocean-water of specific gravity 1·027.

Professor Dittmar's work fully confirmed Forchhammer's conclusion as to the constancy in composition of the sea-water in various parts of the ocean, and further showed that the depth is without influence on the composition of the salt, if we limit ourselves to the ratios between chlorine, sulphuric acid, magnesia, potash and bromine. This last constituent, occurring as it does in very small quantities, and being considerably utilised by sea-plants, was considered by Dittmar to be more liable to local variation than the others. From the determinations of the lime, however, there would seem to be no doubt that its proportion increases with the depth. This result of the separate analyses was confirmed by the analysis of mixtures of superficial and deep waters, and also by the alkalinity determinations, deep waters almost always showing a higher alkalinity than superficial ones. Let us explain what is meant by alkalinity. All sea-water is alkaline to test paper[1] and reagents, and as Dittmar's complete analyses always showed an excess of equivalents of base over those of sulphuric and hydrochloric acids, all this alkalinity must be due to the base united with carbonic acid. Dittmar (after Tornoe) measured this alkalinity by determining how much carbonic acid was required to form normal carbonates (*i.e.*, similar to carbonate of lime) with the base of the sea-water not united with sulphuric and hydrochloric acids. Carbonic acid being a weak acid is probably combined chiefly with the weakest bases—that is, with the magnesia and lime; and the magnesium having a tendency to form double salts, probably forms a double chloride with the abundantly present sodium chloride, leaving the greater share of the carbonic acid to the lime. At any rate, the "alkalinity" measures the potential carbonate of lime, and may fairly be presumed to measure approximately the actual carbonate of lime present. Thus the higher alkalinity of the deeper waters argued a higher percentage of carbonate of lime.

The gaseous contents of sea-water—oxygen, nitrogen, and carbonic acid—are of great importance to the biologist, for, in view of

[1] This was observed as early as 1777 by Bergmann; Von Bibra (1851), although an independent discoverer of the fact, was certainly not the first, as supposed by Tornoe and Dittmar.

the constancy in composition of ocean-water, it is chiefly the quantities of gas in the water which determine the capability of any region of the ocean for supporting life. Owing to the greater solubility of oxygen in sea-water as compared with nitrogen, the air contained in normal sea-water, whence fishes obtain their oxygen, is twice as rich in oxygen as the atmospheric air; but, owing to the slower circulation of the waters, it is much more liable to deterioration; and quite stagnant water, as under peculiar conditions in some Norwegian fiords, and notably in the Black Sea, may become so impoverished in oxygen as to be quite unable to support animal life of any order higher than bacteria. This deprivation of oxygen is accompanied by a rise in the proportion of carbonic acid derived from the carbon of the animal matter which the lost oxygen has oxidised.

The whole of the oxygen and nitrogen and a minute fraction of the carbonic acid are derived from the atmosphere, but the major part of the carbonic acid is formed in the water.

The presence in sea-water of carbonates and loosely combined carbonic acid had been acknowledged long before the outset of the "Challenger" Expedition. In 1777, Bergmann attributed the alkalinity of sea-water to magnesium carbonate; but the general impression was, that there were only minute traces of carbonates, and that the carbonic acid existed mostly in a state of absorption. It was found, however, that the carbonic acid in sea-water was only completely driven out upon distillation nearly to dryness, if no reagents were added. This was considered to be due to the peculiar affinity of some sea-water salt for carbonic acid, various salts being accredited with this power by different investigators. Tornoe then showed by a long series of combined determinations of alkalinity and carbonic acid that in North Atlantic waters the carbonic acid was present as bicarbonate; and Dittmar's discovery of the surplus of base over hydrochloric and sulphuric acids confirmed this result and established it generally, clearing up finally this long vexed question.

In general, the result of Buchanan's determinations and Dittmar's further work in this connection may be stated in brief by saying that "ocean-water from any place or depth contains its surplus base in the form of normal carbonate combined with additional carbonic acid, which latter in the majority of cases falls short of, in a minority of cases comes up to, and very rarely exceeds, that which would produce bicarbonate." Dittmar's final summary as to the distribution of carbonic acid in the ocean is as follows:—

1st. Free carbonic acid in sea-waters is the exception. As a rule, the carbonic acid is less than the proportion corresponding to bicarbonate.

2nd. In surface-waters the proportion of carbonic acid increases when the temperature falls, and *vice versâ*.

3rd. Within equal ranges of temperature, it seems to be lower in the surface-water of the Pacific than it is in the surface-water of the Atlantic Ocean.

The sea being dependent on the atmosphere for its supplies of oxygen and nitrogen, the absolute quantity of these gases present in a sample will depend on the temperature and barometric pressure at the time of absorption. Thus, at 760 mm. and 2° C. (35·6° F.) one cubic foot of sea-water will absorb 13·42 cubic inches of oxygen and 25·67 cubic inches of nitrogen, while at 27° C. (80·6° F.) it will only absorb 8·15 cubic inches of oxygen and 16·13 of nitrogen. The normal proportion of oxygen in sea-water air is thus from 34½ to 33½ per cent., but while the inert nitrogen remains unaltered, the oxygen ever tends to diminish.

In surface-waters the total quantity of gas in solution was found to decrease as one went from the poles to the equator, as also did the proportion of oxygen. In high latitudes the proportion of oxygen is sometimes so high as to amount to supersaturation, 35·01 per cent. being found near the Antarctic Circle. A similar phenomenon was observed by Tornoe in Arctic waters, wherein he found as much as 36·7 per cent. of oxygen. The lowest percentage of oxygen was found in warm regions where oxidation processes are rapid, and fell as low as 32·2 per cent. towards the south-east of the Philippine Islands. This contrast between the percentages of oxygen in warm and cold waters was most pronounced in the water strata from 100 to 300 fathoms in depth. Bottom waters were almost always poorer in oxygen than intermediate waters from great depths. No water was found to be absolutely devoid of oxygen, although in waters from great depths the quantity was often very small. Thus, from a station on the 30th parallel, to the north of the Sandwich Islands, the dissolved air contained only 3·84 per cent. of oxygen, amounting to about one cubic inch per cubic foot of water. From the amount of nitrogen present there must have been originally fourteen cubic inches of oxygen present.

The discussion of Deep-Sea Deposits involved a considerable amount of chemical work, consisting chiefly of analyses of samples of deposits, minerals, corals, manganese concretions, and organic remains, 161 analyses altogether being recorded in the Report on Deep-Sea Deposits. The majority of the analyses were executed by the late Professor Brazier, of Aberdeen; the remainder by Anderson, Church, Dittmar, Gümbel, Hornung, Klement, Renard, Ross, and Sipöcz.

This Report also includes a remarkable analysis of manganese nodules, with special reference to the presence or absence of the rarer elements, carried out with all the resources of modern analysis by Professor Gibson, of Edinburgh. Space will not permit us to quote it in full, but we may mention that he detected and estimated the amount present of sodium, potassium, ammonium, magnesium, calcium, strontium, barium, manganese, cobalt, nickel, zinc, thallium, iron, alumina, copper, lead, molybdenum; also sulphates, chlorides, phosphates, vanadates, carbonates, silicates and titanates, and found traces of lithium, tellurium, and fluorine.

Professor Tait has contributed two valuable Reports bearing on Ocean Physics. The first of these is on the pressure error of the "Challenger" thermometers. In view of the high pressure existing at great depths, a correction of at least half a degree Fahr. for every mile under the sea had been assigned to the thermometers, although protected. This was considered by Professor Tait to be excessive, and he proceeded to investigate the matter and found that pressure alone can affect the reading of the thermometers when let down into the sea, and that in no case does the correction exceed one-seventh of a degree per mile of depth. Other experimenters had been misled in their laboratory experiments by the heating effect due to sudden compression.

The above Report gave rise to a number of interesting questions bearing on Ocean Physics, which were subsequently investigated and formed the basis of his Report on some of the Physical Properties of Water. This includes the investigation of the compressibility at high pressures of fresh and sea-water, of solutions of common salt, and of glass and mercury; it also takes up associated physical questions such as the change of temperature produced by compression, the internal pressure of a liquid, and others.

Both these papers involved a great amount of experimental work and contain much that is of permanent value to pure physics.

A. RITCHIE SCOTT.

V.

Biological Theories.

VIII.—THE CRYSTALLINE LENS.

TWO theories as to the action of the lens in the vertebrate eye are extant, and I have been familiar with both for so long a time that I do not know where I first learnt either of them. Of these, one is to be found in almost any good text-book of physiology, and in some text-books of physics. The other is well-known to physicists, and is the obvious and necessary outcome of the treatment of optical questions by the method of considering wave-surfaces instead of "rays."

The first and almost universally adopted doctrine treats the lens of the eye like the lens of a photographer's camera, and involves the calculation of the focal length of the lens from its "mean refractive index" and the curvature of its surfaces. The second is based rather on a knowledge of the internal constitution of the lens than on its external conformation. Before entering into it let me describe an exceedingly simple experiment which ought to be seen by every student of physiology.

Remove the lens from the eye of a rabbit and press it very slightly between two slips of glass so as to reduce its anterior and posterior surfaces to two parallel planes. Now look at a printed page through it and note that, though its surfaces are parallel and plane, it magnifies strongly. Hold it up, still between the glass slips, at a suitable distance in front of a white screen, and note that this body, now no longer a lens, still produces a clear image.

From the results of this experiment, which I hope every reader will try for himself, it follows that the first of the two doctrines is erroneous, and that neither curvature of the surfaces nor the "mean refractive index" of the lens has any important influence in the formation of the image, and that the function of the lens depends almost entirely upon the arrangement within it of media of different optical densities.

The second doctrine, the true one as it seems, is that when a light-wave falls upon the lens and traverses it, that portion of the wave which traverses the central portion of the lens, having to traverse media in which its velocity of propagation is less than in the peripheral portions, is retarded in its passage to a greater extent than are other portions of the wave, and thus a wave-front which was before plane (as in a beam of "parallel rays") becomes strongly concave, that is, the "rays" become convergent.

The representation in diagrams of the effect of the lens is not difficult if contours of wave-fronts are drawn instead of "rays," and the mathematical difficulties may be avoided in lectures to medical students, by using only those formulæ which do not involve either radii of curvature or indices of refraction. The exact mathematical treatment of the problem, from the point of view of the second doctrine, appears to be almost impracticable; for the measurement of the refractive index at each point in the lens, though theoretically possible, would be both exceedingly laborious and also liable to very great error. A very slight tremor indeed in the razor, at the moment of cutting the section of the lens, would lead to considerable error; and the use of a cover-glass would bring in new errors which it would be practically impossible to eliminate. Such exact measurements are, however, not necessary for the purposes of the physiologist: all he requires is to show roughly that the refractive index does increase as we pass from periphery to centre of the lens; in fact, the only experiment he requires to make is the one I have described.

C. Herbert Hurst.

VI.

The Newcastle Museum of Natural History.

THE Newcastle Museum had its origin in a collection of birds and miscellaneous objects made by Marmaduke Tunstall, Esq., of Wycliffe-on-the-Tees, in Yorkshire, in the latter half of last century, and it was then known as the "Tunstall" or "Wycliffe" Museum. This collection was purchased after Mr. Tunstall's death (in 1790) by George Allan, Esq., of Blackwell Grange, near Darlington. This gentleman had already collected a series of curiosities, but the accession of the Wycliffe specimens and other augmentations gave him so considerable a museum that he had the objects arranged and labelled in special rooms and opened to the public. The collection at this period consisted principally of birds; but other Natural History specimens, certain relics of antiquity, coins, seals, and curiosities formed part as well. The "Allan" Museum was thus comparatively rich, and the records show that it attracted a large number of visitors. After Mr. Allan's death, which occurred in 1800, the collection, with other things, was advertised to be sold, but a number of Newcastle gentlemen, members of the Literary and Philosophical Institution, were successful in buying the museum privately before the sale, and thus it was that this important collection was secured to Newcastle. It formed a nucleus around which the magnificent collections yet to be mentioned have been gathered.

The "Allan" Museum was placed in the old committee-room of the Literary and Philosophical Society for a few years. In 1829 a section of the members of that society formed themselves into a Natural History Society, and, acquiring ground from the parent institution, built special rooms which did duty for many a year as the home of the Newcastle Museum. Here the collections remained and grew until it became perfectly hopeless to do justice to even a part of them; but at length a vigorous effort to provide a worthier and larger habitation was made by many enthusiastic members of the society, chief among whom we must note the well-known Mr. John Hancock. This classic building (the Hancock Museum) was opened by the Prince of Wales in 1884.

As has been said, large accessions had been made to the museum collections. Among such additions acquired by gift and purchase we must note the Hutton, the Charlton, and the Cookson collections of minerals; a collection of Russian minerals presented by the late Emperor Nicholas of Russia; the Loftus, the Prior, the Dew-Smith, the Kirkby, the Atthey, the Abbs, the Trevelyan, the Hutton, the Goring, and the Duff collections of fossils; the Robertson and the Winch herbaria of British plants, and the Bowman herbarium of British and Foreign plants; the Tankerville collection of corals, sponges, etc.; the Alder collection of Mollusca; the Hodge collection of Crustacea and Echinodermata; the Bold collection of Coleoptera and other insects, Wasserman's Lepidoptera, Raine's Lepidoptera; Albany Hancock's Tunicates, Nudibranchs, etc.; and the even better known collection of British birds and eggs and nests made by John Hancock. The Raine collection of the nests and eggs of British birds is also a very interesting and extensive one. Many original drawings, principally Bewick's birds, vignettes, etc., and Albany Hancock's original drawings of the Nudibranchiata, together with numerous books, have also been handed over to the care of the museum. It needs only a glance at the above list to show that the museum is not only rich in specimens, but that many of these are very valuable type-specimens. The Hutton collection of fossil plants from the Coal-Measures is especially noteworthy as forming the basis of, and furnishing the figures for, the "Fossil Flora of Great Britain," by Lindley and Hutton (1831–37). Another most interesting collection of fossil fishes is that which was formed by the late Thomas Atthey, and which was presented by Lady Armstrong. The specimens used in the preparation of Alder and Hancock's Ray Society monograph on the Nudibranchiata, although not on exhibition, are preserved in the museum. A large portion of the museum is devoted to the Hancock collection of birds. We shall notice other important specimens if we now make a rapid survey of the rooms.

As we approach the museum we find that it occupies a commanding position at Barras Bridge, a convenient and pretty part of the city. It is within easy reach of the Medical College, and the College of Science is almost next door. It is surrounded by trees, and the grounds are laid out as a rock garden, which an enthusiastic member of the committee keeps in a never-failing succession of bloom. At the back of the building are large cages, in which are kept certain live animals, and at present one can see there a llama, a herring gull, a peregrine falcon, and a condor. Entering the museum we find ourselves in a corridor decorated with innumerable ruminant horns. Here we can secure a guide to the museum, a guide to the Hancock collection of birds, a catalogue of the local fishes, and another of the local fossils; all the work of the curator, Mr. Richard Howse. There are more ambitious catalogues which we need not at present mention. Passing to the right or left we find that the collections are arranged in three large rooms well-lighted from the roof, in galleries around these rooms, and in large and spacious corridors. A series of workrooms is placed in the back of the building. The collections are displayed in floor-, double desk-cases, and in wall-cases. A uniform white or light background is used throughout, though some of the light-coloured specimens, as can easily be imagined, would be better displayed against a dark background. We find, too, on looking a little more closely, that though the labelling of the main groups is boldly and carefully done, the specimen labels are often very indistinct. There are no special features of display or arrangement; no attempt to teach particular lessons, such as we find in so many modern museums.

The specimens have been simply arranged in systematic or linear order as far as the arrangement of the cases and other circumstances permitted. The first room is devoted to the Invertebrata, the Pisces, Amphibia, Reptilia, and Mammalia; the second to the Hancock collection of birds; and the third holds part of the exhibition of fossils and minerals, which extends into two of the corridors. A third corridor has received bulky rock and mineral specimens and the large cetacean possessions.

The Protozoa, the Medusæ, and the Actinozoa are illustrated by models, and other invertebrate groups by more or less complete series of specimens, chief among which we note the Alder and Hancock Mollusca, and the Insecta. The fishes are altogether represented by stuffed specimens and a few skeletons, including one or two disarticulated skulls. *Gymnurus Banksii* and *Trachypterus arcticus* are conspicuous among the more important forms. Along with the stuffed specimens of Amphibia and Reptilia we see a few spirit preparations. These might with advantage be added to, and attempts made to follow Hamburg, for example, in using shallow, upright, rectangular bottles, so that the specimens might be shown in horizontal, natural attitudes. Among the mammals, we note in passing the Marsupial Mole, *Notoryctes typhlops*, an embryo of the Greenland whale, as well as other interesting cetacean skeletal parts, and the head of a Chillingham bull, while the skeleton of a Chillingham cow may be seen in one of the corridors.

The Hancock collection of birds is a magnificent display of numerous examples of the art of the master. The general collection is effectively shown in separate wall-cases, and a few artistic groups occur in the middle of the room. "How not to do it" is illustrated in some relics of the Allan Museum, shown in the gallery. These specimens, however, are very interesting as having been used by Bewick for his illustrations. The great Auk from this collection, unique in being in immature plumage, and another specimen got by Hancock, are, of course, more than interesting, so is the egg which the visitor may see on application, along with many beautiful plaster of Paris casts made and painted by Mr. Hancock.

The fossils are arranged according to the horizons of their occurrence, and to enumerate them here would be to make this article endless. They have been well arranged (largely in wall-cases provided with wooden terraced shelves), as we should expect when we consider that Mr. Howse, the curator, is a well-known palæontologist. The minerals are arranged conveniently under the heads of the metals. A model showing the formation of the district, and maps or sections would be valuable to the student of these collections.

Enough has been said to show that the museum acts a worthy national part in preserving so much valuable material to the country; that this material has been of considerable importance in furthering the study of certain sections of natural science; and that the cases present an arrangement and display which make the museum an important factor in the local work of higher education. Many specialists have been attracted to it by the wealth of its collections in the departments which it may be said to profess specially, and which have been pointed out. A complaint is often made that the museum is not much taken advantage of. But this cannot be altogether true, for on holidays, at any rate, it is, I understand, well attended. Little attempt, it must be said, has been made to attract visitors by providing striking curios to look at; and it is not at all desirable to do so. Order and neatness in preserving, arranging, and labelling are far more to be desired than cases designed to catch the eye of the curious. A well-arranged case containing tastefully prepared specimens is an attraction in itself, and the visitor will be quite able to appreciate such. A museum must be considered as a means for collecting and preserving material of value in the departments it professes, that this may be of use for the furtherance of research in those departments. And such specimens as it may be found convenient to exhibit should be so arranged and labelled that the lesson they teach may be easily read by those who will. Such an arrangement is made with a distinct educative purpose, and not as a show of curiosities. And looked at in this light, the Newcastle Museum will be found to occupy a first-class place among provincial museums. The curator is a cultured naturalist; and the cases show that the museum's taxidermist is a man who turns out splendid work.

Of course, it will easily be seen that the specimens on view illustrate the natural bias of the individual collectors, and do not, on that account, represent Nature's balance; and this should be kept in mind. There are also some developments which might be suggested other than those pointed out above, but this is not the place to do so.

Alexander Meek.

College of Science, Newcastle.

VII.

Huxley.

THOMAS HENRY HUXLEY was born at Ealing, on May 4, 1825. His father was master in a small school there, and in this school the boy received his first instruction. Little is known of his early life, but it is certain that he early obtained a mastery over languages, more especially German, afterwards to be of the greatest service in his scientific labours. He entered Charing Cross Hospital Medical School in 1842, where he had the advantage of hearing lectures from Wharton Jones. He took the M.B., London, in 1845, the M.R.C.S. in 1846, and entered the naval service, going to Haslar under Sir John Richardson. Contact with so distinguished a traveller and naturalist had no doubt much influence on Huxley's career, and we find him appointed to the "Rattlesnake," then fitting out for a surveying voyage to the Great Barrier Reef, New Guinea, and the Louisiades, under Captain Owen Stanley. He made good use of his opportunity, and even while away sent home several papers on natural history subjects of such importance, that already on his return in 1850, he found himself a man of considerable reputation. He was immediately elected a Fellow of the Royal Society, and received the Royal medal from that body in 1852. Leaving the service in 1853, he succeeded Edward Forbes the following year as Professor of Natural History to the Royal School of Mines. In the same year he became Fullerian Professor to the Royal Institution, and was appointed Examiner in Physiology and Comparative Anatomy to the University of London. In 1849 his first great work, on "Oceanic Hydrozoa," appeared in the publications of the Ray Society; his earliest paper, on the root-sheath of the hair, having appeared when he was a medical student. He was appointed Croonian Lecturer in 1857, and in the same year assisted Tyndall in the study of glaciers. In 1862 Huxley was President of the British Association, a post he also held in 1870, the year of publication of his famous "Lay Sermons." A keen interest in educational matters led him to seek election on the London School Board in 1870, a position only held by him for two years on account of his failing health. In 1869 and 1870, too, he held the presidency of the Geological and of the Ethnological Societies, and in 1873 he became one of the secretaries of the Royal Society, being elected to the presidency in 1883. From 1881 to 1885 he was Inspector of Salmon Fisheries, in which post he succeeded Frank Buckland, and he held for many years the office of Dean at the Royal College of Science. Retiring in 1885 from most of his offices, Huxley gave himself up almost entirely to literary work. He was Lord Rector of Aberdeen University in 1872, and again served in Scotland in 1875 as Professor of Natural History to the University of Edinburgh, during the absence of Sir Wyville Thomson. Huxley's best known works, beyond those already quoted, are "Lectures on the Elements of Comparative Anatomy" (1864), "Lessons in Elementary Physiology" (1866), "Manuals of the Anatomy of Invertebrated and Vertebrated Animals" (1870 and 1871), "Elementary Biology," in conjunction with H. N. Martin (1875), "The Crayfish" (1881), "Critiques and Addresses" (1873), "American Addresses" (1879), "Science and Culture" (1881). He was the great exponent of the Darwinian theories, and his "Man's Place in Nature" (1863) did much to smooth acceptance of the truths elucidated by Darwin and his fellow-workers. His later controversial writings are too fresh in memory to need recapitulation here. One of Huxley's last efforts was to re-issue, in collected form, an edition of his works, other than scientific, in nine volumes. He was chosen a Privy Councillor in 1892. In late years Huxley lived at Hodeslea, Eastbourne, where he died, after a protracted illness, on June 29, 1895, at the age of seventy. He was buried on July 4, at the cemetery of St. Marylebone, East Finchley.

I.—At the Age of Thirty-two.

OTHERS besides those who knew, in earlier life, the great and beloved chief who has so recently passed from among us, will find interest in the portrait of him, at the age of thirty-two, which accompanies this note (Plate xviii). It was taken in the year 1857, and was one of a series of photographs of the Fellows of the Royal Society, published at that date by Messrs. Maull & Polyblank. I have cherished it ever since, recalling as it does to me the earliest impression which his wonderful personality made on my boyish mind. It shows us Huxley in the full prime of manhood—as yet unknown to popular fame, and even three years later to be spoken of by the *Times* as "a Mr. Huxley," when, at the British Association meeting, he demolished Dr. Wilberforce, the Bishop of Oxford. When this photograph was taken, Huxley had been only two years Professor at the School of Mines; he was seeing his "Oceanic Hydrozoa" through the press, his Croonian lecture on the Vertebrate Skull was ready, but not yet delivered.[1] After his first lecture at the Royal Institution as Fullerian Professor, only a year or two earlier, he had been so exhausted by the nervous strain of addressing a popular audience that he had gone home to bed at four o'clock in the afternoon. He had only made Darwin's acquaintance a year before the date of this portrait, and the "Origin of Species" was not published till two years after it. It was this grave, black-browed, fiercely earnest face, which three years later turned its steady gaze on the too venturesome Bishop who, in the discussion at Oxford on Darwin's views, had declared that some men seemed to have special information as to their own ancestry, and that he would like to hear from Mr. Huxley whether it was by his grandfather's or grandmother's side that he was related to an ape. Then said Huxley, in an undertone, to a friend at his side, "The Lord hath delivered him into my hands," and he rose to reply. "He spoke with force and eloquence and a self-restraint that gave dignity to his rejoinder," says an eye-witness of the scene. According to the late John Richard Green, then an undergraduate (quoted by Frank Darwin in his father's "Life"), the conclusion of Huxley's speech was as follows: "I asserted, and I repeat, that a man would have no reason to be ashamed of having an ape for a grandfather. If there were an ancestor whom I should feel shame in recalling, it

[1] Between the period of his return from the voyage of the "Rattlesnake" and his appointment at the School of Mines (1851–1855), Huxley had produced a large number of valuable memoirs on Histology and on the Structure of Invertebrata, published chiefly in the *Quarterly Journal of Microscopical Science* and in the volumes of the Royal and of the Linnean Societies. This is not the place in which to enumerate them; but besides these I should like to cite especially (as showing his great activity and industry) his translation in conjunction with Mr. George Busk of Kölliker's "Histology," his translations in the series of "Scientific Memoirs," edited by himself and Henfrey, his article in the *Medico-Chirurgical Review* on the Cell-theory, his article "Tegumentary Organs" in Todd & Bowman's *Cyclopædia*, and numerous unsigned communications to the *Literary Gazette* and other periodicals.

would be a *man*, a man of restless and versatile intellect who, not content with an equivocal success in his own sphere of activity, plunges into scientific questions with which he has no real acquaintance, only to obscure them by an aimless rhetoric and distract the attention of his hearers from the real point at issue by eloquent digressions and skilled appeals to religious prejudice."

Thirty-four years later, just a year ago this August, the same face was seen once again at the same Association's meeting in the same University city. Huxley, with his hair now silver-white, and his shoulders adorned with the scarlet gown of a D.C.L., rose once more to do battle for the great doctrine of development. With the same precision and the same cold courtesy with which he had rebuked S. Oxon long ago—he now, as it were, nailed Lord Salisbury's admissions to the table; no retreat was possible. The doctrine ridiculed in 1860 was accepted by all in 1894.

E. RAY LANKESTER.

II.—As a Zoologist.

IN looking through Huxley's zoological work, one of the first observations one makes is that in an important respect it resembles the work of younger generations of zoologists, rather than that of his immediate predecessors and contemporaries. Huxley had a great knowledge of the literature of his subject; his own contributions were always illuminated and explained by being put in contrast or in sympathy with the allied investigations of other naturalists. I am unaware at what period he learned to read German, but his earliest papers show that he had made himself familiar with the best work done on the Continent and in England. It is true, of course, that scientific men read French and German before the time of Huxley; but the deliberate consultation of all the authorities available has been maintained in historical succession since Huxley's earliest papers, and was absent in the papers of his early contemporaries.

There were two sharply marked periods in his zoological work. The periods, naturally enough, were separated by the appearance of the *Origin of Species*: but it is a curious accident that in each period Huxley's attention was directed conspicuously to the group of animals that attracted least attention among other zoologists. Most of his papers published before 1859 dealt with invertebrates, though the morphology of these received little attention from others until zoology, quickened by its acceptance of the doctrine of evolution, concerned itself above all with the lowlier types of life. The greater part of what he published after 1859 dealt with vertebrate anatomy. The explanation of this merely is that his "Rattlesnake" material, and matters directly arising from it, occupied the first part of his career. The second part was determined chiefly by his connection with the Geological Survey. His most important contributions to science in this period were upon vertebrate morphology. One may notice here the singular circumstance that although an immediate result of Darwinism was a great increase in embryological investigation, Huxley contributed little or nothing to it.

The first important paper he published was communicated to the Royal Society, in 1894, by Stanley, the Bishop of Norwich. This was the well-known account of the morphology of the Medusæ. He showed that these were composed of an ectoderm and an endoderm; that they were all possessed of thread-cells; that the generative organs were external. He united them with the hydroid and sertularian polypes, and thus laid the foundation of the Cœlenterata. He compared the inner and outer layers of the members of this group with the serous and mucous layers of the vertebrate embryo. Thus, although in later days he made little further contribution to embryology, it is to him that one of the most important generalisations of embryology is due. In 1851 he contributed to the *Proceedings* of the Zoological Society an almost equally important set of memoirs upon Ascidians. He verified Chamisso's discovery of alternation of generations in *Salpa* and *Pyrosoma;* a discovery upon which doubt had been thrown. He described the endostyle in these, and stated, for the first time, that it was a structure common to all Ascidians. He discovered the true nature of *Appendicularia*, which Chamisso had united with *Cestum veneris*, Mertens with the pteropods, and of which Mueller had stated his inability to discover the affinities. He had read and been interested by Von Baer's theory of recapitulation, but he went beyond Von Baer, and made use of the doctrine in the modern fashion. Von Baer implied no more than the existence of a closer resemblance between embryos than there is between adults of different groups. Huxley compared the adult state of Medusæ with the larval state of higher animals; and he pointed out that *Appendicularia* typifies the larval condition of other ascidians. It must be admitted, however, that although in these particular cases he had reached the recapitulation theory, the doctrine as such was not present in his mind. For, in 1853, at the Royal Institution, we find him stating in so many words the view of Von Baer, "An insect is not a vertebrate animal, nor are its legs free ribs (as Geoffroy St. Hilaire thought). A cuttlefish is not a vertebrate animal doubled up. But there is a period in the development of each when insect, cuttlefish, and vertebrate have a common plan."

Lecturing at the Royal Institution in the same year, he expounded another important generalisation that has become a commonplace of modern biology. He identified the protoplasmic part of the cells of plants with the protoplasm of animal cells, declaring that the material in which the life of animals and plants resided was identical. He distinguished between the morphological and the physiological aspects of Schwann's cell-theory. From the anatomical point of view, he declared the theory to be of fundamental importance, agreeing with

Schwann that the cell was the unit of structure. On the other hand, he held that cells were not the physiological units. It is interesting to notice that, although for many years afterwards physiologists were at variance with him upon this point, in the last few years the tendency has been growing stronger and stronger to discard the cell as a physiological unit.

The next great contribution to science was the famous paper upon the morphology of the cephalous Mollusca. This suggested a homology between the arms of cephalopods and the gasteropod foot, a suggestion which for long was almost universally accepted. It contained an account of a schematic mollusc, the illustrious parent of Ray Lankester's more famous child. He assumed that some chiton-like mollusc was nearest the archetype, and that the various forms of gasteropods were derived by twistings of the primitive straight form. The cephalopods were morphologically identical with gasteropods, while the lamellibranchs were modifications of the gasteropod type. He separated the ascidians from the other "molluscs," although he did not go the length of elevating them into a group of equal importance.

We have mentioned what seem to us the most striking points in his pre-Darwinian work. Reading it in the light of our modern knowledge it seems marvellous that he had not declared himself openly an evolutionist. But, as he says himself, he was in a state of suspense regarding the permanence or impermanence of specific forms. He had abandoned the Mosaic notion of separate creations; but, until the importance of Natural Selection had been suggested by Darwin, the problem of species had not aroused any special interest in his mind. It is worth noticing that he had paid little or no attention to specific forms. He had already coined the word "species-monger." The generalisations he had made, although they fitted well with the dynamical view of organic forms that we now hold, fitted equally well with the statical view of Cuvier and Owen.

But, once convinced, Huxley threw himself into the battle for Darwinism, with all the splendid vigour of which he was possessed. "I am sharpening my beak and claws," he wrote to Darwin in November, 1859. Perhaps the earliest and most vigorous blow he struck for Darwin was an anonymous review of the *Origin of Species* in the *Times* of December 26, 1859. The opportunity came to him by a chance. Mr. Lucas, one of the regular staff, and an acquaintance of Huxley, received the book for review in the ordinary routine of his work. But he was ignorant of science, and being much occupied, consulted Huxley, who wrote all but the opening sentences. In those days a great daily journal had the importance in floating a scientific book that it now has with a literary treatise. Huxley's diplomatic avoidance of the prejudices of the readers, and his enthusiastic approval of the method and contents of the volume had a most important influence; and the review had the effect most pleasant to read of now, of cheering Darwin, who was smarting under the ill-informed and ill-natured notices in the *Athenæum* and so forth.

Huxley, with Lyell and Hooker, were the persons to whose judgment Darwin looked forward with most interest; and Huxley, who was first of the three to become a convert, remained for many years the chief exponent of Darwinism. It is not necessary to enter into the details of the conflict; it is in the knowledge of all that it was Huxley who made most converts among scientific and educated persons, and that it was his brilliant rhetoric and intolerable satire that drove the champions of dogma from their position of blustering abuse.

As I have already said, much of Huxley's work after 1859 was determined by his connection with palæontology; it is here dealt with by Mr. Smith Woodward. The later zoological work was chiefly upon vertebrates, and its striking feature was the series of advances it made in classification. Thus, he grouped together the birds and reptiles, inventing the term *Sauropsida* for them. His classification of birds, based in the main upon osteological characters, is the foundation of all the modern classifications. His arrangement of the mammals is the basis of the existing classifications. His treatise upon the homologies of the ear-bones was a great advance upon current views; although other observers, chiefly those who pay attention to embryology, have considerably modified the homologies he accepted. His great paper on the skull and pectoral fin of *Ceratodus*, and on the archipterygium and its relations to fins and limbs, left a permanent impression upon vertebrate morphology. Here he first clearly distinguished the typical ("hyostylic") fish-skull from that ("autostylic") of the mud-fishes, chimæras, and higher vertebrates. His elaborate work upon anthropoid apes, although in certain points it has not been accepted as final, completely upset those anatomists who disputed the practical identity of structure in man and the apes.

If Huxley was great as an investigator, he was even greater as a teacher. Probably no one man ever wrote a set of books that have been read by so many students, and have had so much influence upon methods of education. His introductory primer, written for Macmillan's series, has gone into innumerable editions, and has formed the method of thinking in half the children who have been to school since it was published. His book upon physiography has created a new industry; and although, from what I saw of students and teachers of physiography during two years in which I was occupied in directing and inspecting elementary scientific education in a Midland county, I am convinced that the invention of this selection of the tit-bits of sciences was an educational disaster, still the invention was a great achievement. On the other hand, Huxley's elementary text-book of physiology has probably been as useful as his "physiography" was deplorable. The text-books of vertebrate and invertebrate anatomy remain the most brilliant and logical expositions of comparative anatomy in existence.

P. Chalmers Mitchell.

III.—As Palæontologist and Geologist.

Huxley himself records that when he received the offer of the vacant Professorship of Natural History in the Royal School of Mines, in connection with the post of Naturalist to the Geological Survey, in 1854, he informed the Director-General (Sir Henry de la Beche) that his acceptance of the office was merely provisional, since he felt no interest in fossils. He was an ardent physiologist, and the purely morphological facts of palæontology did not at that time appeal much to his mind. In a lecture delivered at the Royal Institution in the following year, he even regarded the study of fossils as hopeless in seeking for confirmation of the doctrine of evolution. "There is," he concluded, "no real parallel between the successive forms assumed in the development of the life of the individual at present, and those which have appeared at different epochs in the past. . . . The particular argument supposed to be deduced from the heterocercality of the ancient fishes is based on an error, the evidence from this source, if worth anything, tending in the opposite direction."

Within a year, however, the new Professor began to be deeply absorbed in his pursuits, and soon co-operated with Salter in the determination of fossils for the Geological Survey. The mere systematic work of defining and naming genera and species never appeared to interest him, even to the end; but the determination of the structure of the extinct forms of life, with a discussion of their affinities on the basis of his own results, provided long exercise for his almost unrivalled powers. By 1876 he had accomplished so much that the Geological Society of London awarded him its highest and most coveted distinction, the Wollaston Medal, in recognition of his services to geological science. His latest contributions to the study of fossils were read before the Royal and Geological Societies of London so recently as 1887.

Huxley's earliest notes, published in association with Salter, were a technical description of some supposed fish-shields from the Downton Sandstone, near Ludlow (1855), and a discussion of the affinities of the Devonian Crustacean, *Himantopterus* or *Slimonia* (1856). He also contributed to the Geological Society's *Journal* an independent description of the Carboniferous Crustacean, *Pygocephalus cooperi* (1857). The anomalous structure of the supposed fish-shields from the Downton Sandstone, however, appears to have particularly excited his interest; and this led to a series of investigations of the early Palæozoic fishes, which by 1861 completely revolutionised existing knowledge of the subject. In a paper published by the

Geological Society in 1858 he gave a detailed description of the structure of the shields of *Cephalaspis* and *Pteraspis*, finally demonstrating that these remarkable Devonian fossils must be vertebrates of some kind. He even speculated (as it now appears) somewhat wildly, remarking on the certainty that these ancient creatures must be either ganoids or teleosteans; hence, said he, the earliest fishes were not the lowest in the scale, as was commonly assumed. His most original memoir of all appeared three years later as a "Preliminary Essay upon the Systematic Arrangement of the Fishes of the Devonian Epoch," forming the greater part of Decade X in the *Memoirs* of the Geological Survey. Here, for the first time, the fringe-finned fishes (Crossopterygii, as they were then termed) were clearly separated from the higher ganoids, and an entirely new idea was thus introduced into the method of classification. The recognition of the Crossopteryii was the first step to our modern conception of the evolution of the fish-class. We now recognise that all the earliest types of fishes had lobate fins, while these have gradually become shortened up and replaced by long dermal fin-rays in the more modern types.

The Crossopterygian fishes were investigated by Huxley in great detail, and his memoir of 1861 was followed in 1866 by another Decade of the Geological Survey dealing exclusively with the family of Cœlacanthidæ. Here this group was first scientifically defined, and it was particularly described as an example of a persistent type. The various genera of the family, from *Cœlacanthus* of the Lower Carboniferous to *Macropoma* of the Upper Chalk, differ from each other only in the slightest particulars; while the individuals representing them are comparatively abundant throughout the whole series of strata in which they occur.

Huxley's tentative conclusions as to the other Devonian fishes, however, have not stood the test of subsequent research so satisfactorily as his results from the Crossopterygians. Whatever the anomalous fish *Coccosteus* may be, present knowledge seems to demonstrate that it has not the remotest connection with the Siluroids, with which Huxley compared it. There can also be little doubt that *Cephalaspis* and *Pteraspis* are limbless creatures below the fishes; while the Acanthodians are almost certainly specialised Elasmobranchs.

The work on the fringe-finned fishes seems to have been first stimulated by the Rev. John Anderson, D.D., who submitted to Huxley some beautiful specimens from the Upper Old Red Sandstone of Fifeshire to be described in his well-known volume on "Dura Den," published in 1859. The required contribution was duly made, and then followed the memoirs to which we have just referred. These may truly rank as monographs, involving much laborious research. In the same category may also be placed the memoirs on the gigantic Siluro-Devonian Crustacea (in collaboration with Salter in 1859), on *Glyptodon* (*Phil. Trans.*, 1865), on Belemnites (*Mem. Geol. Surv.*, 1864), and on reptilian bones from the Triassic Sandstones of Elgin (*Mem. Geol. Surv.*, 1877). Most of Huxley's researches in palæontology, however, were desultory, with special reference to the successive questions of broad philosophy which presented themselves to his mind at different times. At one period the Labyrinthodontia interested him much, as being on the borderland between fishes, amphibians, and reptiles. He thus described *Anthracosaurus* from the Coal-Measures of Northumberland, *Loxomma* from the Lower Carboniferous of Scotland, several small forms from the Coal-Measures of Kilkenny, Ireland, besides skulls from South Africa and other interesting fragments. At another time Huxley, simultaneously with Cope and Phillips, was suddenly impressed with the remarkable resemblance between the hind-quarters of certain dinosaurian reptiles and those of the ostrich-like (struthious) birds. This led to valuable papers on the small Wealden dinosaur he named *Hypsilophodon*, on *Megalosaurus*, on the supposed dinosaurian bones from the Trias of Bristol, and on other more fragmentary remains from South Africa. He concluded by separating *Compsognathus* from the dinosaurs proper, then grouping these together in a major division, "Ornithoscelida." In expanding the idea, he and his contemporaries expressed themselves a little too confidently as to the bridged gap between birds and reptiles, which was then supposed to be filled; and while gratefully accepting the new facts, subsequent writers have refused to adopt, to any noteworthy extent, Huxley's innovation in nomenclature. In 1875, there came the discovery that the gradual formation of the false-palate, which throws back the internal nostrils to the top of the throat in existing crocodiles, could be traced among the fossil crocodiles. Hence, his paper read before the Geological Society of London on the "Evolution of the Crocodilia." This, again, states many truths, and is as important as his earlier discovery (made simultaneously with Owen) of the reptilian nature of the supposed fish-scutes, *Stagonolepis*, from Elgin. As in the case of dinosaurs and birds, however, the conclusions concerning the evolution of the crocodiles are now proved to have been pushed a little too far, the problem of their early ancestry not being quite so simple as it appeared to be in 1875. The papers on *Telerpeton* (1867) and *Hyperodapedon* (1859, 1869, 1887), reptiles from the Triassic sandstones of Elgin, are also important as emphasising the small differences to be observed between these old types and the existing lizard, *Sphenodon*. Finally, his visit to America enabled Huxley to co-operate with Professor Marsh in the now famous paper of the American professor on the ancestry of the horse, as revealed by the discoveries of early Tertiary hoofed animals in the United States.

More might be recorded, but this brief statement will give some idea of the value and fundamental importance of Huxley's contributions to the progress of Vertebrate Palæontology. His eagerness to penetrate the deeper mysteries may perhaps have sometimes led him astray; while his superficial acquaintance with some subjects on which he professed to make authoritative statements, exposed him to the severe criticism which he occasionally merited and received from Owen and other contemporaries. But his influence on progress cannot be measured solely by his own writings. He inspired many younger workers, by his personal example and advice, to follow the same line of research; and he left the Geological Survey well equipped with an accomplished naturalist, who has worthily followed in his footsteps.

This constant study of fossils, and the intimate practical acquaintance with them thus gained, could not fail to reverse entirely Huxley's earlier judgment as to their bearing on the doctrine of evolution. Thus it was that at York, in 1881, he could affirm before the British Association that, if zoologists and embryologists had not put forward the theory, the palæontologists would have had to invent it.

The problems of Palæontology naturally awakened some interest in Geology, and Huxley found time to undertake the secretarial duties of the Geological Society of London for a period of four years from 1859 to 1862. He was then elected President of the same Society for the years 1868–70. His only contributions to purely geological subjects were three addresses, one as deputy-President in 1862, the others as actual President in 1869 and 1870. The first is noteworthy for two reasons. In it he proposed the term "homotaxis" for the conception which is now familiar to every student; he perceived (with many of his contemporaries) that two distant rock-formations containing similar fossils could not be scientifically termed "contemporaneous." There was no proof of their having been formed at the same time; indeed, the facts of "provinces" and migration were rather antagonistic to the idea of contemporaneity. He therefore proposed that they be termed "homotaxial," in reference to their occupying one and the same position in the geological sequence of strata. The second feature of interest in the 1862 Address is a series of remarks, chiefly based on negative and insufficient evidence, on the persistence of certain types of living things throughout long geological periods; and these "old judgments," as he termed them, needed a good deal of revision in his Presidential Address of 1869. This and his famous plea on behalf of the geologists for more time since the cooling of the globe than physicists then allowed, do not admit of being abstracted. They are examples of Huxley's best style, and must be read to be appreciated. They are among the classics of geological literature.

A. Smith Woodward.

SOME NEW BOOKS.

THE MUSEUMS ASSOCIATION.

MUSEUMS ASSOCIATION. REPORT OF PROCEEDINGS. . . . Fifth Annual General Meeting, held in Dublin, June 26 to 29, 1894. 8vo. Pp. 260, 15 plates. To be had of the Secretaries to the Association: Sheffield and York. Price 10s. to non-members.

THE issue of this Report has been delayed by difficulties with the preparation of the plates, until just before the opening of the 1895 meeting. The Report shows no falling off in the activity of this energetic Association, which now numbers thirty-seven museums and 102 associates; while we are informed that the number of members and associates present at the meeting was larger than in any previous year.

The opening address of the President, Dr. V. Ball, whose lamented death has been so recently announced, has already been published in full in the pages of NATURAL SCIENCE (vol. v., p. 21); and need not be further alluded to.

It is impossible to turn over the pages of the Report without feeling that the Association fulfils its purpose of "the extension of individual experience, and the mutual interchange of ideas." It has become almost a platitude to remark on the difference between the "modern" museum and its predecessors; and the Report for 1894 contains enough modern ideas to perplex seriously a curator of the old type. Those who are ready to make use of the experience of others will derive great advantage from the study of the Report. Every curator knows how often the acquisition of a new specimen involves the designing of a special arrangement for exhibiting it. The authorities of the Science and Art Museum at Dublin have exercised great ingenuity in the elaboration of devices for this purpose, and Mr. H. B. White contributes a paper which is full of information on this subject. The general principles on which to construct a show-case, the suspension of a whale's skeleton weighing some seven or eight tons, the frames used for pictures, the exhibition of coins which require to be looked at from both sides, and many other subjects are here treated; and some are illustrated by figures drawn to scale. Mr. W. B. Pearsall describes a convenient arrangement for exhibiting large series of isolated teeth and other similar objects in such a way as to permit of their being examined from all sides. Mr. F. A. Bather gives an account of fifteen Colonial museums which he has visited, and of the collections and fittings which he has noted in those museums. There are also suggestions for the arrangement of mineralogical and botanical collections, and an illustration, by Messrs. W. E. Hoyle and H. Bolton, of the application of the system of "fractional" cataloguing to Palæozoic fossils.

Dr. H. O. Forbes advocates the centralisation of type-specimens in London, Edinburgh and Dublin. There is much to be said for this proposal; but provided that certain provincial museums contain special collections which compare favourably with the best of the same kind elsewhere, the advantages of separating the type-specimens from the rest of the collection are not all on one side.

Mr. G. H. Carpenter's paper on "Collections to Illustrate the Evolution and Geographical Distribution of Animals" deserves more special notice. The attempt to increase the educational function of museums is certainly a laudable one; but the method employed has its dangers as well as its advantages. Mr. Carpenter has selected such subjects as "Natural Selection," "Variation," "Life-history of Individuals," and so on; and has illustrated them by means of a small number of specimens taken from different groups of animals, and explained by means of printed labels. Some exception may be taken to the length of these labels. It may be questioned whether the amount of information which takes up nearly two pages of small print in the Report would not be better given in a small guide-book. If a museum is to keep up to date, it is necessary to alter labels from time to time; and it is obvious that the longer the label the more chance there will be that some statement or name will in course of time be found erroneous, and will vitiate the entire label. The mistake can be corrected with but little trouble in the issue of a new edition of the guide-book. The printed matter is, moreover, the part which is most likely to be neglected in an exhibit which consists of a few specimens explained by a disproportionate amount of label.

The illustrations are not always worthy of their place. The statement that certain animals are flesh-eaters, needs hardly to be illustrated by so obvious an instance as a Spider, nor does it appear necessary to call special attention to the fact that a Tiger's teeth are structures for offence. Although I would not appear to disparage the system as a whole, or the way in which it has been carried out in the present instance, it seems to me that the illustration of truisms is only one of the dangers which are to be avoided. The series are in some cases constructed to illustrate a theory, and the explanations given of facts may not really be justified by the actual state of our knowledge. "If you fill cases with processes, showing how brushes are made, within six months perhaps some new feature will be invented, and you will be asked, 'What is the use of showing these things which are not up to date?'" This remark was made by the President in the course of the discussion on another paper, and will serve to point the moral of the above remarks. An indiscriminate use of the system in museums which are not presided over by a scientific curator might easily lead to deplorable results. S. F. HARMER.

THE LIGHT STUDY OF CONCHOLOGY.

MOLLUSCS. By the Rev. A. H. Cooke. BRACHIOPODS (RECENT). By A. E. Shipley. BRACHIOPODS (FOSSIL). By F. R. C. Reed. Being vol. iii. of the "CAMBRIDGE NATURAL HISTORY," edited by S. F. Harmer and A. E. Shipley. Pp. xiv., 535, with text-illustrations and four folding maps. London: Macmillan, 1895. Price 17s. net.

"WHY, you might take to some light study; conchology, now." So said Mr. Brooke in "Middlemarch"; and these are the words that Mr. Cooke takes as his motto, not inappropriately. For it is clear that Mr. Cooke entered on his study with a light heart, and lightness is the characteristic of his work in more senses than Mr. Brooke or Mr. Cooke intended.

We are told in a prospectus, issued at the end of this volume, that the "Cambridge Natural History is intended, in the first instance, for those who have not had any special scientific training, and who are not necessarily acquainted with scientific language. At the same time an attempt is made, not only to combine popular treatment with the latest results of modern scientific research, but to make the volumes useful to those who may be regarded as serious students in the various subjects. Certain parts have the character of a work of reference." The value of this volume has, therefore, to be estimated from two distinct points of view.

NATURAL SCIENCE has already alluded to the very interesting nature of that part of the work addressed to the lay reader and to the outdoor naturalist (Fig. 1). The chapters dealing with such subjects as "Tenacity of Life," "Self-burial of Snails," "Showers of Shells," "Shells as Money," "Oysters under the Romans," and "Snails as Medicine," are undoubtedly such as the cheap bookseller would describe as "good reading," and have already proved a happy hunting ground for the daily press and the popular weeklies. But there is real value in the collection of a large number of observations on molluscan bionomics, a branch of his study which the laboratory zoologist is too apt to overlook. It would, perhaps, have been more convenient for those who are expected to use this volume as "a work of reference," had these valuable notes been subjected to a little more arrangement and co-ordination. The deposition and hatching of eggs in *Helix* and *Limnæa*, which forms a section in chapter ii., would have been better placed in chapter v., which is specially devoted to the subject of reproduction. This is one of many instances of confused arrangement, which might have been avoided had Mr. Cooke or his editors regarded their duties in a less light manner.

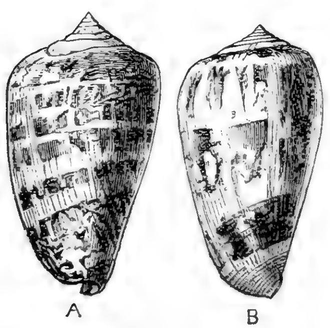

FIG. 1.—A. *Strombus mauritianus*, which mimics B. *Conus janus* in shape. Both from Mauritius. This instance was quoted in our vol. vi., on p. 301.

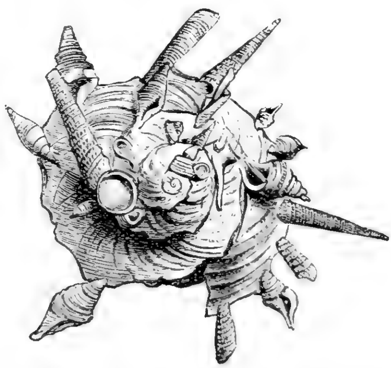

FIG. 2.—*Xenophora* (*Phorus*) *pallidula*, Reeve. A specimen that has "decorated its body whorl exclusively with long and pointed shells." From a "Challenger" specimen in the British Museum, × ½.

In reading these interesting chapters, one or two remarks have suggested themselves, which are here offered in no censorious spirit, but merely as suggestions for a possible second edition. On p. 11, is this sentence, "The problem of the origin and mutual relationship of the various forms of molluscan life is of extreme subtlety. . . . But there is one branch of the Mollusca—the land and fresh-water genera—whose origin is, comparatively speaking, of recent date, and whose relationships are therefore less likely to have suffered complete obliteration." The Devonian and Carboniferous periods are not usually treated with such irreverence. But, apart from that, the argument is curious: if all molluscs arose first in the sea, surely those modified for land and fresh-water conditions must have their origin more obscured than molluscs that remain marine. "Snails as Barometers" is the heading of a paragraph on p. 50; but the subject thereof is snails as hygrometers. A short time ago there was a note in NATURAL SCIENCE on *Xenophora* (Fig. 2); Mr. Cooke has an idea that when this genus coats its shell with foreign objects, "sometimes the selection is made with remarkable care" (p. 64); one would like evidence that the apparent selection is due to anything else than the nature of the surrounding objects. As instances of molluscs that can leap away from their enemies, Mr. Cooke, on p. 65, mentions the Strombidæ, *Terebellum*, and *Trigonia;* he might have added the common *Pecten*, with which one can experiment any day. The following statement on the same page seems a trifle imaginative: "Many Cephalopoda emit a cloud of inky fluid, which is of a somewhat viscous nature, and perhaps, besides being a means of covering retreat, serves to entangle or impede the pursuer." "The Mollusca," it is said on p. 67, "are not much mimicked by creatures of different organisation"; to the few instances here given one may add the

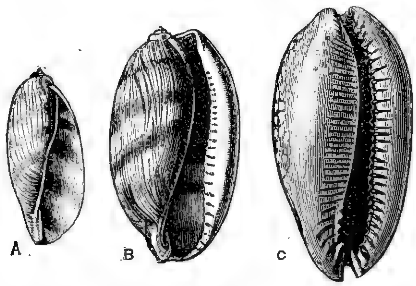

FIG. 3.—Three stages in the growth of *Cypraea exanthema*; from specimens taken at Panama.

curious resemblance of the annelid *Autodetus* to the gastropod *Protocalyptræa*, both in the Devonian rocks of New York (*see* J. M. Clarke, *Amer. Geol.*, xiii., p. 327). In his cases of commensalism Mr. Cooke might include the strange story of the worm, the gastropod, the coral, and the bivalve, related by Bouvier (NAT. SCI., vol. v., p. 86). The section on Variation is valuable; this and the numerous figures of stages of growth may possibly help to check the rash coining of new specific and varietal names (Fig. 3). But we fail to see why specific differences should be confined to "*structural difference* in the organisation of the animal (as distinct from that of the shell alone)." Surely the shell is as much a part of the animal as, say, the liver. The slight calcification of *Mya arenaria* and *Tellina balthica* in the eastern parts of the Baltic is ascribed to "the violent changes of temperature which are experienced in the Baltic" (p. 84). Might not the greater freshness of the water in that part be a still more potent cause, just as it is in the case of *Littorina* (p. 93)? On p. 137, speaking of the dibranchiate cephalopods, the author says, "It is not yet known how the spermatophores find their way into the hectocotylus, or how the hectocotylus impregnates the ova of the female"; thanks to Racovitza this statement is no longer true (*see* NAT. SCI., vol v., p. 321). On p. 400 we are told how fast *Chiton* can walk, and how it rolls up like a woodlouse; but we are not told, perhaps because the fact was too familiar, how it sticks to its stone like a limpet when one attempts to detach it.

Chapters x. to xii. give a summary of our knowledge of the geographical distribution of the Mollusca, especially of the land and fresh-water species. The value of this, which is already considerable, might have been increased by a closer attention to the geographical changes of the later geological periods.

It is, however, when he turns to the deeper questions of morphology and classification, that "the serious student" will have reason to complain of the author's light treatment. Here, indeed, Mr. Cooke reminds us of "the poor cat i' the adage, letting *I dare not* wait upon *I would*." All the reviewers in scientific journals have noticed how he admits with Pelseneer that the Pteropoda are related to the Tectibranchiata, being derived from the Aplysioidea and Bulloidea, and how, though he places them in the Opisthobranchs, he nevertheless separates them from their relatives by the pages devoted to Ascoglossa and Nudibranchiata. The Amphineura are retained in the Gastropoda, but the consequent difficulty of drawing up a description of the Gastropoda is evaded by leaving them without a description. The Cephalopoda, too, which strangely are taken first, are given no general definition. "The classification adopted for the recent Cephalopoda is that of Hoyle ('Challenger' Reports)" (p. v.). Far be it from us to impugn the veracity of the reverend gentleman, but what does Hoyle say to this? Mr. Foord, too, would hardly agree that the fossil Nautiloidea are classified according to his Catalogue, 1888–1891, for in his 1891 part he removed *Bactrites* to the Ammonoidea. Of course, one regrets the retention of the division into Dibranchiata and Tetrabranchiata; Mr. Cooke mentions the other views, but has a remarkably imperfect appreciation of the arguments on which they are based. There is a curious slip on p. 14, where *Dreissensia* is said to be "closely allied to *Mytilus*," although, in the systematic part, the two are referred to distinct orders. The classification of the Pelecypoda is according to Pelseneer and based mainly on the gill-characters. This is doubtless an improvement on the old method, though a palæontologist may regret that no mention should be made of Neumayr's suggestive attempt.

Some strange lapses in morphology are also hardly suitable for the student, unless he be so advanced as to correct them for himself. He will, however, be clever if he discovers what Mr. Cooke means by saying that "the membranous siphuncle" of *Spirula* "is connected with the posterior part of the liver." The shell of *Spirula* is not "of the Tetrabranchiate type"; for it is coiled in the reverse direction and there are other differences. But all Mr. Cooke's remarks on the shell of the dibranchiate Cephalopoda are difficult for a reviewer to characterise. If, with the majority of English writers, he fails to understand the not very obscure homologies of the *Sepia* shell,[1] one does not willingly ascribe this to ignorance or obstinacy. Yet it cannot be lack of intelligence, if only for the reason that so little is required. We are told that the "arms" of the Dibranchiata are modifications of the molluscan foot; but similar information is not vouchsafed concerning those of *Nautilus*, which are uniformly spoken of as "tentacles." On p. 445, under Scaphopoda, it is said, "there is no special respiring apparatus, heart or arterial system, breathing being

[1] As maintained by Voltz, Gegenbaur, Lankester, Steinmann, etc., etc.

conducted by the walls of the mantle." We will not pause to show that this consists but ill with the statement on p. 151 that "in the Scaphopoda respiration is by means of branchiæ"; for that is equally incorrect. The heart of *Dentalium* was first observed by W. Clark, who described its action in 1849 (*Ann. Mag. Nat. Hist.* (2), iv., p. 321). Lacaze-Duthiers, though he saw the structure, did not regard it as a heart; but the recent observations of L. H. Plate (*Zool. Jahrb. Anat.*, v., pp. 325–328, 1892) have proved the point definitely. The heart is a small simple sac situated in a pericardium ventral to the median prolongation of the two nephridia and the stomach. Respiratory chambers are also present in the mantle, on the opposite side to the anus; these, however, are not homologous with the ctenidia of other Mollusca, which some have sought to homologise with the head-tentacles. Had space permitted, a few genial remarks might have been made on Mr. Cooke's treatment of shell-formation and shell-growth, where he has attempted with more valour than success to assimilate modern ideas. He and our readers may be referred to the excellent thesis by Moynier de Villepoix, "Recherches sur la formation et l'accroissement de la coquille des Mollusques," Paris, 1893.

If it has seemed the critic's duty to point out a few blemishes in the book, it is also his duty to praise it for its readable style, in which lapses such as "this must have degenerated their appetites" (p. 33), are not very common. He must also praise Mr. Edwin Wilson for the beautiful illustrations, and congratulate the publishers on their enterprise in attempting a popular Natural History in which the Invertebrata are allowed their fair share of space. The chapters on the Brachiopoda, with which the volume closes, will receive a separate notice. F.A.B.

North Africa.

Stanford's Compendium of Geography and Travel (new series)—Africa. Vol. i., North Africa. By A. H. Keane, F.R.G.S. London: Edward Stanford, 1895. 8vo. Pp. xvi., 639, with nine maps and seventy-seven illustrations. Price 15s.

In Stanford's Compendium of Geography no volume was more useful than that on Africa, by Keith Johnston, for the subject-matter was more limited, and the information buried in sporting journals and travellers' diaries. After passing through four editions, however, that work was hopelessly out of date, and the editor of the series has wisely now abandoned the attempt to remodel it, and trusted to Professor Keane the task of rewriting the whole book. The materials have grown so rapidly that Africa now requires two volumes, and the present one deals only with that part of the Continent north of a line from the Gulf of Guinea to the mouth of the Juba. Professor Keane commences the book by an admirable introductory chapter, opening with the paradox that Africa is a land of contrasts, instead of a land of uniform monotony. He contrasts the dense forests of the Congo, the broad grassy steppes of the interior plateau, and the sandy wastes of the Sahara and the East African Nyika. He compares the low lying malarial deltas and coast plains with the bracing uplands of Mashonaland; the magnificent waterways of the Congo, Nile, and Zambesi, with the areas of inland drainage, and the dry valleys of the Soudan; the arid climate of the Sahara, and its great diurnal range of temperature with the perpetual snows and fogs of Kilima Njaro and Ruwenzori, and the uniform temperature of such humid localities as Zanzibar. The people present differences no less striking: for the continent is the home of the dwarfs, the Herculean Monbutti and the tall, slim Somali; of the fair Berbers, the black Soudanese, the chocolate Bushmen, and the coppery Suahili. The languages may be uniform over vast areas like the Bantu, or may be a complex of very different groups, as in the negro tribes of the Nubar Fular group. Africa is so often represented as a land of dull uniformity that the contrast worked out by the author is novel and suggestive. No doubt every other continent yields similar contrasts, geographical, climatic, and ethnological, and these are probably even more extensive and striking. In spite of Professor Keane's ingenuity and the amount of truth unquestionably contained in his contrast, one feels bound to admit, that when compared with its size and opportunities, the old view is on the whole the true one.

North Africa is divided into six districts which are described separately. These are the region of the Atlas (including Tunis, Algiers, and Morocco), Tripolitana, the Sahara, the Soudan and the Niger Basin, Egypt and Nubia, and Italian North-East Africa, including Abyssinia and Somaliland. Each of these is described separately, accounts being given of the physical features, ethnography, climate and political customs. Politics occupy a leading place, and as a rule are very fairly treated. The author states that the success of the French in Algeria "goes far to gainsay the trite remark that they [the French] do not know how to colonise." He points out, however, that the French have lost £151,000,000 in their fifty-eight years of occupation, and that the claim that there is now an annual surplus in the Budget is due to the fact that the military charges for the army of 7,000 men are not included. The author does fair justice to the abused Portuguese, and refers to their early explorations. This is the more satisfactory, as one of the faults in the book is that in the references to literature, foreign work does not receive its proper share of notice. Thus, Fischer, on p. 16, is mentioned only casually, and the credit due to the first traverse of the Masai country is awarded to another. The most valuable part of the work is that dealing with the ethnology—this is well up to date. The recent discussion as to the presence of dwarfs in Morocco is referred to, and the classification of the tribes includes the results of most recent investigations. The general natural history is less satisfactory. Casuarinas are said, on p. 468, to grow on the banks of the Webi-Shebeyli, which is almost impossible. The author sometimes trusts for his geology to scattered notes in anthropological journals (as on p. 553), with results that are not very encouraging. He tells us that the Nilotic lands have not been below sea level since pre-Tertiary times, which is a statement that requires serious modification. In one place the conclusions are a little previous; as when we are told on p. 246, that the French have overthrown their enemy Samory, a statement which the news of the past three months has shown to be very far from the truth.

The geographical sketches are clear surveys of the physical features. Many popular misconceptions are corrected, such as that the Nile has its largest volume below Berber, instead of at its mouth, a frequently repeated statement due to the fact that the river receives no tributaries after this point; but this ignores the supplies added by springs upon its bed. The "flooding of the Nile" is also explained as a case of percolation of water through the soil, instead of by flow across the surface as is usually supposed. The ludicrous absurdity of the proposal to flood the Sahara by letting in the waters of the Atlantic is held up to ridicule, and the very limited areas which could be submerged are indicated. The book is not one which can be summarised; but it may be recommended as a useful, concise and accurate sketch of the geography and ethnology of Northern Africa. The maps are especially worthy of commendation.

J. W. Gregory.

Distribution of Plants.

Plantesamfund. Grundtræk af den Ökologiske Plantegeografi. Af Eug. Warming, Professor i Botanik ved Kjöbenhavns Universitet. 8vo. 335 pp.

This new work by Dr. Warming constitutes a most original contribution to the study of the distribution of plants. According to his conception the problems of plant-geography present themselves under two distinct heads, the Floral and the Œcological. The first has been already treated, notably by Grisebach and Drude, but hitherto there has been no text-book dealing with the "œcological" (οἶκος, λόγος) aspect of the subject. In a consideration of *Floral Plant-geography*, the first and most important point is to determine a catalogue of the plants inhabiting definite areas, and the next to divide the areas into floral districts, based upon the relationship of the species and genera, and leading to a division of the areas into natural regions; following this there is the determination of the boundaries for species and genera, their distribution and relative numbers in various countries, the consideration of endemic forms, the relation of Insular Floras to those of the mainland, and of Mountain Floras to lowlands, etc., etc.

Œcological Plant-geography deals with quite another problem, it treats of the laws and influences affecting the forms and characteristic groupings of plants, and seeks to teach us how the external appearance and internal economy (*husholdning*) of plants and plant-communities (*plantesamfund*) are regulated according to the supply of warmth, light, nutriment, water, etc., which is at their command. A hasty glance suffices to show that species are not evenly distributed over the districts which compose their zone, but are grouped into companies with very varied physiognomy. The first problem suggested is to find out what species are confined to localities of a homogeneous character. The next, and very difficult one, is a solution of the questions: *Why* they are confined in distinct groups, and *why* these have their peculiarly distinctive features. This leads on to a consideration of questions relating to the internal economy of plants, their requirements according to the conditions under which they live, the manner in which they utilise the external conditions at their command, and adapt themselves to these in their structure and physiognomy, and especially to considerations of the "Forms of Life."

These are some of the complex questions to which Dr. Warming addresses himself. The scheme he adopts in his book is to divide it into sections: the *first* section treats of the factors which play a part in the internal economy of a plant and the influence these exert upon both the external and internal forms, upon the duration of life and other biological facts, as well as upon the topographical limitation of the species: the *second* treats of the arrangement into a system and the characteristics of the communities or "social classes" which are found upon the earth—*Hydrophytous*, *Xerophytous*, *Halophytous*, and *Mesophytous* vegetations; and the *third* of the struggle between the different communities. In the first section the various factors and their influences are considered in turn, although, as is pointed out, these never operate singly, and it is often very difficult to assign to each its separate effect. They are conveniently divided into those whose action is *direct* and those in which it is *indirect*. The former include the *atmospheric factors*, viz., the composition of the air, light, warmth, rainfall and moisture of the air, movements of the air; and the *terrestrial factors*, viz., the character and composition of soils and their chemical and physical action. The indirect influences include the relief of the land, the configuration of the land and sea, the height above sea-level, the latitude as well as other controlling and modifying causes.

The author has brought to his task a store of very valuable material accumulated from his own observations, and he has consulted an immense amount of recent biological literature, but the incompleteness of our present knowledge naturally leaves room for future investigation, and the present work opens out an important field of inquiry which should give an impulse to others to work in the direction indicated.

M. C. P.

Fungus Flowers from Brazil.

Brasilische Pilzblumen. By Alfred Möller. 8vo. Pp. viii., 152. 8 plates. Jena: Gustav Fischer, 1895. Price 14 marks.

Möller's brilliant work on the fungus gardens of the leaf-cutting ants in Brazil, published in 1893, prepared us to regard with more than usual interest any further communication from him. His "Brasilische Pilzblumen," embodied in a recent number of the *Botanische Mittheilungen aus den Tropen*, while adding to our scientific knowledge, has largely enhanced his reputation. Our acquaintance with tropical, evanescent forms is apt to be very vague, dependent as it is on the chance gatherings and observations of passing travellers. Möller studied the fungus-flora of Brazil during three years with splendid success. He has confined himself in these papers to one family, that of the *Gasteromycetes*, which, especially the *Phalloideæ*, are much more abundant in tropical countries than in our temperate regions. He has added four genera and eight species to those already known, and has given us some very interesting details about the forms already familiar to us. He made large use of the photographic camera during the progress of his work, and its accuracy is, therefore, unquestionable. Indeed, a "lightning-sketcher" would almost have been necessary to make truthful drawings, so rapid was the growth and decay of some of the fungi. We have read with special interest the records of growth of the beautiful, though evil-smelling, tropical fungus, "the veiled lady," *Dictyophora phalloidea*. Möller was able to carry home specimens still in the "egg" condition, and to watch the bursting of the enveloping peridium with the marvellous elongation of the stalk. The average maximum of increase was two mm. per minute; but one specimen attained to five mm. during one minute. He states that not only could he see it grow, he could also hear it, the rapid extension of tissue causing a slight crackling sound. The "lady" expanded in the evening, the following morning her beautiful garment hung limp and soiled, and the rays of the morning sun completed the work of decay.

One of the most interesting and important of the fungi discovered by Möller, "*Protubera Maracujá*," belongs to the primitive group of the *Hymenogastreæ*. It has always been a task of great difficulty to understand the relation which the different members of the *Gasteromycetes* bear to each other. The development of "*Protubera*," so carefully worked out by Möller, proves it to be a transitional form between *Hysterangium* and *Clathrus*, thus confirming the view, held by some previous students of the group, that *Clathrus* and its allies had developed from the more primitive form. The other genera, *Blumenavia*, *Aporophallus*, and *Itajahya* belong to the highly-organised *Phalloideæ*. Möller has been led to dignify them with the title "Pilzblumen" (fungus flowers), on account of the striking odour, pleasant or otherwise, which they exhale, and also on account of the colours and forms displayed by the different species, which serve to attract insects, and so aid in the dissemination of the spores.

A. L. S.

Lunar Physiography.

The Moon: A full description and map of its principal physical Features. By Thomas Gwyn Elger. 8vo. Pp. viii-173, with 4 maps. London: Geo. Philip & Son. Price 5s. Map issued separately as whole sheet, 2s. 6d.

A cheap concise handbook to the moon has long been a desideratum, for no member of the solar system is more interesting, is more convenient of study or affords better training to the young astronomer than what the Irish ballad calls the "fine noble creature, which gives us the daylight all night in the dark." The works of Neison, Beer and Mädler, Schmidt, Nasmyth, etc., were either too expensive or somewhat out of date. A popular summary of the whole question of lunar physiography may, therefore, be expected to be of value to the increasingly numerous class of men who possess telescopes of sufficient power to aid in the work of mapping its surface. To these, Mr. Elger's book can be confidently recommended. It is concise, cheap, clear, and, as far as we have tested it, correct. It is conveniently arranged. It commences with a description of the different "earth-forms," which can be recognised on the moon, such as the great plains or "Maria," ridges, ring mountains, including craters, walled plains and crater pits, clefts or rills, and valleys. The exact significance of these different forms is discussed, and most of the principal theories are referred to. The two principal omissions which we notice in the literature is that there is no reference to the remarkable paper by Gilbert, and the still more recent one of Suess. The part of the work which discusses lunar geology is the least satisfactory, for the author's knowledge of the earth is not so well up to date as is that of the moon. This is unfortunate; for the impression is certainly growing that the explanation of lunar topography will come from the study of the geology of the great continental volcanic areas. It is useless, therefore, to quote men such as Professor Phillips, who wrote before the volcanic region of the Western States had been described. Mr. Elger, nevertheless, seriously discusses Phillips' comparison of the lunar ridges to kames and eskers, while his information on these is antiquated, for he says these are "of somewhat doubtful origin," and quotes one explanation of them to the effect that they are "old submarine banks formed by tidal currents like harbour bars." We should have been glad, moreover, if he had indicated the differences between the lunar rills and terrestrial cañons, and not simply dismissed the question by the remark that "the analogy, at first sight specious, utterly breaks down upon closer examination." We would venture to remind the author that cañons are not all due to the same cause as that which made the Grand Cañon of the Colorado.

The main part of the work is occupied by a catalogue of the lunar formations, those of the four quadrants being taken separately. Appendices give lists of the maria, mountains and ray systems, a table of lunar elements, and an alphabetical index to the formations.

The author is quite clear in his conviction that changes are taking place on the moon at the present time, and that exhalations are given off which temporarily obscure certain features. He therefore suggests the detailed study of limited areas, in order to check any such variations in structure or appearance. Some of the cases he quotes, of the disappearance and sometimes reappearance of certain features, are very striking, and certainly seem to prove that the moon is not a dead changeless world and burnt-out planet, as it is so often described.

J. W. G.

The Birds of Brazil.

As Aves Do Brazil, Primeira Parte. Por Emilio Augusto Goeldi, Dr. Ph.; Director do Museu Paraense Livraria Classica de Alves, Rio de Janeiro, 1894. Pp. 311.

This little volume is the first part of a work to be completed in two parts upon the birds of Brazil. The first part, now before us, contains introductory matter and an account of the raptores, psittaa, picariæ, and passeres. The method of classification adopted is plain and old-fashioned, with no attempts at modernity. The owls are grouped with the raptorial birds, the screamers are placed among "grallatorial" birds, between storks and ibises; while the natatores remain the strange assortment of web-footed creatures as in earliest attempts at classification. However, this detracts nothing from the value of the book, which simply is a straightforward guide to the birds of Brazil. It should prove useful to ornithologists, especially to those who have an opportunity of visiting that country, and its portable form will make it more serviceable than more detailed illustrated books.

Dr. Goeldi has prepared some interesting tables of the distribution of birds, showing the peculiar families, and the range of families that occur also in other regions. These, however, contain no novel matter, and, although we highly recommend this little book as a useful guide to its subject-matter, we cannot assign it any value as a contribution to science.

The June number of *Knowledge*, which has been sent us by the publishers, shows that this popular monthly continues to purvey for a large public interesting facts and theories of science "simply worded and exactly described." Special praise is due to the plates, of which the present number contains two, one an excellent reproduction of twenty-three Greek coins, the other showing photographs of two portions of the moon. The number contains an interesting article by Mr. Lydekker on the origin of the giant birds of South America.

Those connected with museums will be interested to hear of the establishment of a new journal, entitled *Revue Internationale des Archives, des Bibliothèques et des Musées*, published in Paris by H. Welter, 59 Rue Bonaparte, and issued in three separately paged sections, headed respectively "Archives," "Bibliothèques," and "Musées." The annual subscription is twenty francs.

OBITUARY.

VALENTINE BALL, C.B., LL.D., F.R.S.

Born July 14, 1843. Died June 15, 1895.

THE untimely death of the Director of the Science and Art Museum, Dublin, removes one of the leading men of science of that city. Born in Dublin, the second son of Dr. Robert Ball an enthusiastic naturalist and superintendent of the University Museum, and the younger brother of Robert Ball, now the well-known astronomer, Valentine Ball was brought up amid surroundings well calculated to foster a love of Nature. He was educated at Chester, Rathmines, and Trinity College, Dublin, holding during his university course a clerkship in the Chancery Office. In 1864 he resigned this post to take up far more congenial work on the staff of the Geological Survey of India. During his service in the East, he paid special attention to the economic aspects of his science, and enriched the memoirs of the Survey by many valuable papers on the building-stones, coal-fields, minerals, gold-bearing rocks, and gems of the country. The main results of his labours in this field will be found in the "Manual of the Geology of India, Part III., Economic Geology," 1881. His geological work, however, by no means absorbed his whole attention; he took advantage of the opportunities offered by his journeys to study the plant and bird-life of the country, and to accumulate notes on the less-known native races of men; such observations were summarised in his "Jungle Life in India."

In 1881, Ball returned to Dublin to succeed Rev. S. Haughton, as Professor of Geology and Mineralogy in the University. He held the chair for only two years, being appointed, on the death of Dr. Steele, in 1883, Director of the Science and Art Museum. During the ensuing twelve years he laboured unremittingly for the development of the institution over which he was placed. Museum administration was highly congenial to his tastes, and he threw himself into the work with the greatest enthusiasm. The Dublin Museum has grown largely under his rule, and the story of its progress was given to readers of Natural Science, in July last year, in his presidential address to the Museums Association, where the accumulation of the various collections, the erection and opening of the new building for the art division, and other recent developments were described at length. To the geological and mineralogical specimens under his care, he naturally devoted special attention. In 1884, Ball attended the Montreal meeting of the British Association, and took advantage of the occasion to visit the principal museums of Canada and the States, and to embody his observations in a valuable report. When, three years ago, failing health warned him to take a few months' rest, he chose to visit Egypt, a country which can hardly be said to furnish a thorough change to a museum officer; while only last year he made a tour of the museums of Scandinavia, Germany, and Austria, a report on which was engaging his attention at the time of his death. For several years past he held the post of Secretary to the Royal Zoological Society of Ireland, and took a leading part in the management of the gardens in Phœnix Park. His leisure studies turned towards the border-land between science and literature. His interest in the relations of the Greeks with the East led to a paper in 1885 "On the Identification of the Animals and Plants of India, which were known to early Greek Authors." The histories of famous gold-nuggets, diamonds, and inscribed rubies, also had much attraction for him, and he edited a new edition of Tavernier's "Travels." His was a nature to be ever active, and it is to be feared that the wear and worry of his responsible post with its delicate relations with various institutions, his desire to supervise personally all possible details of administration, and his resolve to work with his might while the day for work was still his, contributed to materially shorten his life. He was at his office but a short week before he passed away, and though mourning his removal while still in his prime, his colleagues and friends feel that he leaves them the example and inspiration of unflagging devotion to duty. G. H. C.

WILLIAM CRAWFORD WILLIAMSON.

BORN NOVEMBER 24, 1816. DIED JUNE 23, 1895.

ON June 23 there passed away one whose name will always hold a prominent position in the records of botanical science. William Crawford Williamson was born at Scarborough, on November 24, 1816; he received his early education partly in his native town and, to some extent, in a French school.[1] From 1832 to 1835 he made his first acquaintance with medicine in the house of Mr. Thomas Weddell, a Scarborough surgeon, and in the latter year was appointed Curator of the Museum of the Manchester Natural History Society. After qualifying as a member and licentiate of the College of Surgeons in 1840, he became a medical practitioner, and remained for many years an active member of the profession. In 1851, Williamson was appointed Professor of Natural History and Geology at Owen's College; he resigned the chair of Geology in 1872, that of Zoology in 1879, and that of Botany in 1892, when he was made Emeritus Professor. Elected a Fellow of the Royal Society in 1854, he was

[1] The facts of Professor Willamson's early life are taken from an admirable memoir, by C. Bailey, published in the *Manchester Scientific Student's Annual Report* for 1886.

awarded the Royal medal twenty years later; in 1883 the University of Edinburgh conferred upon him the degree of LL.D. In recognition of his ability as a scientific worker he was enrolled an honorary member of several foreign and English societies. Inspired at an early age with a true natural history spirit, Williamson was led by his energy and love of work to publish several papers on widely different branches of natural science. In addition to his contributions at this early period to scientific literature, it should be noted that many of the illustrations of Yorkshire Mesozoic plants in Lindley and Hutton's classic work were drawn by the same hand which in more recent years has enriched the pages of the Royal Society's *Transactions.* During his residence in Manchester as a medical practitioner, Williamson found time for several contributions to different societies on palæontological subjects. At a meeting of the British Association, in 1842, he read a paper on the "Origin of Coal," and from this preliminary note we may date the beginning of his untiring devotion to the microscopical examination of the structure of coal and the tissues of Carboniferous plants. From time to time, at subsequent British Association meetings, short notes have been given, showing the steady progress of his immense undertaking to investigate the minute structure of the coals of the world, and this work was continued up to a short time before his death, when he generously handed over the work of many years to be completed by a younger worker. Most conspicuous among Williamson's work prior to 1860, are his valuable contributions to the History of the Foraminifera. It was, indeed, in this branch of Natural History that Williamson first established a reputation as an original investigator. In later years his energies were centred in palæobotanical researches, and in this chosen field of work he achieved a splendid success. The examination of fossil plants, originally confined to the description and uncertain determination of structureless specimens, was raised to the level of an accurate study by the use of the microscope, inaugurated by Witham, Corda, and others, and followed up by Binney, Carruthers and Williamson. It is not too much to say that the labours of the latter author deserve to be spoken of as marking a new era in palæobotanical science. Among Williamson's earlier papers, mention should be made of a detailed and exceedingly able memoir on the well-known Jurassic fossils for which Carruthers instituted the generic name of *Williamsonia;* since this paper was read before the Linnean Society, in 1868, various attempts have been made to settle the botanical nature of this problematical genus, and recent work tends to a large extent to confirm Williamson's conclusions. Passing over other palæobotanical contributions we must, finally, refer to the invaluable series of memoirs "On the Organisation of the Fossil Plants of the Coal-Measures," begun in 1871 and completed in 1893. It is impossible to give any adequate expression of the importance of these memoirs in a short obituary notice. The labour and scientific skill embodied in this legacy to botanical science have only been at all fully realised in recent years. Hampered by a strong prejudice in favour of a certain classification of Palæozoic plants, established by Adolphe Brongniart, and cramped by a conception of botanical morphology founded solely on recent plants, botanists were slow to accept Williamson's startling conclusions, and it was only by the gradual accumulation of convincing evidence that his results gained general acceptance. There is no longer any serious attempt to deny the existence in the Coal-Measure forests of various arborescent vascular cryptogams, which in their fructification agreed in all essential respects with recent members of the same class, but in their manner of secondary growth in thickness showed the closest agreement with gymnospermous or dicotyledonous trees. Last year there appeared the first of a new series of memoirs under the joint authorship of Professor Williamson and Dr. D. H. Scott; the wealth of material dealt with, and the extraordinary completeness of the detailed description of such plants as *Calamites* and *Sphenophyllum*, afford some indication of the value of that class of work of which Williamson was to a large extent the founder. In addition to the Royal Society memoirs, reference must be made to the masterly monograph on *Stigmaria ficoides*, contributed to the Palæontographical Society in 1886. In the *Proceedings* of the Manchester Literary and Philosophical Society there are numerous papers on fossil plants by Professor Williamson, and the last of his botanical contributions is an exhaustive and elaborate account of certain points in the growth and development of Carboniferous Lepidodendra, communicated in October, 1894, to the society of which he was president for more than thirty years.

Those who were privileged to know Williamson, not only as a botanist, but as a personal friend, will always think of him as a striking personality, in which the enthusiasm of the real student was combined with a generous and open-hearted spirit. Emphatic in his expression of opinion, and at times carried away by the strength of his own convictions, Williamson would occasionally be led to enunciate a general truth in somewhat too sweeping terms. It was this strength of conviction, a steady determination of purpose, and an eager longing to solve difficult problems which enabled him to achieve so much towards the advancement of botanical science. Not only was he a thorough and cautious student in special branches of science, but at the same time a keen naturalist, and eminently successful as a popular exponent of botany and geology. To attempt to form any just estimate of the value of Williamson's life-work, or to call up, however imperfectly, the most striking traits in his character, is a difficult task for one who, like the present writer, is under a very strong obligation to the never-wavering kindness and true friendship of the most affectionate and generous of teachers. His reputation as a man of science may be safely left to the judgment of Continental colleagues, and to future generations of palæobotanical students.

A. C. S.

Dr. E. C. De Crespigny, born in 1821 at Vevey, Switzerland, died at his home at Beckenham, Kent, on February 15 last. Though of foreign birth, his education was chiefly English, and in 1845 he entered the Indian Medical Service. In 1859 he became Acting Conservator of Forests and Superintendent of the Government Botanical Gardens at Dapoorie, near Poonah; but, owing to illness, was obliged to return to England in 1862, where he made his home at Beckenham. The remainder of his life was devoted to the study of botany, and the formation of a herbarium. In 1877 he published a small volume entitled "A New London Flora." A small collection of coloured drawings of plants, made during his residence in India, is in the Botanical Department of the British Museum.

Mr. E. J. Glave, who died on May 12 at Underhill on the Congo, had served under Stanley during the organisation of the Congo State. He visited Lake Nyassa and Karanga in 1893, and made some interesting notes on the burial place of Livingstone. Mr. Glave was an accurate observer, and his skill as a draughtsman gave additional value to the contributions, only too few in number, that he added to the literature of the Congo basin. He did brilliant work for the Free State, and his early death will be deeply regretted by all whom he met in Africa, and who will long remember his bright humour and unvarying good temper.

Owing to the pressure on our space last month we were quite unable to chronicle the deaths of Dr. Francesco Sansoni, the eminent mineralogist of the University of Pavia; Dr. Jules Croissandeau, well known for his work on Coleoptera, of Orleans; Dr. John Anthony, the microscopist, who died at Birmingham on June 3; Dr. F. E. Neumann, the physicist, who passed away at Königsberg on May 23, at the age of 97; Dr. John Byron, the eminent bacteriologist of the Loomis Laboratory, in May; Dr. F. Müller, of Basle, the herpetologist, whose catalogues of the Reptilia and Amphibia of the Basle Museum form valuable books of reference; Sir Samuel Wilson, a Royal Commissioner for the Fisheries Exhibition, who died early in June; A. W. Scherfel, the founder of the Tatra Museum at Felka, who died on April 24; Professor Dr. W. Voss, the mycologist of Vienna, who died at that city on March 30; R. P. Bon, well known as a botanical collector in Tonking and Annam. Dr. Gideon Moore, the mineralogical chemist of New York, died on April 13, aged 53 years; Dr. H. F. C. Cleghorn, formerly of the Forest Department of India, and for long president of the Royal Scottish Arboricultural Society, in May; H. N. Sandbach, the ornithologist of Denbigh, early in June; John H. Redfield, botanist and specialist on vascular cryptogams, on February 28, at Philadelphia, in his 80th year; and Pietro Doderlein, Professor of zoology and geology, in Palermo, on March 28, aged 84.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments have recently been made:—Dr. T. Smith, as Professor of Applied Zoology at Harvard University; Deputy Surgeon-General Billings, of the "Catalogue of the Surgeons' General Library," to the chair of Hygiene in the University of Pennsylvania; W. G. Ellis, as Demonstrator of Botany in the University of Cambridge; Dr. T. G. Brodie, as Lecturer on Physiology at St. Thomas's Hospital, London, in succession to Professor Sherrington; Charles D. Aldright, to be Instructor in Biology in the University of Cincinnati, U.S.A.; Charles Leigh, Attendant in the Library at the British Museum (Nat. Hist.), to be Assistant Secretary and Librarian to the Manchester Literary and Philosophical Society. Dr. E. Hering, of Prague, succeeds Carl Ludwig as Professor of Physiology at Leipzig. Dr. Hans Schinz takes rank as Ordinary Professor of Botany at Zürich. Professor W. Peterson, of Dundee, is elected Principal of McGill University, in the room of Sir J. W. Dawson. Dr. E. C. Quereau becomes Professor of Geology and Mineralogy in Syracuse University, U.S. Dr. T. T. Groom succeeds the late Allen Harker as Professor of Natural History at the Royal Agricultural College, Cirencester, and Mr. S. S. Buckman will now be relieved of the temporary duties he undertook at Mr. Harker's death.

DR. A. KOWALEWSKY has been elected by the Paris Academy a corresponding member (zoology), in place of G. H. Cotteau. Sir Archibald Geikie has been elected a corresponding member of the Royal Academy of Science in Vienna. Dr. A. R. C. Selwyn has been elected President of the Royal Society of Canada for the session 1895–96. Professor T. T. Groom, of Cirencester, has received the degree of Doctor of Science, *honoris causa*, from the University of London. Mr. J. S. Gardiner, of Caius College, Cambridge, will occupy the University Table at the Naples Zoological Station from October, 1895, to March, 1896. Mr. A. W. Rogers, of Christ's College, Cambridge, has been awarded the Harkness Scholarship in Geology. Mr. Walter E. Collinge has been awarded the Darwin Medal by the Midland Union of Naturalists for his researches on the cranial nerves and sensory canal-system of fishes. Dr. Roux has received a gold medal, specially struck for the occasion, from the Paris Municipal Council for his discovery of anti-diphtheritic serum.

JOHNS HOPKINS UNIVERSITY has founded a Geological Lectureship in memory of Professor G. H. Williams. There will be a short course each year, and men eminent in their science will be asked to deliver each series. The first offer has been made, we understand, to Sir Archibald Geikie. This, besides being complimentary to foreign geologists, will be of considerable advantage to American students, for they will thus obtain new and different views of the subject, and will find an increased interest in languages other than their own.

PROFESSOR LLOYD MORGAN will deliver a series of four lectures on the Habits and Instincts of Birds, before the Biological Class of Columbia University next winter.

MEMORIALS to Professor Huxley are mooted. Since he received his early scientific and the whole of his medical education at the Charing Cross Hospital

Medical School, those connected with that hospital have resolved to establish a memorial that "shall take the form of a Huxley Scholarship and Medal, to be awarded annually at Charing Cross Hospital Medical School, and that if funds permit an annual lecture at the Charing Cross Hospital Medical School, dealing with recent advances in science and their bearing upon medicine, shall be instituted." Subscriptions may be sent to Dr. Watt-Black. It has further been proposed to erect a national memorial, possibly in the form of a statue in the Natural History Museum, Cromwell Road.

AMONG the liberal sums so generously given to American institutions we note that of an unknown donor, whose name is never to be revealed, of 250,000 dollars, for the purpose of founding a library, museum, and hall for the University of the City of New York. Mr. C. C. Harrison has given 100,000 dollars to the University of Pennsylvania. The income from the fund, which is in memory of Dr. G. L. Harrison, is to be used for the "Encouragement of Liberal Studies and the Advancement of Knowledge." We learn from the *Daily Chronicle* that the 250,000 dols. subscribed for a proposed Botanic Garden in New York was really subscribed by twenty-two people, and not by two millionaires, as previously reported. It now remains for the City of New York to raise 500,000 dols. by bonds for building purposes, etc., and to present 250 acres of land in Bronx Park. The same newspaper records an offer from six men to build a Hall of Science for Syracuse University at a cost of 150,000 dols., while 110,000 dols. have been offered towards a new medical college.

A SUPPLEMENTARY Charter has been granted to Durham University, and enables Convocation to grant to women any degrees, excepting only degrees in Divinity, which they have the power to grant to men. The degrees of the University of Durham in Medicine, Science, Arts, Literature, and Music are, therefore, now obtainable by women. The Medical and Science Faculties are in Newcastle-upon-Tyne, the former in the College of Medicine and the latter in the College of Science, where women students can receive instruction in the various subjects of these two faculties. The first woman graduate—Miss Ella Bryant—received her degree of Bachelor of Science at the meeting of Convocation, held on June 24.

THE *Twenty-ninth Annual Report of the Museums and Lecture Rooms Syndicate* of Cambridge University has just been issued. The Syndics draw attention to the want of co-operation between those responsible for old buildings and those engaged on erecting new ones, which has caused much inconvenience that could easily have been avoided.

An important change has been made in the arrangement of the Herbarium. Like so many natural history collections in our larger museums this was formerly subject in some degree to a topographical arrangement; the existence of two collections—European and general—frequently necessitated search in two places for any plant; these two collections have now been united, and the geographical arrangement and coloured labels in use at Kew have been introduced. We commend a similar consolidation to all curators in charge of extensive collections. The Samoan and Fijian plants presented to the Herbarium by Baron v. Hüges have been determined by Mr. Burkitt, who is now engaged on those from New Britain. The arrangement of the algæ and mosses is also progressing. Among the chief donations are mentioned Bornean plants from Mr. G. D. Haviland, Indian plants from the Government of Bengal, and Lapland mosses from Professor Elfving. We are glad to see that some work is being done in this Herbarium, and hope it is a sign that the Universities are taking greater interest in systematic botany.

Among the important additions reported as made to the Museum of Zoology are deep-sea Crustacea, presented by Dr. A. Alcock, the White Rhinoceros, to which we alluded in vol. iv., p. 324, a skull of the Elephant Seal, obtained through Professor Jeffery Parker, of Dunedin, N.Z., and several valuable specimens from North-east Borneo, sent by C. and E. Hose. To the Termites, presented by Mr. G. D. Haviland, which constitute a most important collection, we have already referred (vol. iv., p. 407). Dr. Sharp says that this collection has not been incorporated in the Museum as yet, but remains at the disposal of anyone able and willing to work it out. Dr. Gadow's appeal for bird-embryos has been liberally answered by Walter Heape.

The Geological Museum has received fresh additions to the collections previously presented by Professor Wiltshire, including many type-specimens. The Rev. G. F. Whidborne has presented figured specimens of seventy-two species of Devonian fossils. Some fine limb-bones and teeth of *Elephas meridionalis*, *E. primigenius*, and *Bison* sp., dredged off Yarmouth, have been purchased. The work of arrangement, of cataloguing, and of teaching, continues, though under great difficulties owing to want of space. The erection of the new Museum, of which the plans were published in NATURAL SCIENCE for December, 1893, is still deferred, and the heart of Professor Hughes is sick.

IN our April number (p. 232, vol. vi.) we referred to the addition to the Education Code, which permits the visits of board-school children to museums to be counted unto them for "attendance." On Tuesday, June 25, a meeting of board-school teachers was held at the Whitechapel Museum, 77, High Street, Whitechapel, to consider how advantage might best be taken of this beneficent addition to the code. Mr. G. L. Bruce, Member of the London School Board, took the chair, and Miss C. A. Raisin delivered an address in which she pointed out the good to be gained by those teachers who would avail themselves of this permission, and who would properly prepare themselves for each visit. She laid stress on the habits of order and observation that might be inculcated, deprecated an excessive use of note-books, and suggested the formation, by the children themselves, of small collections in each school. In the discussion that followed, there seemed to be a fear (surely groundless) that difficulties would be raised by the Inspectors, whose permission has in each case to be gained; one speaker was doubtful whether a visit to the British Museum would receive official sanction. Some teachers shrunk from the fresh burden laid on them, and complained of the length of time that would be required for such a visit, though it could ill be spared. On the whole, however, the feeling was that, if only the suggestion could be put into practice, it would prove valuable. Mr. F. A. Bather, in proposing a vote of thanks to Miss Raisin, reminded the teachers that they were the interpreters between the curators and the children, and explained some of the aims of the modern curators. He advocated short and cheerful visits with a definite object, the study and explanation of familiar things, and a constant remembrance that the museum was only a makeshift epitome of the whole actual world of nature, industry, and art. While recognising the value of the collector's enthusiasm, he would not waste this in small local channels, but rather have such a museum as the Whitechapel Museum working in unison, as an educational factor, with all the schools in its neighbourhood.

We cannot too strongly impress upon teachers the importance of preparing for the museum visit, and not waiting for the inspiration of the moment. Miss Hall, the curator at the Whitechapel Museum, is in attendance from 3 p.m. to 9 p.m. on Tuesdays and Thursdays, and from 10 a.m. to 4 p.m. on Wednesdays and Saturdays; during these hours she will talk over with the teachers the subject for the next museum visit. The teachers in this district have also the use of an excellent Reference Library—the Museum in question being in connection with the Free Public Library. During the winter, the monthly lectures will be resumed, and a series of demonstrations will be arranged expressly for teachers.

A NEW room, furnished by special subscriptions from some members of the Chester Society of Natural Science, has been opened at the Grosvenor Museum, Chester, and in it the local collections have been arranged. A few features in the collection call for comment. The fossil and recent mammals are arranged together, the former being elucidated by photographs of the restored animals. The general and local distribution of the birds are shown by maps and by printed extracts from W. H. Dobie's paper, "Birds of West Cheshire, &c.," published in the *Proceedings* of the

Society, 1894. The life-histories of the various species continue to receive additions, and twenty-seven specimens are now illustrated. The mounting of the reptiles and amphibians is specially to be commended. Attractiveness is lent to the Bryozoa by photographs of the living animals taken by Dr. Stolterfoth. This museum is already celebrated for its exhibits of life-histories of insects, and Mr. Newstead continues his valuable work in this direction. A fine collection of the recent and fossil Foraminifera of the district, illustrated by drawings and models, has been arranged and presented by J. D. Siddall.

WE are pleased to note that Mr. Edward Wilson's admirable little "Guide Book to the Bristol Museum" has already reached a fifth edition. The museum is now open to the public late every evening, except Friday, and is rapidly growing in popularity. So many elementary students make use of the collection of rocks and fossils, that the Curator has now arranged a special cabinet of specimens best suited to their purpose. They can handle these without fear of damage, and the valuable type-specimens in the exhibited collection are thus preserved from all risk at inexperienced hands.

AN important addition has recently been made to the Liverpool Museum. A room long used for the storing of lumber has been transformed into a handsome gallery for the display of the valuable ethnographical collections. At the opening ceremony, on June 19, addresses were delivered by Sir William Forwood, Mr. W. H. Picton, the Lord Mayor, and Dr. H. O. Forbes, the Director of Museums. We give a few extracts from Dr. Forbes' speech, as reported in the *Liverpool Daily Post.*—"The earliest foundation of the purely ethnographical collection was laid by the purchase made by the Corporation as long ago as 1857, of the large and valuable collection of Captain Savage. The munificent gift of Mr. Mayer ten years later, not of a gallery only, but of a full-fledged museum (with which the Savage collection was incorporated), not only added largely to the special department of ethnography, but, by bringing the museum into a still more prominent place than previously among provincial institutions, was the means of attracting to it further valuable donations. An ethnographical loan exhibition held in Liverpool in 1880, contributed to by possessors of collections all over the country, was instrumental in still further increasing its treasures. At the dispersal of that loan exhibition, the Corporation's collection was exhibited for a short time in a temporary building, but the extension of the art gallery absorbing the ground on which it stood, the greater part of the collection had to be stored away. It was, nevertheless, being constantly augmented by donation and purchase. Among various benefactors to this department, I may perhaps mention specially the late Lord Derby and Sir Augustus Franks of the British Museum, both of them great benefactors to the gallery, as also Mr. G. B. Medley, the late Mr. J. G. C. Harrison, Mr. Clements Markham, C.B., Captain Stubbs, R.N., Consul Harper-Parker, Mr. R. D. Radcliffe, Captain Sibthorpe, and Mr. P. H. Rathbone, whose name occurs on many pages of the catalogue. The collection can never be mentioned, however, without recalling the gift by Mr. John and Mr. Ernest Tinne, of the important collections made by that distinguished traveller, their intrepid relative, Miss Alexandrine Tinne, who devoted her fortune and finally lost her life in the cause of science. Thirty years ago African exploration was a very different and far more hazardous matter than it is to-day. For an unprotected lady to have penetrated, as Miss Tinne did, far towards the source of the White Nile, against difficulties, dangers, and disasters, required an unfainting heart and indomitable pluck not always found even in powerful men, and hers has never been excelled in any male explorer. Liverpool claims the honour of her birthplace, and the collections of this remarkable woman will always have an honourable place in its museum. Besides donations and purchases, this collection owes not a little to the generous loans of several owners. The most valuable and important are those of the late Mr. A. P. Bell, lent by his family, and more especially the extensive collection deposited by the council of the Royal Institution, which contains numerous pieces which it is now impossible ever to obtain. . . . . The Derby and

Mayer Museums appear to many, I fear, to contain collections with little or no relationship with each other, the one being biological and the other devoted to antiquities, pottery, and other works of art. If the buildings in which these museums are housed were so constructed as to enable the biological collections to be arranged in scientific order—that is in the sequence of the origin and development—an arrangement which, I trust, may be possible at no very distant date with the intended extension of these buildings—then this ethnological gallery would follow naturally and immediately after that devoted to the history of the anthropoid animals. . . . In the anthropological gallery devoted to the history of the highest family of the anthropoids, man, we attempt to display his osteology, embryology, his geographical distribution, and the effects of climate and surroundings in producing different races—in other words, his biological history. Then in this gallery we follow his intellectual history, tracing its rise and progress through the barbarous or less civilised peoples, following his culture and achievements in the adjoining galleries of the Mayer Museum. The collections in this gallery are arranged geographically, commencing in the near room with the earliest traces of man; then follows the ethnography of the peoples of Siberia, Greenland, and Labrador, the Esquimaux, and Samoyeds; then that of the Indians of the American continent from Canada to Patagonia; in the further room we traverse the Eastern Hemisphere and study the ethnography of the black peoples or Melanesians of Africa, Australia, Papua, New Hebrides, and Fiji; then of the Polynesians of Samoa, New Zealand, and the Pacific; next the Mongolians of Malaya, China, and Japan; and finally that of the Indian Peninsula and Burmah."

This museum has recently acquired the ornithological collection of Canon Tristram. It contains some 30,000 specimens, and is rich in the birds of oceanic islands.

An important series of Purbeck and other fossils is now being added to the exhibited collection in the Dorset County Museum, Dorchester. The new acquisition is the gift of the Trustees of the Corfe Castle Museum, which was closed last year. The fossil fishes from the Dorset Purbecks are especially fine in the County Museum, and several of them were described by the late Sir Philip Egerton in the *Decades of the Geological Survey*.

The Museum of the Whitby Literary and Philosophical Society, of which Mr. Newbitt is now curator, has been thoroughly cleaned and re-arranged, and proves very attractive to the numerous visitors who frequent that watering-place during the season. All the local zoological specimens and fossils have been placed in the large central room, and the beautiful collection of moths is already in good order. The case of Arctic specimens obtained by the celebrated William Scoresby, a native of Whitby, is also noteworthy; and there are some mementoes of Captain Cook, who served his apprenticeship in the town. The museum of the once-famed Scarborough Society appears in a much-neglected state compared with that of its neighbour further north. Some of the larger fossils are falling to pieces, and it is to be hoped that recent changes in management will tend to restore the reputation the institution once held. Our lamented friend, Professor W. C. Williamson, was the last of the small but eminent band of naturalists who formed and preserved the collection in the early decades of the century.

We have received from Dr. E. A. Goeldi numerous pamphlets relative to the Para Museum. One of these, "Practical Instructions for the Collection of Natural Objects," printed in Portuguese, should prove of considerable assistance to South American Naturalists. It contains, among other things, a reproduction of Natterer's plate of *Lepidosiren paradoxa*, of which animal many examples have recently been received in England. These instructions are also appearing in *Boletim do Museu Paraense*, a new publication of which the second part has just reached us. This part contains a plate of the young and eggs of the famous *Opisthocomus cristatus*.

The editors ask for an exchange of publications, and particularly desire papers relating to South America. Address 399, Caixa do Correio, Para, Brazil.

The collection of European Lepidoptera formed by Th. Goossens has been presented by his widow to the Museum of the Association des Naturalistes de Levallois-Perret. We also learn from the *Feuille des Jeunes Naturalistes* that the Society has moved to more commodious premises in the Rue Lannois.

In his address before the Geological Society last February, recently received, Dr. Henry Woodward referred to the fact that thirty-five years ago Leonard Horner, as President of the Society, with the concurrence of Sir Charles Lyell, Sir Roderick Murchison, and other members of Council, decided to arrange for the admittance of ladies to the evening meetings of the Society. It is believed that the Misses Horner attended those meetings, which, by the way, were held at the apartments of the Royal Society; but the attempt was soon abandoned as a failure.

The sixty-fifth meeting of the British Association will be held at Ipswich on September 11, under the presidency of Sir Douglas Galton. Professor Meldola will preside over the Chemical Section; Mr. Whitaker over the Geological; Professor Herdman over the Zoological; Mr. H. J. Mackinder over the Geographical; Professor Flinders Petrie over the Anthropological; and Mr. Dyer over the Botanical Section. The Physiological Section will not meet; papers on the subject will, however, be read in the Zoological Section.

The Association visited Ipswich in 1851. The town possesses a fine museum, celebrated more especially for its geological collections (crag). Geological excursions to the Crag districts and the Cromer cliffs are being organised, and marine dredging excursions will be made down the Orwell from Ipswich to Harwich. Excursions of general interest will be arranged to Bury St. Edmunds, Colchester, the Broads, Cambridge, Brandon, Dunwich, Wenham, and other places.

The third International Congress of Physiology will be held at Berne, September 9–13. Those interested should write to Professor Kronecker, of Berne. The subscription is fixed at 10 francs.

At an International Conference on the Protection of Wild Birds, held in Paris the last week in June, under the Presidency of M. Gadaud, Minister of Agriculture, a convention was adopted providing for the preservation of species useful to agriculture throughout Europe. England was represented by Sir Herbert Maxwell, Bart., M.P., Mr. Howard Saunders, and Mr. Harford of the British Embassy. The countries which sent delegates besides France were Germany, Russia, Austro-Hungary, Belgium, Holland, Luxemburg, Switzerland, Monaco, Italy, Greece, and Spain.

The International Geographical Congress promises to be a success, if one may judge from the names of intending visitors. We shall give some account of it in our next number.

The Galway Conference of the Irish Field-Club Union on July 11-17, to which we briefly referred in our last number, proved a great success. An excellent circular, with reproductions of some of Welch's and Dixon's photographs, was issued to the members. A full and illustrated account will be published in the *Irish Naturalist* for September.

The beautiful wooden statue of the double of the Egyptian king Ra-Fou-Ab, found by the De Morgan exploration party in one of the pyramids of Dahshur, has been reproduced in *Nature* (June 6) from *Le Monde Moderne*. The statue is believed to date from the 12th dynasty. With it are given illustrations of the exquisite goldsmiths' work of the period, one of which bears the cartouch of Usertesen II., another that of Amen-em-hat III , and a third that of Usertesen III.

PROFESSOR CANAVARI'S scheme for a *Paleontografia Italiana* has met with so much success that the first volume will be issued about the end of the year. It will be a quarto, with twenty plates, and will be published at Pisa, price fifty francs. Materials for a second volume are already in hand, and should the first be a financial success, the second will immediately follow.

WE learn from the *Scottish Geographical Magazine* that Dr. O. Nordenskiöld and Dr. Ohlin will shortly proceed to Tierra del Fuego to explore the country. They will remain there till the summer of 1896. Dr. F. A. Cook will start from New York, on September 1, on an Antarctic Expedition. He will take two small vessels, provisioned for three years, and hopes to reach Erebus and Terror Gulf about the beginning of December. Professor W. H. Dall and Dr. G. Becker, on behalf of the United States Geological Survey, are conducting a natural history expedition to Alaska.

A REUTER'S telegram says that the steamer "Kite" left St. John's on July 9 for Bowdoin Bay, Greenland, to bring home the Peary Arctic Expedition. It is expected to return on October 1. The party on board includes Professor Salisbury, of Chicago, who goes to study the glaciers and geology of the region, and Professor Dyche, of the State University, Kansas, to collect specimens of the fauna and flora, while Mr. Boutillier, of Philadelphia, represents the Geographical Society. Lieut. Peary will probably bring home a great meteoric stone which was found near Cape York.

SEVERAL cases of specimens have reached the British Museum (Nat. Hist.) from Dr. Forsyth Major in Madagascar. The greater part of the collection comes from the forest and the neighbourhood of Ambositra, and consists of zoological specimens, including a very important consignment of skins of mammals, several of which are believed to be new to science, a very fine series of dried plants, and a valuable assortment of ethnological objects from the Betsileo country, among them being many articles of singular interest illustrating the domestic life of the tribe inhabiting this little known part of Madagascar. If all be well Dr. Forsyth Major should now be fairly at work excavating in the marshes of Sirabé for Pleistocene vertebrate remains, the discovery of which was the primary purpose of the expedition.

COAL in the Sahara has been reported to the Paris Academy of Sciences by M. Foureau. The field occupies an area contained between lat. 27° and 28° N. and 5° and 6° 30' E., and has been traced at nine points within the area. *Lepidodendron* has been noted, as well as crinoids and *Producti*.

IN our issue for October, 1894, we quoted a paragraph from the *Pittsburgh Despatch* on adaptation of cats to cold, which stated that the cold increased the thickness of the fur, and the dim light of the storage warehouses tended to lengthen the "feelers." A letter from the Secretary of the Storage Company, published in the *American Naturalist* for June, shows that the facts have been exaggerated, and that the "adaptation" is comparable with that which takes place in warm climates on the approach of wintry conditions.

CORRESPONDENCE.

A Plague for Locusts.

In the spring of this year the coast lands of South Africa were visited by swarms of locusts—fortunately a rare occurrence in these localities; for though the country further inland had often suffered from their depredations, the regions on or near the coast have been mostly spared. There had not, indeed, been such a plague for some thirty years.

Mr. Maurice Evans, of Durban, an enthusiastic naturalist, heard that on a certain sugar estate the locusts were dying in large numbers, and he went up to investigate, and, if possible, encourage the disease. Nature seemed in this case to join with man in his efforts to reduce the numbers of the invading host. "The disease," he reported, "was having very marked effects. There were hundreds of acres of sugar-cane with dead locusts hanging on every leaf, in one case so thickly as to give a grey appearance to the otherwise green cane. They always appear, when dying," he adds, "to cling tenaciously to some object, so that after death it is somewhat difficult to detach them."

Mr. Evans found that the locusts were attacked by a fungus, and he sent to the British Museum several specimens preserved in spirit, that its true character might be investigated. As he had surmised, the fungus proved, on examination, to be an *Entomophthora*, nearly allied to that which attacks house-flies.

The first record of its appearance is in the *Botanische Zeitung*, 1856, p. 882. Fresenius gives there an account of some grasshoppers that had been sent to him which had died from the attacks of a fungus. He described it, and named it *Entomophthora gryllii*. The disease has also been met with on locusts, and there is no doubt that here, in South Africa, we are dealing with the same organism.

The entire body-cavity of the locusts sent by Mr. Evans was filled by the coarse granular mycelium of the *Entomophthora*—a confused tangle of rather dark-coloured hyphæ, with characteristic large oil-drops. Between the segments the filaments had protruded and budded off spores, large pear-shaped bodies that were germinating irregularly *in situ*, and producing again the gross-looking mycelium. Similar little clumps of hyphæ and spores occurred on the face of the insect. The resting-spores of this species have not been recorded, and were not to be found on the specimens sent by Mr. Evans.

It is to be hoped that the disease may have effectually diminished the swarms of the unwelcome visitors; it is hardly likely that the fungus will die out. We cannot say that the ranks of our house-flies have been much thinned by the ravages of the constantly-recurring *Empusa muscae;* but evidently the epidemic among locusts is of a more virulent nature, and for the sake of agriculturists at the Cape we can only wish that it may spread still further.

Annie Lorrain Smith.

NOTICE.

To Contributors.—*All communications to be addressed to the* Editor *of* Natural Science, *at* 22, St. Andrew Street, Holborn Circus, London, E.C. *Correspondence and notes intended for any particular month should be sent in not later than the* 10*th of the preceding month.*

To the Trade.—Natural Science *is published on the* 25*th of each month; all advertisements should be in the Publisher's hands not later than the* 20*th.*

NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

No. 43. Vol. VII. SEPTEMBER, 1895.

NOTES AND COMMENTS.

The Geographical Congress.

THE Sixth Session of the International Geographical Congress was held in London from July 26 to August 3. Its proximity in date to the General Election was most unfortunate, as it kept away many men who might have helped with cash or in kind. Nevertheless, it certainly achieved a striking success, credit for which is mainly due to the two secretaries, Mr. J. Scott-Keltie and Dr. H. R. Mill, who represented respectively—and no better English representatives could have been found—the practical and commercial, and the abstract and scientific branches of geography. The Congress met twice a day for the reading of papers and discussions thereon. These meetings were held at the Imperial Institute, which is certainly admirably adapted to serve as the headquarters of such a congress, though it does not appear to be particularly cheap. Garden parties, evening fêtes and functions gave the geographers opportunity for social intercourse. The papers read were, as a rule, of a high order of merit, though a few trivial and some rubbishing productions, which certainly would never have been accepted for an ordinary meeting of the Geographical Society, were allowed to waste the time of the Congress. The discussions on Polar exploration and on the possibilities of African colonisation attracted most general attention. The former was introduced by papers by Professor Neumayer, Admiral Markham, General Greely, Herr S. A. Andrée and M. E. Payart. The latter was introduced by a symposium, to which contributions were made by Sir John Kirk, Captain Lugard, Count Pfeil, Mr. Stanley, Mr. Ravenstein, Mr. Silva White, M. Dècle, and Slatin Pasha. This was followed by a general discussion, which was an amusing game of cross questions and crooked answers. Mr. Stanley soon fell foul of the rest, owing to a different use of the word science and a different dividing line between common sense and scientific reasoning. Both sides seem to have meant exactly the same thing, but for a while the heat of the discussion was dangerously near tropical. Then, again, Mr. Ravenstein and Mr. Silva White, impressed by the lessons taught by the meteorological records sent home, concluded that the climate is wholly unsuited for Europeans, and that no successful colonisation can be carried out. Their opinions were based on all kinds of barometric, thermometric, and hygrometric observations; but will-power was left out of account. And will-power counts for a great deal, especially when there is a Stanley in the matter. Mr. Silva White also declared that the African natives are quite unreliable, and all labour must either be forced or imported. Then the most valuable suggestion in M. Dècle's paper was the employment of a currency instead of barter goods in African commerce; this he thought might possibly, in the distant future, be managed to some extent. All this greatly irritated Mr. Stanley, who, having made up his mind that Equatorial Africa is to be colonised, is not going to be frightened by a bogie made up of meteorological tables. The talk about the impossibility of inducing the natives to work was a repetition of warnings which he had heard *ad nauseam* during the founding of the Congo Free State, but which he had, apparently, never expected to hear repeated, now that there are over 100,000 native porters at work on the Congo; while, as to the coinage, which M. Dècle seemed to regard as a matter for the distant future, there had been a paper currency in extensive use on the Congo for years. The discussion was mainly of interest from the contrast between the pessimistic predictions of the armchair geographers and the healthy contempt which Stanley expressed for difficulties and dangers. The last paper of any special general interest was Mr. Borchgrevink's account of his landing on the Antarctic Continent.

The only noticeable weakness in the Congress was in the attendance of British geographers. The foreigners came in great force, and the number included most of the leading geographers of the Continent. At the soirées the foreign guests almost swamped the English hosts. At the meetings this was still more noticeable. Prince Roland Bonaparte, for example, read a paper on the periodical variation of the French glaciers. These particular glaciers were first studied by Englishmen, and our countrymen have all along played a leading part in their exploration. We could easily pick out an English eleven which we would confidently back against any that could be formed in France for knowledge of the topography and geology of these French glaciers. There is, moreover, in England a most energetic school of glacialists, but we could not see in the room a single representative of this, or any of the many Englishmen to whom the glaciers of Dauphiné and Savoy are more familiar than the London parks. It was almost pathetic to see three such men as Penck, de Lapparent, and Murray presiding over, and to hear Naumann reading a masterly paper on the Fundamental Structural Lines of Asia Minor to, an audience of a dozen people, whose appreciation of the subject was such that Naumann had to spoil his discourse by explaining the meaning of "fault" and other equally simple terms. The contrast between this and the Geological Congress held in London, 1888, was very striking. The explanation is, no doubt, partly due to the fact that in England physical geography is studied rather as a branch of geology than of geography, and the geologists were not tempted to abandon their field work and remain in London. At the Geological Congress the honorary president was Professor Huxley, whereas the office was filled on the present occasion by one king and four princes. The vice-presidents at the one were twenty-two of the leading geologists of the day, representing the twenty countries who sent delegates to the Congress. The first two pages of the list of honorary vice-presidents of the Geographical Congress looks like the record of the attendance at a levée. This probably gave English geologists, who are a democratic race, the impression that the Congress would be social rather than scientific, and thus they did not interrupt the season's field work and return to London to welcome their foreign colleagues. When they know the names of the men who came, and the character of the contributions laid before the meeting, we cannot but feel that many of them will deeply regret their absence.[1]

Deep-seated Water.

To bore for water at the celebrated falls of Trollhättan seems at first to be a carrying of coals to Newcastle. That it can hardly be so is shown by the fact that not only one bore-hole, but two or three, have been or are being sunk through the hard gneiss rocks at great expense. The history of these deep sinkings is one of much interest, both practical and scientific.

Twenty-seven years ago, in a paper on the geology of Spitzbergen, Nordenskiöld published some observations on the influence of cracks in masses of igneous rock. His ideas, subsequently developed and now put to a successful test, are, in a few simple words, somewhat as follows. In all large masses of igneous rock—or in such tracts of gneiss as extend over many hundred miles of Sweden—there are cracks and joints of varying extent and direction. Even if such cracks were at first quite insignificant they would slowly but inevitably be increased in size by a small but perpetually active set of forces. When, under the influence of cold, the rock contracts, the cracks are widened; thus a vertical crack (*c.c.*) becomes filled with water, sand, or mud. When, under the influence of heat, the rock expands, the crack, which would naturally be closed, remains wedged open by its new contents. Thus a pressure, minute but irresistible, is brought to bear on the rock-mass and forces it in a horizontal direction. And the process is repeated and repeated through the ages, as the cracks again widen and become filled with more water,

[1] We hope to publish an article on the work of the Congress next month.

sand, or mud (*c'.c'.*). Similarly, if there be slanting cracks, enclosing between them a wedge-shaped portion of rock (*a*), then with each contraction the wedge sinks, perhaps only a micromillimetre; but it sinks and sinks continually, and with each expansion the same lateral pressure forces the rock-masses in a horizontal direction.

But this system of forces can only act to a certain distance. Various theoretical considerations, such as the limit to which surface variations of temperature extend, and the resistance of the igneous rocks to a breaking strain, led Nordenskiöld to the conclusion that the vertical cracks could not penetrate further than from thirty to forty metres below sea-level; and that, at about that depth, there would be formed a series of horizontal cracks (*b.b.*), separating the upper moving portions of rock from the more deep-seated lower portion. If these conclusions were correct, it would follow that the water which slowly soaked down the vertical cracks would collect in and flow along the deep-lying horizontal cracks, and that there would be a large and constant source of fresh water at thirty to forty metres

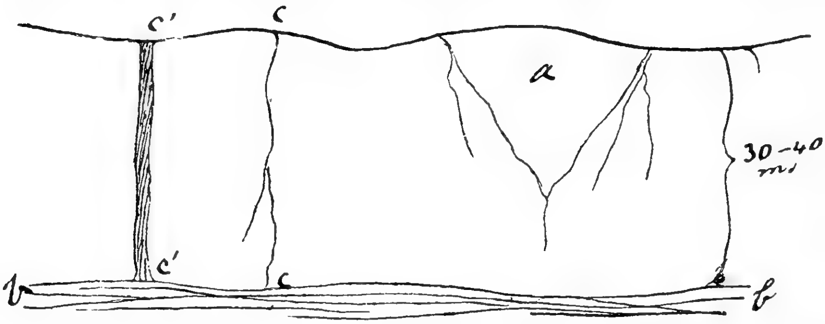

DIAGRAM EXPLAINING ORIGIN OF DEEP-SEATED WATER. Facsimile of a rough sketch by Baron Nordenskiöld.

below sea-level. With the aid of the diamond drill, this conclusion has lately been put to the test, and so far as the constant pressure of fresh water at the indicated depth can confirm it, the theory is fully confirmed.

The scientific consequences of this theory are evident and important. The recognition of large quantities of water included in and passing through the solid masses of gneiss, granite, and the like, is welcomed by those who ascribe to aqueous agencies the secondary changes that they believe to be still taking place in such rocks. Here, too, if one will but grant sufficient time, is suggested a potent cause of lateral pressure, of cleavage, and even of overthrusts and shearing.

But the confirmation of the theory has consequences no less important from the practical point of view. An entirely new water-supply is made available, and one can incur the considerable expense of the boring, confident that the money will not be wasted. Such a source of fresh water is of special value to lighthouse keepers on waterless islands in precarious communication with the mainland. An instance is the boring on the Island of Arkö, one of the first that was made. There are now twelve such wells in Sweden, and there will soon be some in Finland. The fact that purity is a conspicuous character of the water thus derived, renders it of much value to the manufacturers of aërated waters; and it is this that explains the sinking of so many bore-holes at Trollhättan, otherwise so profusely supplied with water.

The Scientific Use of Shorthand.

The value of speed in writing is so obvious that it is strange that shorthand has been so little used by naturalists. Medical men seem more alive to its advantages, for there exists a "Society of Medical Phonographers." At its recent annual meeting its president, Dr. W. R. Gowers, F.R.S., who is an enthusiastic phonographer, delivered an address which so clearly states the merits of this system that we are glad to quote part of it.

Dr. Gowers stated that the object of the Society was "to promote the work of their profession, alike in medical science and its application in practice, by freeing it from one grave hindrance which the present has inherited from the past. Writing to-day is what it was when Caxton made it mechanical, with no attempt at improvement until the present generation. But now a method of writing is available in which simplicity of symbol corresponds to simplicity of sound, and which needs, with a greater average of legibility, only one-third of the time and less than one-third of the labour of ordinary writing.

"Science rests on observation, which without immediate record is of little value; not only is memory inadequate, but record at once reveals unsuspected imperfections in observation. Compared with longhand, shorthand permits, in a given time, twice the amount of record, while leaving twice the time for observation. The latter must be more minute and more precise to permit the fuller record, and the first effect of the use of shorthand is on the quality of work. The constant use reacts on the worker, and it is again found true that 'writing maketh an exact man.' In the daily work of the practitioner, which is peculiar in being a form of personal science—knowledge constantly increased by observation—record is most important. It changes vague impression into definite knowledge, and increases that ability which is so important to those who suffer. For most practitioners, record is practically impossible with longhand; it is possible for all with shorthand. The service of this, however small its influence may be thought, multiplied by numbers becomes incontestably important. The chief means adopted by the Society is the issue of medical literature in lithographed phonetic shorthand—a monthly periodical, and other publications. But the facility of writing and secure legibility which phonography affords, have led to useful interchange of thought in other ways. It is important that the student should be familiar with shorthand before beginning professional studies, for it helps him in every form of work. It is much to be desired that shorthand should be made an extra subject in the entrance examination. It needs but a limited and short expenditure of time, and this is soon regained. It can, however, be quickly acquired at any age. It is now taught at many schools, but its subsequent use is not sufficiently encouraged. It may seem strange that the value of this mode of simple writing—quick, easy, and secure—should first be thus recognised by members of the medical profession; but it is noteworthy that in their hands its use will probably have most direct influence on the welfare of others."

POST-GRADUATE STUDY AND RESEARCH AT CAMBRIDGE.

THE new statutes respecting "research" degrees have been approved by the Senate of the University of Cambridge, and await only the confirmation of her Majesty in Council. In the probable event of the confirmation being obtained, the statutes will come into operation at once. The persons who are to be eligible must be twenty-one years of age at the time of their entry as "advanced students," and they must reside in the University for six terms. They must, in most cases, be graduates of a British or foreign University; but, in "exceptional cases," persons devoid of a diploma may be admitted on the presentation of evidence of special qualification. This special qualification is to be considered by the Degree Committee of the Special Board of Studies, with which the proposed course of advanced study or research is most nearly connected. All applicants must state the course or courses of advanced study or of research which they intend to pursue.

Here are the gates thrown widely open, and we have to look to the appointed gatekeepers that the unfit do not enter. It is clear enough that they will be thronged by persons seeking an easy degree for commercial purposes: and we must look to the "special committees" for a stern rejection of those who come for degrees rather than for work. It is most desirable that the large number of American graduates who go over to Germany for advanced work under new teachers should have the opportunity of coming to England: it is equally desirable that Scotch graduates should be able to enter English universities without having to pass again through an elementary mill; and the new statutes make this possible. But the host who have attended evening lectures and so forth have been clamouring for degrees; it is necessary that the strict letter of the statute "exceptional cases" should be maintained. After residence for two terms and pursuit of either "advanced study" or "research" the student, under the new regulations, may either compete for certain prescribed parts of the Tripos examinations, or may present the results of his research to a special committee. When he has passed the Tripos, or been awarded a "Certificate of Research," and has kept six terms, he may proceed to the degree of B.A., and thereafter, like those who have become bachelors on the old regulations, he may proceed in due course to the higher degrees.

ANTI-DARWINISM.

HOPE is beginning to flutter her wings again in the breasts of those who fear evolution. In the *Edinburgh Review* for July a thoughtful essayist makes notices of Bateson's "Variation" and Beddard's "Animal Colouration" the occasion of a crafty diatribe against Darwinism. He takes Bateson's arguments against continuous variation, and Beddard's exposure of the fantastic extremes to which some have pushed the doctrines of sexual selection, mimicry, and so forth, as evidence that at last the Darwinian stronghold is being taken, not by assault from without, but by defection of its scientific garrison. Now, it certainly is the case that many able naturalists at the present time are criticising the theories grouped round Natural Selection with great vigour. There is no likelihood that Darwinism will pass into an unassailable dogma, or that scientific men will have to subscribe to thirty-nine articles—even with the latitudinarian subscription acceptable in the English Church. But, apparently, it is necessary to repeat what Darwin and his illustrious disciples have stated, in season and out of season. Natural Selection, sexual selection, and all the various theories of the mechanism of evolution may turn out true or untrue. You may find among fifty competent naturalists fifty different views as to the extent of their operation. But evolution is true, and it was through Darwin's illuminating principle that evolution first became accepted as probable, and since has been accepted as inevitable by the great majority of those competent to judge. There may be what the Edinburgh Reviewer considers a revolt against Darwinism; but among famous naturalists of to-day you shall not find six (of whom we do not doubt the Edinburgh Reviewer to be one) who do not believe that the evolution of animals and plants has been placed beyond doubt, and that Darwin's work was the moving cause in the formation of this belief.

MR. GRANT ALLEN'S VIEWS.

IN the *Fortnightly Review* for July, 1895, Mr. Grant Allen has an amazing contribution to Biology. He calls it a "flank movement against Weismann." Characteristically enough, he begins by a misstatement of Weismann's relation to the problems of heredity. He writes: "Before he (Weismann) intervened, we were all of us asking, 'How is transmission of acquired characters possible?' Weismann broke in with the prior question, 'Is transmission of acquired characters possible?'" Now it is a fact, notorious among biologists, that from the time of Darwin's provisional hypothesis of pangenesis until Weismann reopened the question, people were not asking "How is transmission of acquired characters possible?" Practically everyone who wrote with biological knowledge, and everyone who wrote without biological knowledge, assumed that acquired characters were transmitted, and troubled very little about the "how." The question Weismann raised was, not whether such transmission were possible, but whether or no it actually occurred. And whatever may come of Weismann's speculative views, the result of the controversy he raised has been that naturalists, instead of taking the inheritance of acquired characters for granted, are in two minds as to whether or no they are ever inherited. The majority of supposed cases has been disproved: there is little but the theoretical possibility left.

This, however, is a small matter, and Mr. Grant Allen deserves so well of the public for his admirable efforts and achievements in the popular presentation of science that we might have passed it by. But his own suggested contribution, offered as a "piece of bare philosophical thinking," is too primitive in its naked simplicity to avoid the interference of the scientific police. He suggests that the great mystery is not inheritance, but assimilation; not why John Evans begets little Jack Evans, but why the brown bread and beefsteak John Evans eats becomes turned into the flesh and body of John Evans. Certainly, the mystery of assimilation is great enough; though, perhaps, it is only more complicated, and not, in reality, deeper than the mystery involved in a crystal, growing in a mixed mother-liquid, attracting only particles like its own particles, and building these new particles into a predetermined geometrical structure. The mystery of inheritance is not the mystery of assimilation, but something more. An amœba feeds upon not-amœba: grows: divides: and there are two amœbæ. But a fertilised egg-cell feeds: grows: repeatedly divides, and the ultimate product may contain not a single cell like the original egg-cell, but forms a structure like that from which the egg-cell came. Here is a mystery within a mystery; the "me" feeding upon the "not-me" and growing, not into "me," but into my father. Mr. Grant Allen's apparent simplification of the problem is attained only by ignoring it.

Diphtheria Anti-Toxin.

At the recent meeting of the British Medical Association there took place an important discussion upon anti-toxin. It was remarkable how favourable were the reports by different specialists upon the new remedy. Dr. Sydney Martin explained in detail, with the aid of elaborate diagrams, the extent to which the anti-toxin had counteracted the effect of the diphtheria poison in a large number of cases under his observation. Dr. Goodall, speaking from his experience of the clinical treatment under the Metropolitan Asylums Board of the severer forms of the disease, declared that only 22 per cent. had died under the new treatment, while 33 per cent. of those not treated with anti-toxin died. He thought, however, that the new treatment had little mitigating action upon concomitants of the disease, such as albuminaria and paralysis. Professor von Ranke, from Munich, and Professor Baginshi, from Berlin, were enthusiastic about the remedy. Even Mr. Lennox Browne, who has done his best to criticise the new treatment, stated that he was not an opponent of this method. Dr. Sims Woodhead said that the results of the new method were exceedingly favourable, more favourable than his bacteriological work led him to anticipate.

In fact, the general tone of the discussion was highly favourable to anti-toxin. Those singular critics of modern medicine who attack everything that is new, especially if it have the remotest connection with experiments upon living organisms, were conspicuous by their absence. Without doubt, however, they will be as active as ever in the evening newspapers and in circulars touting for subscriptions. If the great British public would only realise that medical men are actuated, not only by a genuine spirit of scientific truth, but by the knowledge that any delusive statistics will speedily be exposed by other medical men, they would be the less ready to listen to professional agitators. Whatever be the future of anti-toxin, it will depend, not upon the shrieks of agitators, but on the statistics of the authorities who employ it.

The Function of the Supra-renals.

The new physiology is proceeding with investigation of the "ductless" glands. Everyone knows that the thyroid has been shown to form a secretion which, carried by the blood all over the body, exercises the strongest effect upon the general vital activities of the body. It is concerned chiefly with the metabolism of the tissues. Where the thyroid is absent or diseased, degenerative changes rapidly ensue all over the body; and those changes may be arrested, or at least palliated, by injection of thyroid juices. Oliver and Schäfer have recently been investigating the action of the supra-renal capsules, organs whose function was completely unknown. They find that the supra-renal secretion produces striking physiological effects upon the muscular tissue generally, and especially upon that of the heart and arteries. Its action, apparently, is directly upon the muscular tissues: not mediately through the central nervous system. For they found that supra-renal extract had a direct effect upon the pulsation of an excised frog's heart. The same investigators have published a preliminary note (*Journal of Physiology*, July) upon the action of the pituitary body. They find that this mysterious organ is a secretory organ, and that its action is to raise the blood-pressure.

The Minute Structure of Spleen.

In the *Journal of Anatomy and Physiology* for July, 1895, Dr. E. W. Carlier describes a new method for investigating the structure of the spleen. Everyone knows that it is most difficult to obtain preparations of the spleen in which the minute structure is properly shown. In an animal that has died naturally, degenerative changes have begun in the spleen before preparations can be made; even in a freshly-killed animal the ordinary methods of "fixing" the protoplasm leaves much to be desired. Dr. Carlier proceeded by anæsthetising the animal deeply. The thorax was then rapidly opened, the apex of the heart removed, and a cannula fastened in the aorta. All the blood in the animal was then washed out by irrigation with normal saline solution, heated to the temperature of the animal's body. Immediately afterwards the saline solution was replaced by a warm solution of picro-corrosive sublimate. This penetrated into the smallest capillary of the animal's body and killed and fixed every cell in every organ in its normal condition.

The Cœlome and Nephridia.

Not long ago it was held that animals like *Hydra* possessed one cavity, the cœlenteron, communicating with the exterior by the mouth; while the *Cœlomata*, from the lowest worms up to man, were built on the plan of one hollow cylinder within another. The inner cylinder, opening at one end by the mouth, at the other by the anus, was the alimentary canal: the space between the alimentary canal and the body-wall was the cœlome. Subsequent research has modified the primitive simplicity of this view. The "cœlome" and "cœlomic spaces" are certainly not spaces of the same order in different sets of animals. Among the spaces we have first learned to separate "hæmatocœles," or blood-spaces, which are the most conspicuous cavities between the alimentary canal and the outer body-wall in many animals. But, more recently, distinctions are being made among cœlomic cavities that are not "hæmatocœles." In a valuable paper in the *Quarterly Journal of Microscopical Science* (June, 1895) Mr. Edwin S. Goodrich, one of Professor Ray Lankester's assistants at Oxford, puts together in a luminous fashion the results of later investigations. According to his excellent account, the cœlome is essentially a genital pouch, or set of pouches, hollowed out in the mesoblastic somites, and giving rise to the genital products. In simple cases, like *Amphioxus*, the most anterior of these pouches arise as direct outgrowths from the archenteron; but, however they arise, they most frequently fuse below the gut into a wide chamber lined by peritoneum and popularly known as the cœlome. From this chamber ducts grow outwards towards the exterior, sometimes breaking directly through, sometimes meeting slight invaginations of the epiblast, sometimes fusing into longitudinal ducts. These centrifugally developing peritoneal ducts or funnels are the genital ducts and have nothing to do with true nephridia. They are to be found in the vast majority of cœlomates: in oligochætes, for instance, as the oviducts and vasa deferentia; in vertebrates as the tubules of the pronephros.

True nephridial tubules are structures of another kind. Typically, they develop centripetally from outside inwards, and favour the suggestion that nephridia primitively were skin excretory organs. In actual development each arises as a single large cell, the interior of which develops a vacuole with a tuft of cilia—in fact, becomes a flame-cell, like those which flicker under the microscope when a live turbellarian is examined. From the flame-cell a tail of small cells grows towards the outside, and a duct is hollowed out in the thickness of these cells. Complications arise in two ways. In many cases, for instance in the common earthworm, these nephridia break into the cœlome, the flame-cell becoming the nephrostome, and the whole structure assuming a false analogy with a peritoneal funnel. Such a false analogy, Mr. Goodrich thinks, has led many investigators to derive peritoneal genital ducts from nephridia. The second complication occurs in such cases as the vertebrates, where the primitive peritoneal ducts assume excretory functions and become comparable with nephridia. Just as the nephridia in some cases have broken into the cœlome and so have posed as peritoneal funnels, so peritoneal funnels have occasionally assumed excretory functions and posed as nephridia. In the latter category are the pronephric tubules of vertebrates.

Mr. Beddard's Monograph.

Some time ago we received from the Clarendon Press a copy of Mr. Beddard's beautiful Monograph on the Oligochæta. We are glad to say that Professor Franz Vejdovsky has promised to write a detailed notice of the work for our columns, and our readers will thus have the opinion upon it of the greatest continental expert. As most naturalists are aware, Mr. Beddard has been working on Oligochætes for the last fifteen years, and has contributed largely to our knowledge of the group. The cost of the illustrations of the volume has been largely defrayed by the generosity of Mr. J. P. Gassiot, F.Z.S., who, at the suggestion of the Secretary of the Zoological Society, placed a sum of £100 at Mr. Beddard's disposal for the purpose. The Clarendon Press have published the volume in a sumptuous fashion; and it forms a notable addition to the list of modern scientific monographs.

The first part (148 pages) deals with the anatomy of the group: there is not yet enough material for a systematic account of the embryology that would contain any substantial addition to Vejdovsky's memoir. The last 500 pages are systematic.

It is interesting to notice, in reference to our last note, that Mr. Beddard takes a different view of the relation of the genital ducts to the nephridia from that of Mr. Goodrich. At one time he held that there was evidence for the derivation of a paired nephridial system, like that in *Lumbricus*, from a diffuse system, like that in *Megaloscolex*: later investigations by Spencer, Benham, himself, and especially by Vejdovsky, led him to believe that both diffuse and paired systems are equally ancient. Similarly, at one period of his investigations, he was inclined to abandon, as Mr. Goodrich does in his paper, the current view that the genital ducts were derived from nephridia. Latterly, however, he has returned to the generally-accepted view, and holds that the genital ducts certainly are modified nephridia. He thinks that the difficulty as to the coincidence of generative ducts and nephridia in a segment is cleared up by his discovery of multiple nephridial pores in *Octochætus* and other genera. Moreover, actually in the case of *Octochætus multiporus*, he was able to trace the development of the genital ducts from separated portions of the pronephridia.

Carbonic Oxide Poisoning.

In a recent number of the *Journal of Physiology* (July, 1895) Dr. John Haldane gives the results of experiments he has been making on the process of carbonic oxide poisoning. The experiments were made in connection with his investigation, now in process, into the nature and action of the poisonous gases in the air of coal mines. He concludes that the poisonous action of carbonic acid diminishes as the oxygen tension increases, and *vice versâ*. With an oxygen tension of two atmospheres the poisonous action was abolished in the case of mice. The disappearance of this poisonous action is due to the fact that at high oxygen tensions the animals can dispense entirely with the oxygen-carrying function of hæmoglobin. The poisonous action of carbonic acid is entirely due to its power of combining with the hæmoglobin of the red corpuscles, and so putting them out of action as oxygen-carriers.

This adds another to the remarkable series of results Dr. Haldane has obtained. He has already shown that carbonic acid and the organic substances in foul air are not the direct poisons they have been supposed, but that it is the diminution of oxygen-tension, usually associated with their presence, that does the damage. Carbonic oxide has been regarded still more as a direct poison, and the discovery that an increase of oxygen restrains and finally overcomes the disastrous results of its presence has an important practical as well as theoretical bearing. The generation of oxygen, rather than attempts at ventilation, would seem to be the new method for protecting dangerous mines.

Adders and Their Young.

Readers of Natural Science may remember a note of ours early in the season respecting the alleged habit of young adders, that of taking refuge in the mouth of their mothers. At the time we were, and still are, sceptical as to the habit. But it must be remembered that a large body of tradition and popular belief exists in favour of it, and that more than one naturalist believes in it. There are many districts in Britain where adders are abundant; for instance, in many parts of the New Forest, in Devon and Cornwall, in Wales, and in the Scotch Highlands. Adders should have their young about them all through August in England, and well on to October in the Highlands. Every naturalist should be on the outlook for them. They are to be found most easily by stealing along hedgerows and ditches in sunny places. Quietness is necessary, as they are easily disturbed and conceal themselves rapidly. The best way to catch them is to pin them between the prongs of a forked stick, and then, with a pair of forceps or small tongs, to place them in a tin case. If it should fall to the lot of a reader to see anything like the supposed habit, he should use every endeavour to secure the specimen. Let it be remembered that it is now too late for verbal testimony—there is enough of that and to spare. The adder must be killed, preserved in spirit, and opened by a skilled naturalist in the presence of witnesses. As we have already said, the Editor of Natural Science will be more than willing to receive any such specimen, and place it in the best hands for examination, giving all due credit to the owner of the specimen.

Determination of Sex.

M. de Kerhervé has communicated to the *Mémoires de la Société Zoologique* (viii., 2) a further account of his studies upon the reproduction of Entomostraca. He found that with various species of *Daphnia* kept in captivity, it was easy to provoke the appearance of males among the broods. As long as the conditions of temperature and nutrition were favourable, the daphnids reproduced parthenogenetically and gave rise to females only. The rate of reproduction varied directly with the nutrition. With well-fed daphnids reproduction was so rapid that three or even four generations might be seen lying one within the other, a veritable picture of the old idea of evolution. While the young were yet within the brood-pouch of the mother they had given rise to new generations of young within their own brood-pouches, while in these again the young might be detected. But when the animals were subjected to a lower temperature and to an impoverished food-supply, males were produced in excess of females.

M. de Kerhervé regards these interesting, although not quite novel, results as being quite opposed to Weismann's views. He thinks that it is a clear case of the direct effect of the agency of external circumstances to the exclusion of internal causes. It is, however, obvious that even here internal causes are at work, although the direct stimulus comes from without. M. de Kerhervé himself shows that, in the case of different species, the same external influences operated differently: one of the factors is what may be called the specific constitution.

The Fossil Birds of La Plata.

It may be remembered that in his account of the La Plata Museum, in Natural Science at the beginning of last year, Mr. Lydekker gave a brief description of the gigantic fossil birds of Patagonia, which at that time were only imperfectly known through the writings of Ameghino, Moreno, and Mercerat. Our knowledge of these remarkable fossils has lately been greatly increased by a paper of Ameghino's descriptive of a large series of bones, including all the important parts of the skeleton (except the sternum) of several species of the remarkable genus *Phororhacos*. From this description it appears that these birds, unlike the recent Ratitæ, possessed heads very large in proportion to the rest of the body. In the larger species of *Phororhacos*, *P. longissimus*, the skull is said to have been upwards of two feet in length, and about ten inches high at the hinder end of the beak. This latter was laterally compressed something like that of the Puffin, and was hooked at the tip. The mandible, unlike that of nearly all recent birds, turned up at the anterior end. It was originally stated that the jaws bore teeth, but this is now found to be incorrect.

The wing-bones were of the usual form, but proportionately very small, so that it seems improbable that these birds were capable of flight, though, no doubt, the wings were employed to aid in running or, perhaps, in swimming. The ulna bears strongly marked impressions of the insertions of the quills of the secondaries.

The bones of the hind limb of one of the smaller species were together about three feet in length; the toes, of which there were four, were armed with strong hooked claws. The posterior vertebræ of the tail did not unite to form a "pygostyle" for the support of the tail feathers as in the Carinatæ, but remained separate from one another, and are said to have been perforated by a notochordal canal.

Besides *Phororhacos*, several other genera are described, some differing so widely that they will doubtless eventually be placed in separate families. The name "Stereornithes" has been adopted for these large birds from the Eocene (?) of South America, and it has been suggested that *Gastornis* and *Dasornis* from the Lower Tertiary deposits of England and France may be representatives of the same group, which has been regarded as the ancestral stock of the living Ratitæ. It seems quite as likely that the Stereornithes are a group of birds not necessarily closely related to one another, the members of which have, to a greater or less degree, lost their power of flight, owing to the influence of their environment.

Botany and the Science and Art Department.

In the August number of Natural Science we referred to a complaint against the method of testing candidates for the South Kensington Examinations in practical botany in the elementary and more especially in the advanced stage. We are inclined to take a wider view of the question and ask if the Department has selected the best means of awarding the grant placed by Government at its disposal for the encouragement and aid of scientific teaching.

Without a doubt there are numbers of men and women, younger and older, who, while anxious to get a knowledge of the various sciences, are quite unable to pay fees which would adequately remunerate any teacher capable of acting as a trustworthy guide. In some cases the student is anxious only to improve his own position by accumulating the certificates of the Department; he may want to earn the right to become in turn a teacher of the subject. The elementary school teacher is a case in point. But there are many who take up a science purely from love of it and a desire to know something about the rocks and stones, the plants and animals, which are to be found outside the busy town in which they are doomed to spend the best part of their lives. And these are at least as deserving of encouragement. Given, then, that there are students asking for knowledge, and on the other hand a Government Department charged with the duty of helping them to that knowledge, the question arises as to whether the means at present adopted is the best and only means.

Quite recently a new step was taken by Government in appointing a number of inspectors, who were to visit the different classes and, presumably, to see that proper instruction was given. But, if the inspectors' report counts for nothing in the partition of the grant, and the latter still depends solely on examination results, why go to the additional expense of an increased staff? Obviously, if the instruction given falls below the standard, the students will fail in their examination, and no other test is needed. Perhaps examinations are a necessary evil; but it strikes one that some account might also be taken of work actually done by the students, especially of practical work, which sadly needs encouragement, though it is far and away the most valuable. Let the Department provide notebooks in which the student shall each evening enter the result or some account of his work on actual specimens with illustrative sketches. These could be looked through and reported on by the inspector, and count towards the earning of a grant in which a final examination at the end of the course might, if necessary, share.

Failing to pass, or inability to sit for, the examination should not necessarily preclude payment. At the end of May, when many of the examinations are held, holidays are beginning in large firms, and sitting for the examination may mean the loss or spoiling of the hard-earned yearly fortnight's rest from business. Under present conditions either student or teacher is the loser; generally the unfortunate teacher. The Department, in their syllabus, are emphatic, and rightly so, in insisting on a practical knowledge, but, at the same time, are in many points extremely dilatory in its practical encouragement. Classes must be held between October and May, but the best time for practical work, at any rate in geology and botany, is between May and October. As our correspondent asks, could not some encouragement be given to field classes in the summer months? Doubtless they are held here and there by enterprising teachers, but students are so generally well aware that they "don't count," that they are not nearly so well supported as they would be were they a recognised part of the course.

In the *Memoirs and Proceedings of the Manchester Literary and Philosophical Society* (ser. 4, vol. ix., p. 179) Mr. Thomas Hick describes the internal structure of *Calamite* leaves. While the anatomy of the root, stem, and fruit of these old-world Equisetums has been worked out in considerable detail, little or nothing was known of that of the leaf. Hence Mr. Hick's memoir forms a valuable supplement to our previous knowledge of these fossil plants. The leaves examined were very small, being those borne by the delicate ultimate branchlets, and recalling in appearance and habit those of a well-grown Chara. The observations recorded show that they were simple uni-nerved structures, with a central, delicate, vascular bundle arranged on the collateral type, and surrounded by a cortex in which can be distinguished an inner layer of long cells with black contents continuous with a similar layer in the twig, and styled "melasmatic" tissue, and an outer, thicker layer of assimilating tissue. Surrounding the whole is a single-layered epidermis, consisting of cells of uniform size, with thickened outer walls. A transverse section of a leaf recalls in general outline that of a pine-needle, being rounded on the under surface and more or less flattened above, with a large median protrusion above the vascular strand.

We print this month an article by Mr. R. D. Oldham, of the Indian Geological Survey, upon the alleged occurrence of traces of Miocene man in Burma. In common with other journals, we inserted a notice of this supposed discovery. The flakes in question showed such indisputable evidence of human workmanship that, had the claim that they had been collected from actual Miocene deposits been verified, we must have accepted this date for the age of man. We are glad to be able to publish such an authoritative correction of this report as that by Mr. Oldham.

I.

Natural Science in Newcastle.[1]

IT will be my purpose to bring before you a brief history of the progress of biology in Newcastle, with especial reference to its museums; and it would be the neglect of an obvious duty if, as introductory to this, reference were not made to the little band of able naturalists of a past generation, since to them was due the origin of the two societies still working here, the "Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne," and the "Tyneside Naturalists' Field Club."

About the year 1829 certain scientific men, among whom were Joshua Alder, William Hutton, Thomas, John, and Albany Hancock, William Hewetson, George Waites, George Burnett, William Robertson, and George Abbs, conceived the idea that it would be at once pleasant, profitable, and advantageous in all ways if they should meet together frequently for the purpose of conversation and discussion on the several branches of natural history, to the study of which they were devoting their time. To this end they instituted "Wednesday evening meetings," for such was the designation by which these friendly gatherings were known. They were held fortnightly, at seven o'clock, at the houses of the members in turn. All unnecessary expense was avoided; a simple tea was given by the host; while two things were distinctly forbidden—discussion on political topics and the use of alcohol. Any discovery made by a member was communicated, specimens of interest were exhibited, and the conversation was, for the most part, confined to scientific subjects. The meeting usually broke up about midnight. Naturalists in neighbouring places, in passing through Newcastle, were frequently invited guests, and as such a guest I was, when a young man, once present and enjoyed a delightful evening. Before the party separated the next house of meeting was fixed, and invitations were then given to those who did not themselves entertain; but it was understood that any member was at liberty to bring with him any naturalist who was temporarily in the town. Joseph Blacklock, R. S. Bowman, and Dr. Embleton became members at a later period, and the last-named

[1] From Canon Norman's Presidential Address to the Museums' Association at Newcastle.

venerable physician, known, not only by his writings, but also by the fact that long years ago he assisted Albany Hancock in his earlier anatomical investigations,[1] is the only still surviving member. Mr. R. G. Green and our excellent curator, Mr. R. Howse, were, however, frequently invited guests. It is to Mr. Howse that I am indebted for most of these particulars respecting this Club. He tells me that he was a regularly invited guest from the year 1846,[2] and that in 1857 he attended a meeting held at Mr. Blacklock's lodgings, at the Barras Bridge, to meet an old friend, William Kennett Loftus, who had just returned from his Assyrian expedition and then visited Newcastle for the last time. This was the latest occasion on which he attended, but the Wednesday evening meetings seem to have lingered on for a year or two more and then gently expired, having fulfilled their mission, about 1860. It has seemed especially desirable to call the attention of the members of the "Museums Association" to these "Wednesday evening meetings" and to the stimulus they were the means of giving to the study of natural history here; since the establishment of such friendly social gatherings in other towns might be productive of much good in bringing men of kindred tastes into close association and creating an impetus towards active work.

It will be noticed that the members of these meetings for the most part became eminent in the branches of science to which each more especially devoted himself, while at the same time they were continually gaining knowledge, and more extended range of interest, from the association with those who were pursuing different paths through the vast fields of Natural Science.

Tyneside Naturalists' Field Club.

It will be convenient now to refer to the Tyneside Naturalists' Field Club.

The "Berwickshire Naturalists' Field Club," still in a flourishing condition, has the honour of being the oldest field club in the kingdom; and the Tyneside club is the next oldest, and may in some measure be considered an offspring of that of Berwickshire, since Ralph Carr, Esq., of Dunstan Hill, who was a member of the Berwickshire Club, took a very active part in starting it, and was its first president.

The first meeting of the Tyneside Naturalists' Field Club was held on the 25th day of April, 1846, in the room of the Natural History Society, the Rev. R. C. Coxe, vicar of Newcastle, being in the chair; at this meeting the rules were drawn up. At the ensuing meeting, held on May 11, it was resolved that the Club, besides holding

[1] *e.g.*, A. Hancock and D. Embleton, "On the Anatomy of Eolis, a genus of Molluscs of the Order Nudibranchiata." *Ann. and Mag. Nat. Hist.*, vol. xv., 1845, and ser. 2, vol. i., 1845, and vol. ii., 1849.

[2] I may mention that it was in the following year, 1847, that Mr. Howse published his first paper known to me, in *Ann. and Mag. Nat. Hist.*, vol. xix., on the Dogger Bank "Fusi," and their ova-capsules and embryos, illustrated by an admirable plate.

field meetings, "undertakes the formation and publication of correct lists of the various natural productions of the counties of Northumberland and Durham"; and also "that a succinct account of the geology of the district be prepared." It was further resolved that "local collections be formed and placed, with the consent of the Natural History Society, in the Newcastle Museum." Sub-committees to carry out these views were appointed, and included many still honoured names; in various branches of Zoology, John and Albany Hancock, R. E. Bewick, M. J. T. Sidney, J. H. Fryer, Joshua Alder; in Entomology, James Hardy, J. T. Bold, John Hancock, and Thomas Pigg, junior; in Botany, Messrs. Thornhill, Thompson, and J. Storey, and the Rev. J. T. Bigge; in Geology, Messrs. Hutton, Fryer, Sopwith, Loftus, and King.

From the first the *Transactions of the Tyneside Naturalists' Field Club* took a high place in Natural History literature, and this continued during the lives of the able naturalists who were its parents, and I well recollect Dr. John E. Gray, a most competent judge, speaking to me of those *Transactions* as the most valuable provincial Natural History publication in the kingdom. Our naturalists now are fewer in number, and neither the Club nor its publications are in the flourishing condition they once were. Let us hope that a time of revival will come. There have been published six volumes of the original *Transactions of the Tyneside Naturalists' Field Club*, and eleven of the new series, which dates from 1865, from which period the joint papers of "Natural History Society" and of the "Tyneside Naturalists' Field Club" have been issued under the title *Natural History Transactions of Northumberland and Durham.*

[As the Newcastle Museum of Natural History was described in the August number of NATURAL SCIENCE by Mr. Alexander Meek, it is not thought necessary to include here the section of the address devoted to this institution.—ED., NAT. SCI.]

THE MUSEUM OF ANTIQUITIES.

The Museum of the Newcastle Society of Antiquities is nearly coëval with the present century. Its nucleus consists of the antiquarian portion of the Allan Museum handed over to the Society of Antiquaries by the Literary and Philosophical Society, who had come into its possession, and who retained for a time the zoological portion in their own hands. Round this nucleus were gathered the results of various excavations at Borcovicus, Habitancum, and other Roman stations, also some interesting Saxon stones, and the fragments of the remarkable Rothbury Cross. With the exceptions above mentioned, the treasures of the museum have been gathered piecemeal through the generosity of individual donors, and there has been no considerable purchase from any other collection.

The museum is, on the whole, richer in remains of the Roman than of any other period. There is, however, a large collection of coins (not exhibited to the general public), including an almost complete series of the Stycas of the Anglian Kings of Northumbria.

A portion of the museum still remains in its old quarters at the Norman Keep (where the Society regularly holds its meetings); but the larger part, including the almost unique collection of Roman altars, is now deposited in the building known as the Black Gate. This interesting edifice, formerly the principal gateway of the castle, was rescued from destruction and thoroughly repaired by the Society of Antiquaries, and was opened as a museum on the occasion of the visit of the Archæological Institute to Newcastle in the year 1884. It is important to observe that the museum is now in course of re-arrangement, a process which, it is hoped, will be completed by the end of the current year.

The general plan of the collections when thus re-arranged will be this :—

1st Floor.—Roman inscribed stones.

2nd Floor.—Prehistoric Roman and Mediæval antiquities.

3rd Floor.—Collections illustrating the local history of Newcastle-upon-Tyne.

The curators of the museum are Mr. Charles James Spence, of North Shields, and Mr. Richard Oliver Heslop, of Corbridge.

MUSEUM OF THE UNIVERSITY OF DURHAM COLLEGE OF MEDICINE.

The University of Durham College of Medicine, Newcastle-upon-Tyne, was founded in the year 1851, and admitted into connection with the University of Durham in 1852.

The museums of comparative anatomy and pathology, of materia medica and hygiene are open to students.

A catalogue has been issued intended to be used in illustration of the text-book descriptions of diseased structures.

The number of students who attended the college during the academic year 1894–95 was 220.

A. M. NORMAN.

II.

The Geology of Ipswich and its Neighbourhood.

IT is many years since the British Association met in the Eastern Counties, and a good deal has recently been learnt about East Anglian geology. In fact, since 1868 many of the principal memoirs have appeared, including the classical ones of Messrs. Wood and Harmer (6), and of Professor Prestwich (2); the officers of the Geological Survey also have since that date commenced and completed an examination of the whole district (3, 4, 5). It may be useful under these circumstances to devote a few pages to a sketch of the geology of the region around Ipswich; for the British Association's excursions form an important part of the scientific work of the geological section, and in this country there are few other opportunities for British and foreign geologists to meet and compare notes in the field.

The first thing that will strike a visitor traversing East Anglia is that it is essentially a region of low plateaus, cut into by wide, shallow river valleys. This flatness of the country and absence of any dominant elevations may not be conspicuous from the rail, which nearly everywhere keeps to the valleys, but, nevertheless, it is a characteristic feature. The geology of these table-lands is usually very monotonous, most of the interest being concentrated in the valleys and cliffs, which cut through the glacial deposits to the fossiliferous Tertiary beds below. Thus it will be found that geologists describing this country tend to follow the valleys, though the deposits described may be totally unconnected with the river-systems.

The most ancient rock visible at the surface within twenty miles of Ipswich is no older than the Upper Chalk, but it may be interesting to mention that a boring at Harwich penetrated to the Palæozoic rocks, and further information on the Palæozoic floor will probably be communicated to the meeting. In the boring at Harwich the Chalk was 890 ft. thick, then followed 61 ft. of Greensand and Gault, which rested on a hard slaty rock, apparently of Carboniferous age. Thus the Upper Cretaceous lies directly on Palæozoic rocks, the whole of the other Secondary strata being absent.

In the immediate neighbourhood of Ipswich the Upper Chalk is reached in the lower part of the valleys at several points. It is succeeded by a thin representative of the Thanet Sands, here, unfortunately, seldom yielding determinable fossils, though casts of *Nucula* and *Cardium* are in the Ipswich Museum. Next occur the current-bedded and variable Woolwich and Reading series, consisting here mainly of sands, but with occasional lenticular masses of red-mottled clay. These have yielded no fossils near Ipswich.

The lower part of the London Clay is well seen at various places, particularly in the sea-cliffs at Felixstowe and Harwich, where it yields remains of turtles, fish, and pyritised plants. An enormous quantity of London Clay fossils is also obtained from the gravelly base of the Crag, but these are principally phosphatised bones and teeth of sharks. It is probable that short excursions during the meeting of the Association will give an opportunity for an examination of all the Eocene deposits represented near Ipswich.

There is little doubt that, for the majority of visitors, the geological interest centres around the fine series of Pliocene and Pleistocene deposits represented in the Eastern Counties. The succession is apparently more complete than anywhere else in Northern Europe, and we must travel as far as Italy and Sicily before meeting with so continuous a series of strata belonging to these periods, and so large a variety of fossils.

Between the lowest Pliocene deposits and the London Clay there is a marked break and unconformity, so that the gravelly base of the Pliocene is full, as already stated, of derived Eocene fossils. Of these a good series will be seen in the Ipswich Museum; and it will be noticed also that mixed with them occur some derivative fossils of very early Pliocene date. True Miocene fossils are apparently missing; though a few possibly derived from Oligocene beds do occur. This Pliocene basement bed is, or rather was, extensively worked for phosphatic nodules, and though many of the nodules are inorganic, there is so large a mixture of bones and teeth as to make the "nodule bed," miscalled a "coprolite bed," one of the most celebrated horizons in Britain for Tertiary fossils. The fossils consist to a large extent of bones or teeth of whales, dolphins, and sharks; though mixed with these are many teeth of land animals, such as the mastodon, rhinoceros, tapir, pig, and deer. It is unfortunate that the competition of cheaper foreign phosphates has rendered it impossible any longer to work these pits, but a few sections will probably still be visible, though it is difficult now to obtain any mammalian remains.

The oldest undisturbed Pliocene deposit yet found in the Eastern Counties is a soft limestone composed mainly of shells and bryozoa. This is the so-called Coralline Crag, which has yielded a most prolific Older Pliocene marine fauna, showing affinities with that of the existing Mediterranean and a similar climate. Above the Coralline Crag, and resting unconformably on it or on the London Clay, follow false-bedded marine sands, with fossils pointing to shallow water and to a sea getting colder and colder as time goes on. This gradual climatic change is well exhibited by the various sections around Ipswich. At Walton, for instance, the oldest part of the Red Crag contains fossils indicating a climate not greatly colder than that of the Coralline Crag period. At Butley the newer part of the Red Crag yields more boreal species; while at Chillesford the arctic mollusca form a still larger proportion of the whole. Near Cromer, on the Norfolk coast —which will be visited by one of the excursions—a later stage, the Weybourn Crag, is represented. This crag, though still full of characteristic Pliocene mollusca, yields a very large percentage of arctic forms. The gradual refrigeration of the climate in the course of time, the disappearance of the southern and extinct forms, and the incoming of the Arctic species, is well exhibited in a table of the marine mollusca drawn up some years since, and here reproduced:—

	Total.	Arctic.	Mediterranean.	Extinct.
Weybourn Crag	53	9	0	5
Chillesford Crag	90	7	2	14
Fluvio-marine Crag	112	9	7	18
Red Crag of Boyton, etc.	199	13	23	55
Red Crag of Walton	148	2	22	50
Coralline Crag	420	1 (?)	75	169

The evidence yielded by the marine fauna of the Pliocene period does not tally, however, with that of the land and freshwater species. It is often stated that after the gradual refrigeration of the climate there was again a warm period, before the commencement of the actual glaciation of East Anglia, and that this mild interval is represented by the Cromer Forest-bed with its temperate fauna and flora. Of this Pliocene alternation of climates I do not think there is any real evidence. The Newer Pliocene marine fauna, from whatever horizon it is obtained, is always somewhat arctic, the whales and the few marine mollusca of the Cromer Forest-bed being just as boreal as those of the Crag below. The Pliocene land animals and plants, on the other hand, from every horizon are, with one or two exceptions, temperate species. The necessity, so often noticed by geologists, for two parallel classifications for the marine and for the land faunas, is nowhere more marked than in the Newer Pliocene period, and in describing the deposits I have been obliged to keep the parallel faunas quite distinct (4).

The reason for this singular discordance between the apparent climatic conditions as shown by the marine animals and that evidenced by the land and freshwater fauna and flora is probably very simple and due to a slight change in the physical geography. During the deposition of the Coralline Crag the sea was open to the south, and everything points to a genial climate. But when the shoaler water Newer Pliocene was being deposited, land connected England with

France, so that southern land animals could cross freely. The same land barrier, however, isolated the North Sea, so that it was only open towards the north, and not only was the sea therefore colder than the air, but only northern species could enter this enclosed area, and any southern forms happening to die out could not be replaced. For this reason it is probable that the temperature of our Newer Pliocene sea may not have been quite so low as the marine fossils alone would appear to indicate.

Though the Cromer Forest-bed is not visible in the immediate neighbourhood of Ipswich, yet as it is intended so to arrange the excursions as to give an opportunity of examining all the Pliocene deposits, a short description of this stage may be useful (3).

The Cromer Forest-bed consists of a series of land, freshwater, and estuarine deposits formed in the delta of a large river, which seems to have been a continuation of the Rhine across the shallow bed of the North Sea. Though thin, these deposits are of great interest, owing to the prolific fauna and flora which they contain, and to the evidence which they yield as to climatic conditions immediately previous to the Glacial Epoch. The plants of the Forest-bed, and also to a large extent the invertebrate fauna, show a close approximation to the present inhabitants of our Eastern Counties; for though the occurrence of such species as the spruce fir, the water-chestnut, and the extinct *Paradoxocarpus carinatus* would give a peculiar character to the flora in the eyes of a botanist, yet any ordinary observer would only notice the forests of oak, Scotch pine, beech, birch, elm, hazel, hornbeam, and cornel. The lakes were full of yellow water-lily, water-crowfoot, and various existing species of pondweeds, their shores were occupied by thickets of alder and willow, of osmunda, or dense growth of reeds and sedges. Amid these the few and rare extinct plants might easily be overlooked.

If, however, while wandering through these Pliocene woods or along the shores of the Pliocene broads we were to meet with any of the larger mammals, this illusion would be entirely swept away. Nearly all the larger species are now entirely extinct or are extinct in Europe. Among the most abundant were three species of elephant, two of rhinoceros, a hippopotamus, two horses, and various peculiar deer. The carnivora included bears, hyænas, the machærodus, and the glutton. Among the rodents was a gigantic beaver. A few of these large mammals survived down to Pleistocene times, and some are still living, but most of them appear to have been exterminated during the first glaciation.

The stages immediately succeeding the Forest-bed are still, notwithstanding all our efforts, most imperfectly understood. Marine sands overlying the Forest-bed near Cromer contain in one place arctic shells, in another a bed of oysters, which cannot stand intense cold. Between these marine sands and the earliest Boulder Clay occur patches of laminated clay and loam, often very suggestive of stratified glacier mud, containing an intensely arctic flora. There are no trees, only dwarf willows, birches, and herbaceous plants, such as point to a temperature fully twenty degrees lower than at present.

It has already been mentioned that glacial deposits occupy the surface over great part of East Anglia. The classification and correlation of these is extremely difficult; but so far as can be made out, the oldest of them are only feebly represented away from the Norfolk coast, in the region where the arctic plant-bed above mentioned has been found. In the neighbourhood of Ipswich the most striking representative of the Glacial Epoch consists in the great sheet of unstratified Boulder Clay which extends southward nearly to the Thames and northward into Lincolnshire. The mode of origin of this sheet of morainic material is not yet clearly understood, for it is totally unlike anything now being formed by alpine glaciers or deposited in arctic seas. We should not forget, however, that an ice-sheet flowing over a flat country, where the average temperature is near the freezing point, is subjected to conditions entirely unlike those of an alpine glacier flowing down a steep valley into a temperate climate. It is, therefore, only with the ice-sheets of the Arctic and Antarctic regions, or with the wide glaciers of Alaska, that we can profitably compare the ancient glaciation of the North Sea basin. Space will not permit us here to discuss this question, but attention may be drawn to the address by Professor T. C. Chamberlin, entitled "Recent Glacial Studies in Greenland" (1). The facts there brought forward throw a flood of light on some of the obscure points in the glaciation of East Anglia, and anyone studying the intricate glacial deposits of the Norfolk coast should read Professor Chamberlin's description and examine his photographs.

One very puzzling peculiarity of the East Anglian Boulder Clays is likely to come forward prominently at the Ipswich meeting. This is the strange mixture of erratics from different districts. Blocks from Yorkshire, and perhaps Scotland, are mingled promiscuously with others from the islands in the Baltic or from the coast of Norway. There has been much discussion as to the meaning of this mixture; but, from the fact that many of the boulders are worm-eaten beach stones, subsequently glaciated, it is probable that most of them were scattered over the bed of the North Sea by floating ice, to be afterwards merely ploughed up and carried forward by the ice-sheet.

It might be thought that so recent a period as that of the dying away of the arctic cold would be thoroughly understood; but such is not the case, one of the most difficult problems in Pleistocene geology being to make out the relation of Palæolithic man to the Glacial Epoch. In this respect the County of Suffolk is particularly well situated, for the deposits newer than the Boulder Clay are very peculiar and often highly fossiliferous. At Stutton, on the north side of the River Stour, for instance, is found a brick-earth with elephant remains and land and freshwater shells, including the southern *Helix fruticum* and *Hydrobia marginata*, both now extinct in Britain. At Hoxne, on the other hand, overlying the Boulder Clay we find an interesting flora, including the dwarf arctic willows, *Salix polaris* and *Salix myrsinites* and the dwarf birch *Betula nana*. Numerous palæolithic implements have been obtained from the same pit, where they were discovered nearly a hundred years since by John Frere. It is to be hoped that the Ipswich meeting will produce some communication on the relations of the various isolated deposits later than the Boulder Clay, for this is a subject that ought more easily to be worked out in Suffolk than in any other county.

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Clement Reid.

III.

Some Recent Insect Literature.

IN a former review, contributed to NATURAL SCIENCE (vol. ii., pp. 114–119), I noticed a new description of the ear situated in the tibial joint of the front leg in long-horned grasshoppers. A summary of a recent account of another insect sense-organ with an apparently auditory function may also be of interest. Forty years ago Mr. Johnston was the first to discover that the swollen basal joint of the antenna in certain gnats and midges contained a complicated structure, which he interpreted as an organ of hearing. Subsequent observers have investigated the subject, among the more recent a well-known contributor to the pages of this Review, Dr. C. H. Hurst (1). The latest memoir on the subject (2) is due to the labours of Mr. C. M. Child, whose work seems so exhaustive as to leave but little for future investigators to learn about the structure of the organ, though a considerable field remains for experimental research into its various functions.

In the insects in which this organ is most highly developed, the males of certain gnats (especially *Mochonlyx*) and midges (Chironomidæ), the second joint of the antenna is enormously swollen and cup-shaped, being somewhat concave on its distal aspect. Here, around the insertion of the next succeeding joint, is a plate, called by Dr. Hurst the tympanum, produced into numerous processes, in connection with which are long, rod-like cells, united by means of nerve-threads with large ganglion cells, which are arranged within the outer wall of the swollen antennal joint, and connected with large offshoots of the main nerve of the antenna. In the females of these insects a similar organ is present, but in a far lower stage of development, the antennal joint being not nearly so much swollen as in the males.

The most important point, perhaps, in Mr. Child's work is the discovery of a homologous organ, though in a far more rudimentary condition, in the corresponding antennal joint of insects of several orders. The organ is shown to be present in many other genera of Diptera, in Hymenoptera (*Formica*, *Vespa*, *Bombus*), in Lepidoptera (*Epinephile*), in Coleoptera (*Melolontha*), in Rhynchota (*Aphis*, *Strachia*), in Neuroptera (*Gibelbula*), in Planipeunia (*Sialis*, *Panorpa*), and in Tricoptera (*Phryganea*). Only in the Orthoptera (*Phasgonura* and *Stenobothrus*) which he examined did Mr. Child fail to find the organ. The presence of the structure in different stages of development in so many different kinds of insects is of considerable interest, as it throws light on the steps by which it has reached the high grade attained in the male gnats and midges. Mr. Child believes, with much reason, that the advance in structure corresponds to an advance in function, from the apprehension of mere touch-sensations to that of definite sound vibrations. There must indeed be a stage at which the former are merged into the latter. In the gnats and midges, where the organ is specially developed in the males, it has doubtless a special sexual function. Dr. Hurst and Mr. Child both point out that experiments have shown the hairs on the shaft of the antennæ of a male gnat to vibrate to the same note which is known to be produced by membranes connected with the thoracic spiracles in the female. The "ear" in the male's antenna, therefore, enables him to ascertain the proximity and direction of a mate, for the hairs vibrate most readily when the path of the sound cuts them at right angles—that is, when the sound comes from the direction towards which the antenna points.

Here, then, we have an instance of the male insect hearing a sound produced by the female. It is well known that in most insects which produce sounds, the musical performance is characteristic of the male; and an old writer has been so ungallant as to congratulate the cicads upon having silent wives. Some observations on shrill, chirping notes produced by small water-bugs of the genus *Corixa* were brought to my own notice last year. Finding that although the sounds had been previously heard by several naturalists, both in Great Britain and on the Continent, there had apparently been no explanation of them offered beyond the fact that the front feet were drawn across the face, I examined those limbs in both sexes of several species. This study (3) showed the presence, in the males only, of a row of extremely fine pegs, or teeth, on the flattened tarsal joint, and it seems evident that these form a musical "comb" which sounds when the foot is rapidly drawn across the sharp edge of the face. Last year a French observer, M. Ch. Bruyant (4) heard similar notes from *Sigara*, a minute relation of the *Corixæ*, and described a similar comb-like instrument as their cause.

While such insects call each other by a "song," others—the humble glow-worm a well-known example—attract by a shining light. An interesting paper by Herr P. Schmidt (5) gives some particulars of luminous midges (Chironomidæ) which have been observed in various parts of Russia, in Pomerania, in Persia and Turkestan, the earliest quoted notice of the phenomenon being a century old. In certain localities the shining midges are said to be so numerous as to make entire shrubs glow with their light. These insects proved, upon examination, to belong to a form of the common species *Chironomus plumosus*. But Herr Schmidt does not consider that the shining serves any useful purpose, such as that of attracting a mate. It rather appears to be due to the presence of injurious micro-organisms in the body, as all the luminous midges observed were exceedingly sluggish and apparently sickly. The presence of bacteria was, however, not definitely proved by microscopic research. Herr Schmidt compares these insects with a luminous crustacean *(Talitrus)* described a few years ago by M. Giard. This shining individual was evidently sick, being far more sluggish than his companions, and only surviving a few days. Microscopic examination here revealed swarms of *Micrococci* in the foot, while healthy, non-luminous *Talitri* inoculated with these became in their turn shining and sickly.

A lengthy, minute, and laborious memoir on the glands of the Hymenoptera has lately been published by another French naturalist, Mr. L. Bordas (6). He has investigated the salivary glands, the food canal, the renal (Malpighian) tubes, and the poison-glands in several genera of most of the larger groups of the Hymenoptera, comparing the varying developments of corresponding organs in each. Six sets of salivary glands were found in almost all the insects of the order examined, while four other sets were found in some instances. Some of these are grape-like (racemose), consisting of numerous follicles, while others are unilocular; the ducts of the racemose glands are spirally strengthened, like tracheal breathing-tubes. Mr. Bordas correlates each pair of glands with a primitive segment of the head, but careful embryological research will be needed to confirm such a speculation. The food canal is described as it occurs in insects of the various families, and its different regions — fore-gut (comprising pharynx, gullet, crop, and gizzard), mid-gut, and hind-gut, including the rectum—are compared, their elaboration being traced through the pupal stage, from the comparatively simple digestive tract of the larva. The Malpighian tubes in larvæ are only four in number; during the pupal state these disappear, and a much larger number of tubes is developed for the perfect state. These are more numerous in the Hymenoptera than among insects of any other order, more than a hundred being sometimes present; their number is, generally speaking, inversely proportional to their length. Mr. Bordas accepts the view, now generally held, that the function of these tubes is renal; it will be in the remembrance of students of insect anatomy that Mr. Lowne, in his recent work on the blow-fly, maintains the older view that their function is rather hepatic.

The most interesting section of Mr. Bordas' work is, perhaps, his description of the poison-glands in various Hymenoptera. He states that hitherto only those of the hive-bee have been described, and he now figures the organs in many other insects of the order.

There are always two glands present, an acid and an alkaline. The former may consist of a simple tube, of a bifid tube, of paired tubes, or of a bundle of tubes. The epithelial coat of these consists of several layers of cells. They open into a large oval or spherical poison-reservoir, from which proceeds the duct to the sting. The alkaline gland is a somewhat thick, irregular tube, whose epithelial coat consists of but a single layer of cells, thrown into folds; its duct opens alongside that of the acid gland. A third, accessory, gland is present in some cases. A remarkable fact established by Mr. Bordas is that of the presence of these poison-glands (or their homologues), not only in the stinging (aculeate) Hymenoptera —wasps and bees, but also in the boring (terebrant) section of the order—ichneumons, sunflies, etc. The exact function of the glands in these latter insects, which do not sting, would be an interesting subject for research. Mr. Bordas insists that the sting of aculeate and the ovipositor of terebrant Hymenoptera are identical structures. In the concluding part (just issued) of the work referred to above, Mr. Lowne promulgates the same view, and expresses his opinion that the egg is ejected through the basal part, at least, of the sting in bees and wasps.

In a former review (NAT. SCI., vol. iii., p. 446) I noticed Professor Miall's description of a carnivorous crane-fly larva (*Dicranota*). The same naturalist, in conjunction with Mr. N. Walker, has quite recently (7) given descriptions and figures of the larva and pupa of *Pericoma canescens*, another two-winged fly, but belonging to the family Psychodidæ. The very small, hairy flies of this family may often be observed on window-panes, and the larvæ described were found in a paved water-channel and on the banks of muddy ponds. The grub can live either in water or air, and feeds on freshwater algæ. It breathes air by means of two spiracles situated at the end of paired processes, one on either side of the second body-segment (mesothoracic); and two other spiracles at the extreme hinder end of the body. The hindmost segment, on which these latter open, bears four processes, each provided with a number of filaments set with very fine hairs. These feather-like structures act as a cup which encloses air, so that the grub, which "seems most at home in water just deep enough to cover the body," can feed with its mouth at the bottom, while its tail is at the surface. If entirely submerged, as by a sudden flood, the feathery processes enclose a bubble of air, which will serve for respiration for a considerable time, the spiracles being kept dry. When full-grown, the larva leaves the water, and the pupal stage is passed by the insect, buried in the earth or beneath a stone. The pupa breathes by means of a pair of respiratory trumpets on the prothorax. The value of this paper is increased by an appendix, due to Baron Osten Sacken, giving an account of all the literature relating to the development of Psychodidæ. The latest memoir quoted herein is a description, by Dr. F.

Müller, of some Brazilian larvæ of the family, which breathe by spiracles at the hinder end, and also by means of pupillæ in connection with the tracheal tubes. These, protruded in water, function as gills; in air they are retracted.

Dr. H. J. Hansen has lately given us an excellent description with figures (8) of a very interesting and obscure African insect. This is *Hemimerus talpoides*, a small, brown, blind, wingless, cockroach-like creature, described by the late Mr. F. Walker from specimens from Sierra Leone. On account, apparently, of its short, stout legs this naturalist placed it near the Mole-Crickets, a family with which it has no near affinity. Later, Mr. H. de Saumere examined a single dried female, and believed he discovered therein a fourth pair of jaws fused to form a second labium. On the strength of this observation (now shown by Dr. Hansen to have been quite incorrect) *Hemimerus* was afterwards distinguished by being placed in an order all by itself. But though Dr. Hansen has proved the jaws of the insect to comprise the three pairs always characteristic of the class, and satisfactorily settled that it is an undoubted orthopteron, he has been able to note some important facts in its habits and life-history. The specimens which he examined came from the Cameroons, and were found by their captor, in quantity, jumping about on the skin of a rodent (*Cricetomys*) and penetrating between its hairs. Dr. Hansen remarks that the jaws of *Hemimerus* are not adapted for sucking blood, and suggests that it probably does not live parasitically on the rodent itself, but preys upon smaller insects which are truly parasitic. If this be so, the *Cricetomys* has cause for gratitude.

The most remarkable observation made by Dr. Hansen on *Hemimerus* is that the female bears living young in a very advanced stage of development. Several embryos were found in a mother, each less in size than that anterior to it in position. Between the head and the pronotum, in the larger embryos, an unpaired organ was noticed which Dr. Hansen believes to be "in connection with the internal wall of female genital organs, and thus serve the nutrition of the young ones, which are growing to the astonishing size within the mother." That is to say, its function is supposed to be analogous to that of the umbilical cord of a mammal. From the arrangement and comparative development of the embryos, Dr. Hansen concludes that only one is born at a time, an interval of several days elapsing before the next is ready to be brought forth. Such a method of reproduction is unique among insects, though, of course, examples of the birth of many living larvæ at the same time are sufficiently familiar.

Though the general aspect of *Hemimerus* reminds one of a cockroach, Dr. Hansen gives reasons for believing its affinities to be more with the Forficulidæ than with the Blattidæ. He would, therefore, place the insect in a special family not far from that of the Earwigs.

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GEO. H. CARPENTER.

IV.

The Nucleolus.

THE gradual improvement in our optical and chemical means of research has allowed us to peer ever deeper and deeper into that anatomy of plants and animals which lies beyond the reach of our unaided sight. First, it was the cell, consisting primarily of a wall, and, secondarily, of "contents," which was revealed to us. Later, the cell-contents were endowed with importance at the expense of the wall, and were shown to consist essentially of protoplasm and nucleus; at the present day we attempt to push the limits of our knowledge further still, and speak of the finer structure of protoplasm and of the compound nature of the nucleus. We have learnt, thanks to the diligent and patient labours of several observers, that the nucleus consists of many parts. It is bounded on the outside, in some cases at any rate, by a membrane; intertwined throughout its space is a fine threadwork of a substance chemically known as "linin," which is distinguished by the extreme difficulty with which it stains; embedded within the substance of these threads are a greater or less number of deeply staining granules —the chromatin or nuclein-grains; the interstices of this nuclear filament are occupied by a ground-substance of uncertain composition; and, lastly, there occur in most nuclei one or more spherules or variously shaped grains—the nucleoli—with properties peculiar to themselves. It is with these last-named bodies that the present article is concerned.

In the first place, it must be mentioned that the term "nucleolus," like so many other names occurring in the study of the cell, has come to be applied to several things of an entirely dissimilar nature.

Carnoy has classified the nucleoli as they are found in the literature of the cell in the following manner:—

(1) *Nucléoles nucléiniens*, which are merely granules of nuclein, either free or in connection with the nuclear threadwork.

(2) *Nucléoles noyaux*, which form, as it were, a nucleus within the nucleus, being in fact miniature nuclei possessed of all the usual parts, embedded in a substance extremely like, if not identical with, protoplasm, and occupying the rest of the nuclear space. These peculiar structures have been described in Rhizopoda and other animals.

(3) *Nucléoles plasmatiques,* the nucleoli proper. They contain no nuclein, whatever else they may consist of, and they have, according to Carnoy and Zacharias, a definite structure.

A peculiarly interesting case is to be found in the nucleus of *Spirogyra.* Here is a network winding through the nuclear space which, from the small effect of the ordinary stains upon it, we can conclude consists of linin with but few granules of nuclein embedded in it. This latter substance appears to be aggregated into one or two comparatively large spherules, which are usually spoken of as "nucleoli." But since by the unqualified term we mean only the nucleoli proper, the *Nucléoles plasmatiques* of Carnoy, the name is evidently misapplied in the case of *Spirogyra.* The spherules are to be spoken of according to Meunier (16) as *Nucléoles noyaux*, or, to follow Moll and others (17 and 10), as *Nucléoles nucléiniens,* but not as nucleoli simply.

Such determinations as the above, in which we are guided by morphological features and micro-chemical reactions, would be greatly facilitated if we knew more of the part played by the true nucleolus in the general physiology of the cell. As the case stands, we know but little of the functions of the nucleus as a whole, and still less of the duties of its component parts. With regard to the nucleolus, opinions are most divergent. One body of observers maintains that it is merely a reservoir of food-material for the more vitally active portions of the nucleus, whilst another group holds that it itself takes a prominent part in the performance of the life-activities of the cell. Strasburger, Carnoy, Pfitzner, and others, have all spoken for the former view, while the names of Flemming, Zacharias, and Oscar Hertwig may be mentioned among those who support the second theory.

The observations by Flemming (7), Bütschli (4), and Rosen (19) of the frequent occurrence of vacuoles in the nucleolus may have some bearing upon this point. Rosen, moreover, affirms that these vacuoles are particularly abundant in plants, and that they are filled with tannin. This, however, seems to be extremely doubtful. Many careful examinations, notably those of Büttner (3), point to the entire absence of tannins from the nucleus.

In forming a distinction between nuclein-grains and nucleoli, which are the two things most often confused, the safest guide we can follow is the dissimilarity in their behaviour during cell-division; the nuclein bodies will be seen, upon the entrance into activity, to break up into the chromosomes or nuclear-segments, while the nucleolus will to all appearances vanish altogether, probably becoming dissolved in the nuclear sap. A second datum of almost equal importance, which must be taken into account in forming all conclusions as to the nature of the nuclear structure observed, is its behaviour with micro-chemical reagents. So difficult, however, is the investigation of these minute parts of the nucleus that we cannot wonder at the great divergence of opinion upon their nature, both structural and chemical.

Many great masters in the study of the cell grant a distinction between nuclein-bodies and nucleoli only with the greatest hesitation. Strasburger (1882) in his work, "Ueber die Theilungsvorgänge der Zellkerne, etc.," believes that the two bodies are but different stages of development of the same thing. He thinks that as the nuclein-bodies increase in age, they grow, and that with their growth a change in their power of staining takes place, so that they ultimately reach the size and have the properties characteristic of a nucleolus. In a later work (24) Strasburger fully grants a dissimilarity in the substance of nuclein-grains and nucleoli, basing his opinion partly on their relative solubilities in various solvents, and partly on their different behaviour during cell-division. In a yet more recent writing (25) we find Strasburger mentioning the similarity of reaction of nuclein and nucleolus. The same hesitation in the expression of a definite opinion is to be found in Guignard (8); he, like Strasburger, believes in the passage of the nuclein-grain into a nucleolus. As the former body increases in size it undergoes a chemical change, so that it reacts differently towards colouring fluids at different periods of its existence. According to this theory, therefore, we may meet in the nucleus with nuclein-grains possessed of their distinguishing reactions; we may meet also, side by side with these, with other grains, the chemical behaviour of which is dissimilar from that presented by nuclein, and yet different from that of the nucleolus; and we may meet besides with yet other grains, larger in size, and different in chemical properties from either of the two former ones, which are stamped by their peculiarities as veritable nucleoli; and all these three things (and under the second heading may be included many varieties) are but phases of one and the same body.

Flemming (7) sees a radical difference between nucleoli and nuclein-bodies; so also Pfitzner (18), who studied the nuclei of *Hydra*. Jurányi (14), on the other hand, regards the nucleoli as thickened parts of the nuclear threadwork, and hence as consisting of nuclein.

Schmitz (20) not only classes nucleoli and chromatin-grains together, but includes in the same category the pyrenoids, those curious bodies with a still obscure function which are met with in the chromatophores of many Algæ. The grounds for this belief seem, however, to be insufficient to bear it out. Zacharias has shown that there is a certain similarity between nucleoli and pyrenoids, but that it is not a close one, and that, moreover, both these bodies are sharply distinguished from nuclein.

In 1881 Zacharias published the first of his series of articles on the micro-chemistry of the cell; they have appeared in the *Botanische Zeitung*, and their value can be best expressed by saying that they are among the most important contents of a periodical in the pages of which lie the very foundations of botanical science. In his earliest contributions (29) he ascribes to the nucleolus a two-fold structure; it consists, he says, of comparatively dense and resistant plastin, and of more easily soluble proteids. Plastin, it may be remarked here, is the characteristic proteid of the protoplasm, of which it forms the framework, and Zacharias has been led by his observations to conclude that it is likewise the framework of the nucleus and its parts; hence, instead of employing the special term "linin" for the nuclear threadwork, as is done by many other authors, he uses "plastin" to denote the formed constituent both of the protoplasm and of the nucleus.

Carnoy has also come to the conclusion that the nucleolus consists of dense plastin and of less dense proteid substances, but of no nuclein. In 1885 Zacharias issued his article on the "Nucleolus" (30). He examined particularly the case of *Galanthus nivalis* (Snowdrop), because here he was able to obtain large and favourable examples. These observations fully bore out his former views, and he further was brought to the belief that the plastin may be considered as arranged in a network, with the other proteids occupying its meshes. But of this he makes no positive statement, waiting for others to confirm these points.

In the last-mentioned article we find the behaviour of the nucleolus towards various solvents and staining reagents very fully discussed. With pure water, it seems, the nucleolus is unchanged, while the other nuclear parts, including the chromatic portions, swell up and become transparent, thus rendering the nucleolus particularly evident. As the water is further imbibed into the nucleus, this increases in size, and finally bursts, liberating the nucleolus as a shining, sharply defined body. Alcohol also brings out the nucleolus clearly. Prolonged action of 10 per cent. sodium chloride solution extracts from the nucleolus a portion of its substance, and leaves behind a part which has a loose constitution and slight power of staining. A somewhat similar removal of a portion of the nucleolar substance is brought about by the penetration of artificial digestive fluids. These render the nucleolus indistinct, and cause a diminution in its size; the remnant which is left behind no longer stains with neutral carmine solution, and a 10 per cent. common salt solution has no action upon it. The digestive fluid leaves the nuclein-grains unaffected, and it can be seen that, abundant as these may be in and around the nuclear threadwork, they are entirely absent both from the nucleolus and the protoplasm. The action of common salt and of digestive fluids upon the nucleolus gives great probability to the view that this structure consists, as Zacharias and Carnoy affirm, of two separate materials, and is not built of a single substance (pyrenin) as Schwartz and others maintain.

The action of carmine stains also sheds considerable light upon the constitution of the nucleolus. Neutral carmine colours that part of the nucleolus which digestive fluids abstract; the digestive-remnant and the nuclein-grains of the nucleus are left unstained. Alkaline solutions of carmine colour the nucleoli rapidly and deeply, but act on nuclein only slowly and never very intensely. Acid carmine solutions have precisely the opposite effects, being especially nuclein stains with little action on nucleoli. This behaviour with different carmine solutions again points to the two-fold structure of the body in question, and to the entire absence of nuclein from it.

In direct contradiction to these views Schwartz (22) asserts that the nucleolus consists of a single substance—pyrenin, which has a close chemical resemblance to the material composing the wall of the nucleus, and which he accordingly names "amphipyrenin." This pyrenin exists, he says, in two modifications, the soluble and the insoluble forms, the former being found in young nucleoli, the latter in those which are older; but what is to be clearly borne in mind is that both forms are chemically similar, and hence to be included under the single name of pyrenin. He has studied the action of different reagents upon the nucleolus most carefully and patiently; but invaluable as his results are, it would be out of the question to enter into their details here. It may be mentioned, however, that they frequently are at variance with those of Zacharias; for instance, Schwartz believes it to be extremely probable that the substance of the nucleolus is in itself soluble in water (in contradiction to Zacharias), but that upon the injury of the cell in examination, the penetration of acid substances or tannins contained in the cell-sap of the protoplasm fixes and renders the nucleolar substances insoluble. He fully bears out Zacharias in the opinion that nucleoli are entirely dissimilar from chromatin-grains.

Another interesting point connected with the nucleolus is the change which this undergoes with increasing age. We are very largely indebted to Johow (13) for information in this respect. There seems to be a decrease in size, and often an entire disappearance of the nucleolus in older cells; moreover, in cells which no longer undergo division, the nucleolus exhibits slow changes of form, more or less amœboid in nature (*e.g.*, cells of *Chara*), the pseudopodial processes becoming separated from the main body of the nucleolus, and drawing themselves together as a number of disconnected granules, still giving the ordinary nucleolar reactions.

In what has already been said it will be seen that there is much which is uncertain and undetermined; but there yet remains a question to be dealt with which surpasses all else in point of indecision and variety of opinion. This is the inquiry into the fate of the nucleolus during cell-division.

The only point as to which there is a consensus of opinion is that the nucleolus, at the time of activity, disappears. What becomes of it? Which, if any, of the new structures appearing in the nucleus (or in the protoplasm), may be derived from the nucleolus? These are at present open, although much-discussed questions.

Some have thought that the nuclear-spindle owes its origin to this vanished structure, others, and perhaps the majority, including Flemming (7), Jurányi (14), and Went (27), are of opinion that there exists a direct connection between the nucleolus and the chromosomes. Strasburger (24) also sees a connection between these two things, but not a direct one. The nucleolus, in his belief, is dissolved in the liquid portions of the nucleus (nuclear-sap), and part of it may then serve as a food-stuff to the chromosomes, and be absorbed by them whilst the rest remains behind in solution. When the daughter-nuclei are formed, the nucleolar substance collects together from the threadwork and from the nuclear-sap to form fresh nucleoli. Since, as has been pointed out above, we have very good reason to believe in the dissimilarity between the materials of the chromosomes (nuclein) and the materials of the nucleolus, it is not easy to see how any such relations can exist between the two.

Zacharias (30) has watched the disappearance of the nucleolus from the cells of *Chara*, in which he noticed that it loses its definite outline and changes its shape in slow amœboid movements, becoming at the same time diminished in size, finally to vanish altogether. He thinks that it is probable that the more easily soluble proteid constituents of the structure are dissolved, whilst the plastin framework remains intact, but hidden by other plastin elements in the dividing nucleus.

Of late days, much attention has been given to those structures of the cell spoken of as attraction-spheres and their central-particles or centrosomes.

The exact life-history of these organs of the cell, for so we may term them, is not yet ascertained, but much speculation has been rife in connection with it. Only one of these hypotheses will interest us in the present article, it is the one recently propounded by Karsten (15). In studying certain cells of *Psilotum* he found, at the time of division, the nucleoli, of which there may be several, lying close to the periphery of the nucleus and, on the absorption of the nuclear-membrane, two nucleoli passing out into the protoplasm and taking up their positions at the poles of the nucleus. He further asserts that in some cases he was able to detect a distinct radiation around each nucleolus, and from these observations he concludes that the nucleoli give rise to the centrosomes of the attraction-spheres, and are subsequently re-formed into the nucleoli of the daughter-nuclei.

Another theory of considerable interest, and of recent date, is that of A. Zimmermann (32). In the opinion of this observer, the nucleoli wander out of the nucleus at the time of division and find their way into the protoplasm as bodies of varying size; when nuclear division has taken place, it is probable that the nucleoli travel back to the daughter-nuclei and once more fuse together into the ordinary nucleolus. The grounds for this belief are certain observations on the micro-chemical behaviour of cells of *Equisetum*, *Psilotum*, *Vicia faba*, Liliaceæ, etc., in which it was noticed that, at the time of nuclear activity, particles, some large, some small, appeared in the protoplasm, and that these gave all the characteristic reactions of the nucleolus. With regard to these theories of Karsten and Zimmermann, the observations of Guignard, lately recorded in an article on the origin of the attraction-spheres (9), have no small significance. The centrosomes, he says, are always and invariably (in the plants examined) to be found outside the nucleus, and, although at certain periods of nuclear division the nucleoli may be seen lying in the protoplasm in the neighbourhood of the spheres, yet nucleoli and centrosomes are always distinct from one another. In the formation of the spore-mother cells of *Psilotum* the nucleoli, which are present in numbers, were seen to find their way into the protoplasm, and then to diminish in bulk, although their ultimate fate could not be made out. Thus the researches of Guignard support the views expressed by Zimmermann, but stand at variance with those of Karsten.

From the foregoing it will be perceived that our knowledge of the chemical, structural, and physiological relations of the nucleolus is still very imperfect; but when we recollect how extremely minute this structure is, we must feel that we should not reproach ourselves with this uncertainty, but rather marvel at the skill and patience of those who, after all, have told us much already. Their chief praise, however, is that they have started us upon a new line of research which promises to bring us nearer than any previous one to the highest problem of biological science; for it is indisputable that within the cell lies hidden the riddle of Life, which has been a puzzle to mankind through all time.

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Rudolf Beer.

V.

The Rôle of Sex.

Part I.

The Use of the Term Sex.

ACCORDING to Skeat the word sex—*sexus*—is derived from *secare*, to divide. If this is true, the word "to divide" was modified to express that which is divided or distinguished from something else; thus, we have the male sex or division, and the female sex or division. By a further extension of the use of the word we have the sexual organs, or sexual instincts, meaning those parts or qualities on whose difference the division or distinction depends. Both in the early use of the term and in its modern every-day application, it is the difference between the sexes which is felt to be the outstanding character which merits notice, and requires indication in the name given.

But biologists who have studied the lower forms, both of animal and of plant life, have discovered that the simpler the organism, the fewer are the characters which distinguish the sexes from each other; until forms are finally reached all the members of which are precisely similar to each other and show no indication of sex—maleness or femaleness. Nevertheless, these little organisms sometimes conjugate with each other as a preliminary step to reproduction, and in this respect resemble higher organisms where the conjugating individuals are different. Thus *Ulothrix* produces microspores which coalesce with precisely similar microspores from other individuals, and these subsequently develop to adult size and character. Biologists recognise that reproduction with conjugation is a character which *Ulothrix* shares with higher animals, and they have so extended the use of the term sex as to include as examples of sexual reproduction the conjugation of types precisely similar to each other; types which, like *Ulothrix*, show no indication at all of maleness or femaleness. Thus it has come about that a word, originally meaning "to divide," is now, in a strictly technical sense, used to indicate "that which joins," and this is one of the many instances which exist of words which completely change their meaning during the gradual growth and development of language.

By this useful and perfectly justifiable extension of the term sex, we can distinguish sexual reproduction—that is, reproduction after conjugation—from reproduction in which no conjugation takes place, or asexual reproduction.

For an example of the latter we have not to go far, for the microspores of *Ulothrix*, if they fail to meet and coalesce with other microspores, may develop by themselves, gradually growing into adult specimens.

It will be observed from the foregoing that in a study of sexual reproduction we have two important and quite distinct problems to discuss, problems which have unfortunately too often been treated as if they were one. In the first place, we may concentrate the attention upon the act of conjugation, and enquire as to its utility; and in the second place, we may seek for an explanation of how it is that in the vast majority of cases the conjugating forms are dissimilar to each other, and may therefore be termed male and female. It will be convenient to study the second problem—that of sexual dimorphism—first, chiefly because its solution may clear the way for the first and by far the most obscure question, "why should organisms conjugate at all?"

Sexual Dimorphism.

There can be little doubt that the earliest form of conjugation was between forms similar to each other and exhibiting no sexual difference, and that sexual dimorphism arose subsequently. This is believed because in existing organisms it is only in very simple and primitive types that we find the absence of sexual differences, and these differences become most pronounced in more highly organised and later types.

If we enquire why dimorphism arose, we naturally ask ourselves the question, what can have been and what are its special advantages? To show the existence of an advantage, will, by the light of Darwin's work, give at any rate a complete and reasonable hypothesis for the development of dimorphism. Accepting the fact that living organisms constantly tend to vary in an almost infinite number of ways, we can readily understand how, at one time or another in the history of a species, individuals might be met with whose reproductive cells differed considerably from each other, say in size. If now it can be shown that, for purposes of conjugation, or for anything else, this variation had a distinct advantage over ordinary members of the species whose reproductive cells were all of the same size, then we may rely on natural selection for the perpetuation of this fortunate variety. While the gift of a purse might be of advantage to a beggar in our streets, it would little avail the traveller dying of thirst in the Sahara: a possession, a power, a property may be of advantage to one and not to another; for this point will be determined by their conditions of life. Probably sexual dimorphism would not be of advantage to those lower forms which do not possess it; otherwise it is difficult to imagine its non-occurrence and non-preservation through variation and natural selection. Equally probable is it that sexual dimorphism is or was of advantage to those forms which now possess it.

If now we study the conditions of life, both of those which are not, and those which are, sexually dimorphic, and if we find certain conditions absent in one case and present in the other, we may assume, at any rate provisionally, that these latter conditions determined sexual dimorphism by making it advantageous wherever it should appear as a variety.

If we study in detail some of the life-histories of the lower forms, both those which are dimorphic and those which are not, we shall find that wherever certain difficulties in the way of conjugation appear, there dimorphism is also present.

Those forms which, though conjugating, are not dimorphic, are of the most simple structure, consisting of single cells, or small colonies of these. In all cases, so far as I can determine, conjugation is most easy and effectual, for they are either (1) free swimming, (2) free crawling, or (3) they are nearly opposed to each other. As an example of a free swimming form we may take the *Paramœcia*, which are free swimming and active infusoria. When conjugating, two individuals come in contact by their ventral surfaces, exchange nuclear matter, separate, and then divide. Of three *Paramœcia*—A, B, and C—A may conjugate with B or with C, or B may conjugate with C; three possibilities, two only of which could, of course, take place were a sexual difference present. As another example of a free swimming form, *Heteromita* may be instanced.

As an example of a freely crawling form, we may take *Amœba*, which crawls along by the aid of its pseudopodia. Conjugation has recently been described in this form—two individuals meeting and completely fusing as a preliminary to subsequent division.

As an example of individuals which are from their position in easy reach of each other, we may instance *Spirogyra*, whose long filaments lie side by side in the water. From these, short processes arise, springing from the contiguous borders of neighbouring filaments; they pass towards each other, join, and their contents become united. In some forms of *Spirogyra* the processes differ from each other in activity, the only indication of dimorphism present.

Other examples of plants living in close contiguity and where conjugation is remarkably easy, may be taken from the *Confervoideæ isogamæ*.

When we pass to the examination of the conditions under which dimorphism exists, we find that dimorphic forms are either (1) simple cells, which are fixed and far apart from each other, or (2) individuals that have undergone cell-differentiation, with the result that the reproductive matter is contained within special reproductive cells. In both cases, as we shall see very soon, there are certain difficulties in the way of easy conjugation.

As an example of simple fixed cells we may take the case of

Vorticella. These are fixed by a stalk to weeds or stones, and of course they are unable to cluster close to each other for lack of food. In order that conjugation may occur, the *Vorticella* generally divides into two halves, one of which re-divides into from two to eight parts. These become ciliated and free swimming; they swim to and conjugate with an ordinary stalked *Vorticella.*

By far the larger number of instances of dimorphism are to be found in higher and more complex animal and vegetable forms. Here, the individual consists of cells, some of which exist for protection, others for movement, others for purposes of nutrition, and others, again, are the reproductive cells. Here, we meet with two distinct kinds of dimorphism, both of which may be termed sexual. In the first place, the special reproductive cells, or gametes, are different from each other, and this we may term *dimorphism of the gametes;* and in the second place, the whole individual may be dimorphic, *dimorphism of the individual.*

Thus, in *Hydra*, one individual specimen produces two kinds of reproductive cells or gametes, and these may be termed male and female gametes. One individual hydra does not, however, differ from another individual hydra—there are no male and no female hydras: the individual may be termed hermaphrodite, from its producing both male and female gametes. In by far the larger number of plants and animals a division of labour occurs, and the male gametes are produced by one individual, the females by another, so that in this case we may speak of a male and female *individual*, more especially as these individuals generally come to differ from each other in qualities other than that of merely producing different reproductive cells.

Dimorphism of the Gametes.—Now it is very probable that the first indication of dimorphism was the production by individuals not dimorphic themselves of gametes which were dimorphic, and that dimorphism of the individual was a subsequent product. The reason for this belief is the fact that the more complex double dimorphism prevails to a greater extent in higher than in lower forms of life. Concentrating our attention upon the dimorphism of the gametes, we find that, as already indicated, it is associated with certain difficulties in the way of conjugation. In *Vorticella* these are obvious, and hardly less so among animals which have undergone cell-differentiation. Even where individual dimorphism has furnished special ducts and organs for bringing the gametes together, these, on account of their small size (they are generally microscopic) have got to travel what is for them a considerable distance before conjugation can occur. While we may allow that dimorphism is present in association with difficulties in the way of conjugation, we have only taken the first step in our investigation; we have yet to understand how dimorphism can overcome these difficulties.

We might suppose that the production of moving gametes would be sufficient to bring conjugation about, and we have still to explain why the gametes are of two kinds, female and male; we have, in fact, to explain why of the two kinds of reproductive gametes the first are large, and are approached by rather than approach the other kind (these we term the female gametes, ova, etc.), while the second are small, actively approach, or are carried by outside agencies to the female gametes (these we term male gametes, sperms, etc.). Now, the utility of this dimorphism will be apparent when we call to mind certain facts in the physiology of the early stages of reproduction. A reproductive cell is a highly differentiated cell; it contains matter capable of reproducing a new individual, but is devoid of the power of assimilation and nutrition. It has no organs for feeding or digesting food, for then, indeed, it would be fully equipped for all the main purposes of life; it would be a person or an individual. After it has started away from the parent organism, its life as a gamete must necessarily be short, and every movement it makes, every hour it lives, expends some of its limited potential. When the gametes conjugate, and active development occurs, some time must elapse before organs of nutrition are formed, and all this time capital must be used up, and they must have, one or both of them, a supply of capital at hand. In the case of many animals—the fowl, for instance—the store of capital is very great, and weighs hundreds of times more than that part which directly develops into the chick. The gametes, therefore, not only require to be brought together, but after conjugating, they must start life with sufficient capital.

If both gametes were motile, and carried each of them a portion of this capital—frequently very abundant—it is evident that a great expenditure of energy would be required. The conditions, actually in existence, where the capital is a part of the quiescent cell and the moving cell only carries its hereditary material, conduce to the saving of energy, and are, therefore, advantageous. In the case of the fowl's egg, no existing cell could propel even a small fraction of its substance; but leaving such an extreme case, we find that the female gamete, with its store of capital in almost every species that can be named, is many times greater than the male gamete. The advantage of having this store of capital lodged with the quiescent gamete is obvious; but the dimorphism which we find in nature has other advantages in addition to those just mentioned, and one of the most important appears to me to be the following:—If both sexual cells were similar and motile, conjugation would rarely occur, because it would be impossible to "time" them in their chase for each other. Suppose that a hypothetical individual (A) gives off moving gametes, and that another individual (B) gives off similar gametes, and that new individuals are produced by the conjugation of the gametes of A and B; unless A and B had some method of timing the formation of these gametes, A might, and probably would, form its gametes at a time when B had none at all. The arrangement that actually obtains has a very obvious advantage over this conceived condition, for the gametes swim about until they find a large and quiescent form, which is waiting, and can wait an indefinite time for their appearance. In the case of the fish and frog the motile cells are discharged over the quiescent ones, and in the case of the mammal the motile cells are discharged into a duct containing the ova. Here, were the ova motile, there would be less likelihood of their meeting, for they would probably move away from the spot ultimately reached by the motile cells.

We can see that dimorphism is a necessary corollary of the existence of certain conditions, and we see how, supposing that *Volvox*, for instance, at one time or another produced several cells all of one kind, any variety of *Volvox* which developed some of the cells large and quiescent, and others small and motile, would have a distinct advantage, which might lead to the perpetuation of the variety.

Dimorphism of the gametes permits, we have seen, the act of gametic conjugation to take place in a very economical way, and more economical than if the gametes were similar. We may now very naturally ask whether or not dimorphism plays any other rôle than that we have assigned to it. This may very likely be the case, but at present it is difficult to find any characters which distinguish all male from all female gametes, other than those already described; their dimorphism seems to be adapted to economising of energy and nothing more. Of course it is not intended to discuss peculiarities of the gametes special to a species, arising to suit special conditions, but reference is made solely to those points which are of general application.

In their erudite work on "The Evolution of Sex," Geddes and Thompson, struck with the size and quiescence of the female gamete, and with the small size and frequent activity of the male gamete, view the female as preponderatingly assimilative or anabolic, and the male as preponderatingly katabolic. The female gamete builds up her bigger self; the male gamete uses up the trace of capital he possesses in active mechanical movements. This, of course, implies a constitutional difference between the two gametes—a building up and a breaking down constitution. It appears to me very doubtful whether the evidence, taken as a whole, points in this direction, and for the following reasons. Many gametes—pollen-grains, for instance —do not possess the power of movement. They are inert masses, small in size, and carried by the wind or by the aid of insects. We have no reason to suppose them more katabolic than the ovules, unless we have indication of this in the presence of tissue metabolites, or unless we have evidence of active protoplasmic movement which we know must result in metabolites. This evidence is wanting, or, at any rate, very incomplete, and we cannot fall back upon their smaller size; for though smaller, it by no means follows that they are more katabolic. The most katabolic cells in the body are, perhaps, the muscle cells, and yet they are the largest. We are driven back, therefore, to our first statement, which appears to contain all the facts of universal application at present known, namely, that there are gametes which are larger, contain capital, and are approached by the others—these are termed female; and there are those which are smaller, which actively approach, or are passively carried to, the ova—these we term male.

Dimorphism of the Individual.—Having indicated the obvious advantages which result from dimorphism of the reproductive cells, let us now turn to a consideration of the individual as a whole.

Volvox produces both motile—male—and large quiescent—female—sexual cells. But *Volvox* A is like *Volvox* B, every specimen producing both male and female cells. *Volvox* as an individual has no sex, strictly speaking. *Qua* reproductive cell there is sex difference—dimorphism; *qua* individual *Volvox* there is no such difference.

In by far the greater number of higher forms the male cells are carried by some, the female cells by other, individuals; there is a division of labour, and here *qua* individual we may introduce the terms male and female: there is individual dimorphism. In most cases the two individuals are modified on different lines, and this modification is, we find, always associated with some useful purpose. Organs are specially developed to bring about the more complete mixing of the reproductive elements, other organs to aid the nutrition and development of the young, other organs for protection or active aggression. Division of labour, an obvious economy, necessitates the possession of the organs of nutrition by one individual—the female—and of organs of defence by the other—the male.

These sexual differences, as we term them, vary both in kind and degree. Except by dissection, we cannot distinguish those fish whose sole functional difference is, in one case, to produce ova and discharge them in the sea or on the river bottom, in the other, to produce sperms and discharge these over the ova. The male stickleback, on the other hand, with his multifarious duties of builder and guardian, is distinguishable at once from his mate; and the sexes in the rays and dogfish are very distinct, for here, again, important and different duties are undertaken by each of their sexes. The starfish, which produces sperms, is, both in external and internal structure, similar to the starfish which produces eggs, for in this class the duties of maternity and paternity are usually no more than to grow their reproductive cells and simply discharge them into the sea where they conjugate and develop. In the mammal, where the ova develop within the mother, important structural differences exist between the sexes; the mother becomes a nurturing individual, and the father a protecting one.

If we now turn to a study of dimorphism of the individual, with a view of determining whether or not there are any characters common to all males, or whether there are any characters common to all females, we shall, I think, encounter difficulties similar to, and as great as, those which beset the question, "Are there any characters common to all animals which separate them from all plants?" Every species has its peculiar dimorphism, and only in nearly allied species are these dimorphisms similar. The organs of copulation present in the mammal are absent in a large number of non-mammalian types; in one form the hair, in another form the horns, in another form the wattles, in another form a different pigment of the skin or plumage, serves some useful purpose and distinguishes the sexes. The attempt to establish the male sex as preponderatingly katabolic, and the female as preponderatingly anabolic, falls to the ground as soon as we carefully examine the case. If we take size—an unsatisfactory test at most—as an indication of a preponderance of anabolism, we find examples of both females and males who are larger than their partners in life. The female dipteron, ant, spider, or frog may be larger than the male, but the male bird generally, and the male mammal invariably, is bigger than the female. As to an active katabolic constitution, it is true that some males are more active than their partners, but it is doubtful whether this is the case, say, with the carnivora and with most birds; there is no difference in the starfish, and the advantage is with the female in those cases where the male is parasitic.

It is highly probable that plants and animals developed out of very primitive forms, adapting themselves in a thousand ways to their surrounding conditions, so that we can find among some plants and some animals almost every quality possessed by living beings. It is impossible to say that a certain quality A is present in all plants and distinguishes them from all animals, and the attempt to find such qualities, at one time considered so important a matter by biologists, is being given up. Now, in just the same manner, we are bound to believe that the individuals carrying the male and female cells became modified in a thousand ways; so much so that there is no quality which serves to distinguish all male from all female individuals, except, indeed, that they carry respectively male and female reproductive cells.

J. B. HAYCRAFT.

VI.

The Alleged Miocene Man in Burma.

THE November number of NATURAL SCIENCE and of the *Geological Magazine* contained notices of Dr. Noetling's paper "On the Occurrence of Chipped (?) Flints in the Upper Miocene of Burma," in the course of which the reviewer accepts as an established fact that worked flints have been found by an experienced geological surveyor in a stratum of either Upper Miocene or Lower Pliocene age—a statement which appears to have found its way without qualification into other periodicals, and even text-books. Dr. Noetling was obliging enough to show me over the locality where these flint fragments were found, and as the question of the existence of man in these Miocene beds is too important to be settled by the *ex cathedrâ* statement of even so eminent an authority as Professor Rupert Jones, I would offer the following remarks, in the hope that they may inspire that due amount of scientific caution which is desirable where a conclusion so revolutionary is still incompletely established.

There are two distinct issues which must both be decided affirmatively before we can say that the existence of man in Miocene times in the Irawadi valley has been proved. First, are the flakes of Miocene age? secondly, are they of human origin? The second I do not propose to discuss; but with regard to the first, the statement that a flake was found partially embedded in the rock requires, in the circumstances of the present case, an explanation. The site is on a spur running out into one of the valleys which have been cut back into the plateau; the crest of this spur falls somewhat rapidly and then rises slightly to the outcrop of the ferruginous conglomerate, whose exposure on the crest of the spur is, to the best of my recollection, about 50 ft. long by 8 to 10 wide. No vestige of soil or sand is here, all having been removed by rain and wind, but there is a thin coating of ferruginous gravel overlaying the solid rock, and it was on this surface, as pointed out to me by Dr. Noetling, that the flakes were found. Ordinarily, there would be no hesitation in ascribing anything found in this layer of loose material to the underlying rock; but it is not the same as finding a flake, or fossil, embedded in a bare vertical exposure below the level to which the rock had been loosened by weathering. It must be remembered that the degree of proof required varies inversely with the inherent probability of the proposition to be proved, and when we are dealing with the evidence for the existence of Tertiary man, we must demand most irrefragable evidence both of the derivation of the remains and of the age of the stratum they are supposed to be derived from. In the present case the latter is clear enough, but as regards the former there is a possibility of the flakes, if products of human handicraft, having been dropped on the spur, or washed down from the plateau above, and subsequently become partially embedded in the weathered surface; the possibility being rendered more probable by the fact that the implements are not confined to the outcrop of the fossiliferous ferruginous bed, but are scattered over the surface of the plateau above.

Under these circumstances, it cannot be said that the Tertiary age of the flakes has been proved, and till more complete evidence has been produced it is impossible to accept the existence of man in either Miocene or Pliocene times as one of the established facts of geology.

R. D. OLDHAM.

SOME NEW BOOKS.

THE TRADITION OF THE FLOOD.

ON CERTAIN PHENOMENA BELONGING TO THE CLOSE OF THE LAST GEOLOGICAL PERIOD, AND THEIR BEARING UPON THE TRADITION OF THE FLOOD. By Joseph Prestwich, D.C.L., F.R.S., F.G.S., etc. 8vo. Pp. xii., 87. Macmillan and Co., 1895. Price 2s. 6d. net.

THE author's life-long researches into the evidence of repeated changes in the level of land and sea, their causes, results, and relative order in succession, more particularly in the British Islands and Western Europe, have proved to be of great value to his fellow-geologists in elucidating the geological structure and history of the regions concerned. They have also enlightened many amateurs and other inquirers on collateral subjects, such as the local and general supply of coal and water, the distribution of particular soils, and as to special topographical features—for instance, gravel-terraces at different levels.

One geological feature among others has especially attracted his attention and had his careful consideration to a great extent, namely, a widespread superficial coating of loose material, consisting of broken rock-matter, but forming neither common gravel and loam, nor soil and humus. This was recognised, to some extent, and called "head" by De la Beche and Godwin-Austen. Prestwich defines it as a special class of "drift," which he calls "rubble-drift." It occurs on hillsides as fragmentary stones mixed with broken bones; also in some clefts and hollows; on coasts it covers old ("raised") beaches, and on some plains and plateaux it forms part of the widespread loamy beds known abroad as the "Lehm," or "Loess," but, like the foregoing, commingled with land-shells and the bones of land animals. These bones may be broken, but have not been worn by transport in rivers, or by glaciers or coast ice, nor have they been gnawed by beasts of prey. Hence the author long ago deduced the conclusion that they must have been dispersed from local centres by water pouring off rising areas of ground after having been submerged by the subsidence of land under water. During this earlier change of level the creatures sought higher and higher levels for safety, and, dying there, their remains were brought down by the retreating waters during the emergence of the land, whether by slow, sudden, or intermittent elevations. The loose ruins of the rocky structure of the tops and slopes of the high places, whether frittered away by frost or by alternate heat and cold, and left, perhaps, for ages before the submergence, came down at the same time, often breaking and crushing the larger bones where the diluvial rush or local precipitation into fissures was greatest. Large areas have been swept bare, slopes, hollows, and clefts retaining some of the *débris* or detritus.

This hypothesis of a widespread and relatively short submergence, followed by early re-elevation, seems to the author to satisfy all the important conditions both of the problem of an extensive deluge, and of the nature and disposition of the "rubble-drift" or "head."

In this exposition of his views on the subject, Dr. Prestwich treats briefly of the Mosaic and Chaldean accounts of the traditional deluge; and gives his reasons for not accepting as satisfactory the supposition of its having been a valley flood in the Babylonian region.

He also premises that extreme Uniformitarianism cannot be allowed to have any force against his explanation; for "uniformity in degree in all time" is not allowable, though the law of "uniformity in kind" cannot be questioned. It is evident that upheavals and down-sinkings have taken place in many periods of the Earth's history; but their relative intensities may and must have greatly varied.

The geographical distribution of the rubble-drift in England, the Channel Islands, France, Spain and Portugal, Italy, Sicily, Malta, and other Mediterranean Islands, Greece, and the coasts of North Africa and of Asia Minor, is broadly sketched, and careful descriptions of special examples are given in detail, with some illustrative sections.

The author remarks that the absence of marine remains in the rubble-drift might be thought to be inimical to the idea of its having been formed by sea-water retreating from the land after having submerged it for some time; but he thinks that the time was too short, and the water too much muddied with the recent wear and tear of surface-soils, for sea animals to have thrived there. The absence of water-channels and of water-worn material shows that the rubble-drift was not due to exclusive rainfall and river-action. Nor could the conditions of the Glacial Period have coincided with this drift-formation, for ice-sheets would not have allowed of the existence of the creatures whose remains are met with in the rubble; moreover, the land-shells would have been broken, if present, and the bones of animals would have been rubbed and worn. Nor does a "wave of translation" embrace sufficient probable results to account for many of the observed facts.

When these changes of level took place, Man must have existed, for his implements, chipped out of flints, are present at many places in the rubble-drift, having been swept off the surface all over the area treated of by the author, as well as in such cave-earths and loess (sometimes with human bones) as were contemporary with it. The relative date of the rubble-drift can be calculated, though not clearly, from the extent to which it has been worn away on cliffs; and (coincidently) from the probability that Palæolithic Man existed at the close of the Glacial Period, within a period of from 10,000 to 12,000 years of our own time.

With these observations on facts and theoretical deductions, Dr. Prestwich seems to have found good cause to express his opinion that natural results from changes of tension in the mobile earth-crust would bring about oscillations of land and sea, such as have often happened; and that such a change gave rise to a submergence, and subsequent emergence, seriously affecting certain regions, their surface and their inhabitants, within the history of the human race.

He recognises the absence of direct evidence as to similar diluvial materials existing far eastward of Europe, in that region where the "Mosaic Deluge" has always been supposed to have occurred. The extensive European area, however, where the movements of land necessary for the incursion and retrogression of sea-water must have taken place, is quite sufficient, he thinks, to have driven a large proportion of the then existing populations to hills and mountains as places of refuge; from which centres those that survived proceeded in time to re-people the low-lands, and to be the source of traditional legends of the great event.

Of course, Dr. Prestwich takes cognisance of only such purely natural features and incidents as are mentioned in the Hebrew and Chaldean legends of the "Deluge," when he refers to these in connection with his subject. He does not find it necessary to allude to other legends; and he leaves it for others to trace the origin of such legends, whether in distant parts of the earth or nearer home.

This little book of well-digested knowledge will certainly produce good results towards a clearing away of old-fashioned, fanciful, mystical, and non-natural ideas about any so-called "Universal Deluge." It gives a good geological standpoint for the consideration of a diluvial catastrophe, of limited extent, in South-European, and probably West-Asiatic, regions, which must have occurred since Man began to inhabit this part of the World.

T. Rupert Jones.

The Life of the Broads.

Birds, Beasts, and Fishes of the Norfolk Broadland. By P. H. Emerson. Illustrated with sixty-eight photographs, by T. A. Cotton. 8vo. Pp. i.-xix., 1-396. London: David Nutt. Price 15s.

The Eastern counties are so famous for the visits which they receive from rare birds, that we turned with an unusually keen anticipation of enjoyment to the neat and attractive volume now before us. Indeed, the prospectus of the work promised a large amount of novel information, though we cannot discover that the promise has been fulfilled. Mr. Emerson comes before us in the *rôle* of a new writer on natural history, a capacity in which his name will of course be strange to ornithologists. He appears to aspire to belong to that modern school of writers of which Mr. Warde Fowler and the Son of the Marshes are the best known exponents. These gentlemen write for the many, rather than for the scientific few, and their lack of profound originality is much more than compensated for by the rich eloquence in which their finest thoughts are clothed. It would be difficult to over-estimate the importance of these cultured and æsthetic writers, who bring before us the sights and sounds of Nature in graceful and polished periods. Mr. Emerson's writings likewise possess the charm which is born of artistic perception. He is able to *idealise* the common facts of natural history which have come under his notice, and there can be no doubt that, so far as a limited experience carries him, he does his best to reproduce for us whatever he has hitherto learnt in his field rambles. Before we proceed further, it is only right to warn the reader that Mr. Emerson's writing possesses one great defect. He is far too self-conscious. He seems to be ever playing to the gallery, and anticipating the applause of the gods. This unpleasant feature is accentuated by the censorious tone which Mr. Emerson has found it necessary to adopt. At the first start he falls foul of the work of the best avian artists in Great Britain. "The monstrous and gaudy decorations of Selby, Gould, Dresser, and the illustrations to Booth's 'Rough Notes,'" make our experienced author "gasp for breath"; albeit, they contain much of the best work of such brilliant artists as Neale and Keulemans.

"Any marshman can point out the glaring errors of the meretricious and false woodcuts illustrating Yarrell and Saunders." As a matter of fact, Mr. Saunders' "Manual of British Birds" is embellished with some beautiful little woodcuts by a no less talented draughtsman than Mr. G. E. Lodge, whose cuts of the barred warbler and goshawk were directly based on living birds. A little further on, Mr. Emerson exposes the superficiality of "the Son of the Marshes," "whose writings possess but little artistic charm" (*sic*). Nor is he content with informing us that Mr. Saunders' manual is 'cataloguy' [whatever that may mean], and "far from lucid." He soon finds fault with the writings of those who have, alas! joined the majority, and can no longer splinter a lance in self-defence. Poor Richard Jefferies "did not know summer from spring," and his natural history notes have been discovered by our new prophet to be "inaccurate." We admit that Jefferies had no more claim than Mr. Emerson himself to be considered a scientific naturalist; but Mr. Stevenson belonged to the first rank of British ornithologists. We are gravely informed that Mr. Stevenson "did not know intimately the outdoor life of the birds he wrote about from personal observation!" It was reserved for Mr. Emerson to expose the "inartistic nature" of the accomplished man whom all his contemporaries delighted to honour; he has also detected the worthlessness of Mr. Stevenson's "pseudo-poetical vein." The truth seems to be that Mr. Emerson is an accomplished egotist, and will have us measure all other naturalists by his own high standard of merit. Nor must we forget to inform the readers of this notice, that though Mr. Emerson bases his text professedly on his personal observations alone, in sober truth most of the more noteworthy accounts of Norfolk birds were supplied to him by humble marshmen, whose valuable experiences are a marked feature of this book. Having thus drawn attention to the points upon which Mr. Emerson has gone out of the way to court unfavourable criticism, we have much pleasure in commending the dainty essays on feathers, fur, and scales, which make up our author's zoological treatise. If Mr. Emerson could be persuaded to leave alone the beam which he thinks he sees in his neighbour's eye, and to polish up his prose a little more—for it is not always either lucid or grammatical—we feel sure that his poetic fancies would find a large number of admirers. Mr. Emerson knows how to observe the wild creatures of the fens, and his criticisms are generally based upon reflection. For example, his remarks upon the habits of the rook (*Corvus frugilegus*), though they may contain no new facts, yet state the facts already familiar to practical men with praiseworthy accuracy. And the more we read, the more favourably we are impressed. Whether Mr. Emerson thinks fit to discourse upon pheasants or rats or eels, his freshness and vivacity are equally reliable, and cannot fail to afford great enjoyment to him who reads. It is true that these pages lack much of novelty. Mr. Emerson has seen the Great Reed Warbler in Norfolk. He even asserts that he has seen the Desert Wheatear, though as to that we must beg to register a verdict of "not proven," for we do not understand that Mr. Emerson has studied ornithology across the seas; rare wheatears are not to be identified at a glance even by experts, certainly not by amateurs. Some of his essays are rather meagre; that, for example, in which he informs us that "the goldfinch, or 'draw-water,' is not a bird of graceful build nor sweet song, yet is he dear to the Philistine, who loves variegated colours, because he satisfies a rude barbaric taste for colour; for he is a 'gay bird,' and he is great at parlour tricks, like his lover; for cannot he draw his water and seed to his cage by a simple mechanical contrivance? and so he delights the populace as do the performing elephant and the contortionist." This is poor stuff, and unattractive. But such passages are the exception. The account of the author's *rencontre* with an osprey, given at p. 192, is perfectly delightful, and may be read with pleasure many times. Here, too, is a pretty little idyll of the ringed plover. "In April, as you walk by the sea, bordered by the shifting sand dunes, fringed with marram, fortalices that protect the flat land from the sea, you will come across these birds feeding in the pools left by the tide on the shifting shore; and if you leave the beach and wander over to wind-sculptured galleries, decorated with dry marram roots, you may in some cosy hollow, where the gravel lies thick upon thorn bushes, come upon the ringed plover's eggs, placed on the finer stones. There are generally three of these eggs [this is not our experience], and they are difficult to see, even when pointed out to you by more experienced eyes; but nowhere are they common in this district. You will always, too, find a bit of seaweed near the eggs. Later in the year, too, when the marsh-mowers' voices sound over the sand-hills, you may find the stone runner's eggs, for they rear two broods in a season. As the sun gains power, and the bright hot days of July beat down upon the gleaming sand-hills, you will, as you wander by the marram-fringed sea, come across little flocks of these pretty birds flying from pool to pool feeding, calling as they rise and fly down the beach before you, alighting fanwise on the yellow sands. That is the time to shoot them, for they make a capital dish, and taste nearly as sweet as a snipe (p. 268)." Before we take leave of our author, mention must be made of the numerous illustrations which have been so happily devised to secure the popularity of this dainty book. Personally, we must confess to a preference for the tiny vignettes of birds' nests, many of them based on photographs taken *in situ*; they have been selected judiciously, and are fairly distinct in detail. The full-page plates are less satisfactory, being based apparently on photographs of *stuffed* birds; but with the exception of the sand grouse (a bird which our author has never seen in life, and had better by far have omitted from his text), they are certain to be received with favour. H. A. Macpherson.

Plankton Studies on Lake Mendota.

The Vertical Distribution of the Pelagic Crustacea during July, 1894. E. A. Birge, Professor of Zoology, University of Wisconsin, assisted by O. A. Olson and H. P. Harder. From the *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters*, vol. x. Issued June, 1895.

This is an elaborate report on a laborious experiment. Lake Mendota, in Wisconsin, has an extent of about six miles by four, with a greatest depth of about eighty feet. Of the crustacea captured during July, nearly two-thirds consisted of *Diaptomus oregonensis*, Lilljeborg. Three species of *Cyclops* supplied nearly one-third, and the balance was made up by two species of *Daphnia* (curiously distinct in vertical distribution) and one or two other entomostraca. Nearly 50 per cent. of the whole number were taken in the first ten feet from the surface, 30 per cent. in the second ten, and over 15 per cent. in the third, leaving a scattered few for the remaining depths. In October, however, "as soon as the temperature of the lake became uniform from top to bottom, the crustacea became pretty uniformly distributed, showing an arrangement wholly different from that of the summer months." The predominant crustacea also varies with the time of year.

In Bohemia, at Lake Balaton, which is about thirty-six feet deep, "Francé found that the Plankton animals come by night to the surface, begin to descend at dawn to the deeper regions, remain there until early in the afternoon, when they begin to re-ascend, suddenly appear at the surface shortly after sunset, and there remain overnight." "His view is that the animals seek the cooler waters." But at Lake Mendota "there is practically no diurnal movement of the crustacea, or, if any, it is downward by night and upward by day," and Dr. Otto Zacharias is quoted as announcing, from observations made in the middle of September at Plön in Holstein, that the plankton of that lake shows no diurnal movement.

Other statements may be adduced which show that the subject is not a little complicated. Thus, de Guèrne and Richard, writing in 1889 on the freshwater Calanidæ, say, "it is certain that various types, *Diaptomus graciloides*, for example, are met with at the surface as well by day as by night; others, such as *Heterocope saliens*, have been found much more abundant by night than by day; but these are only isolated cases, to be explained, perhaps, by special circumstances (the search for food, etc.)." They note that *Limnocalanus macrurus* lives generally in the cold waters of the bottom of the great lakes, yet that specimens have been taken out in the daytime at the surface in the Gulf of Bothnia. Giesbrecht finds that in the Gulf of Naples the Copepoda are abundant at the surface in winter and scarce in summer, most of them at the latter season descending into deep water, though a few species swarm at the top. He is inclined to suppose that the diurnal migrations of pelagic animals take place under the influence of light, the annual under the influence of temperature.

To the report on Lake Mendota, ample as it is, some additions would still be of advantage. The temperature of the water in July is given only for the surface, and not for the lower levels. The ingenious dredge employed could only be used vertically. It is probable, therefore, that the actual floor of the lake was not explored, as that could scarcely be effected except by horizontal dredging. The observers do not appear to have noted whether the specimens, from whatever level they came, were, as a rule, captured alive. Nothing is said of the enemies to which the various crustacea are exposed at each or every season in this particular lake. In various waters the conditions of safety, comfort, and food-supply must be so diversely combined for the several species that the habits of many are likely to vary more or less according to the place of abode, as well as according to the time of year. For determining such questions numerous observations are needed, and it must be allowed that Professor Birge and his friends have made a highly useful contribution towards the required series. T. R. R. Stebbing.

British Moths.

The Lepidoptera of the British Islands. By Charles G. Barrett, F.E.S. Vol. ii. (4 parts). Heterocera, Sphinges, Bombyces. 8vo. Pp. 372. London: L. Reeve & Co., 1895. Large paper edition with coloured plates (41-86). Price each part, 3s. plain, 5s. coloured.

Just two years have passed since the first volume of Mr. Barrett's work, dealing with the British butterflies, was noticed in our pages. The present volume contains the first instalment of the moths. A hundred and eighty species are dealt with in the two volumes, so it is evident that the rate of publication must be considerably accelerated if the two thousand or so British Lepidoptera are to be described within a reasonable time.

The families of moths included in this volume are the Sphingidæ, Sesiidæ, Zygænidæ, Zeuzeridæ, Hepialidæ, Cochliopodidæ, Chloephoridæ (Nycteolidæ), Nolidæ, Lithosiidæ, Arctiidæ, Liparidæ, and Psychidæ. According to the time-honoured arrangement of our British lists, the first three are united as "Sphinges," and the rest are called "Bombyces," though some other families usually included under the latter term—the Lasiocampidæ, Endromidæ, Saturniidæ, etc., are not comprised in this volume. We believe that they will be dealt with in the next. It is high time, however, that these misleading group-terms, Sphinges and Bombyces, were dropped from zoological literature. The three families included under the first name have nothing in common except their tapering antennæ, and, as Mr. Hampson has recently shown, the Sphingidæ on the one hand, and the Sesiidæ and Zygænidæ on the other, should stand almost at opposite ends in a series of Lepidoptera approaching a natural ideal. The "Bombyces" are a still more heterogeneous group, and Mr. Barrett, though he considers the term "very convenient," is unable to furnish a single definite character by which a moth referable to it may be recognised. A concurrence of imaginal and pupal structure points out the first three and the last of the "Bombycine" families, as given here, to be much nearer to the so-called "Microlepidoptera" than to the other "Bombyces." On several pages of the volume Mr. Barrett, indeed, mentions Dr. Chapman's recent comparisons of lepidopterous pupæ as throwing light on the true relationship between the families, but he remarks that to deal at length with the subject "would occupy far too much space in a work such as the present." We cannot by any means agree with this opinion. In such a book, which will be, when completed, a standard for reference by the vast company of British naturalists who collect butterflies and moths, it seems most desirable that the classification should be arranged on the most correctly scientific lines with which recent research has furnished us. Space devoted to the consideration of the true affinities of the insects collected would surely be of value to the collector, and might lead him to use part of his material in some worthy morphological inquiry. The peculiar habit of many lepidopterists of speaking of their favourite insects by the specific name only—"*convolvuli*," "*caia*," etc.—betrays an exclusive attention to species to the neglect of the more comprehensive divisions, which is responsible for the antiquated sequence with which these naturalists have been so long contented, and which, we regret to think, Mr. Barrett's book will still perpetuate.

There are no synoptic tables of families, genera, or (except in a very few cases) of species; the lack of these will seriously detract from the value of the book for the elementary student, especially in the edition without plates. A novice wishing to make out a moth new to him, would have to read through the descriptions of all the families, then those of all the genera of a family, and, lastly, those of all the species of a genus, a task which it would require no small patience to bring to a successful issue. The advanced worker, on the other hand, will not need Mr. Barrett's detailed descriptions of the species. Careful and accurate as these are, we would gladly have exchanged them for some remarks on modern classification and a reliable set of synopses.

In addition to the detailed descriptions of the moths, just referred to, Mr. Barrett gives much valuable information on the variation which each species exhibits. Some very beautiful and striking forms are described and figured, and we are grateful to Mr. Barrett for not having thought it necessary to give to each a special name. As in the first volume, the facts of variation alone are noticed, theories as to the cause thereof being severely left alone. The preparatory stages of each insect are also carefully described, while the habits of caterpillar and moth are fully set forth with the detail to be expected from so experienced a collector and observer as our author. The British localities for each species appear to have been compiled with much care, and the difficulty of making such information reliable is rendered very great by the vast number of records which are scattered through our entomological magazines, and the untrustworthy nature of a not inconsiderable minority of them. Mr. Barrett seems to have well sifted doubtful captures, and his long experience of moths and those who catch and sell them renders his opinion on such subjects of much value. The pages of his book will furnish a storehouse of facts for students of the range of species within the British Islands, and we are very glad to notice that the insular distribution is supplemented by a summary of the general distribution of each insect. It is sad to read of the restriction of range or total extinction undergone by some rare species, it is to be feared from the greed of collectors. *Lælia cœnosa* has apparently disappeared from our fauna, and *Ocneria dispar* has only been preserved in a domesticated condition by rearing the larva through many generations. Some solace for these losses is afforded by the recent immigration of *Callimorpha hera* into Devonshire, where this beautiful moth has apparently established itself without artificial help.

With regard to specific names, Mr. Barrett gives, in equally conspicuous type, both those of the Doubleday list, so familiar to the older British lepidopterists, and those of the Staudinger Catalogue, used in Mr. South's later list. As the Doubleday name in each instance stands first, we presume that is preferred by the author. In the introduction (in vol. i.) Mr. Barrett deliberately declines to settle the competing claims of the various names in use. We rather regret this, as any objection he might have to the generally accepted names of the Staudinger Catalogue would be undoubtedly worth consideration, while if there be no valid objection to them, it is very undesirable to perpetuate differences of specific nomenclature between British and Continental naturalists. In generic nomenclature, uniformity is of course impossible, unless the value of generic divisions can be agreed upon. We would only point out that the name *Liparis*, which has so long been familiar as the type genus of the "Tussocks," properly belongs to a fish. In Mr. Kirby's recent "Catalogue" it is replaced by *Lymantria*, and the family name should, of course, be changed too.

The coloured plates which accompany the large paper edition are good. Presumably on account of the issue of the work in the two forms, there is no reference whatever to them in the text, an omission which certainly diminishes their usefulness. Nor does even an advertisement in the plain edition (which alone we have received for review) give any hint of their existence. But for our power of access to a library where the larger edition has been taken in, we should have been debarred from the pleasure of mentioning them.

While, therefore, the method in which the larger aspects of the subject are dealt with by Mr. Barrett leaves much to be desired, his work must prove a most valuable book of reference for all interested in the problems of migration, distribution, variation, and habits presented by the best known group in our insect fauna. The labour involved in such an undertaking as this is immense. We heartily congratulate the author on the progress which he has made, and hope we may see the succeeding volumes appear at less distant intervals than that which has elapsed since we had the pleasure of noticing the first.

Outlines of Zoology.

Outlines of Zoology. By J. Arthur Thomson, M.A., F.R.S.E. Second Edition revised and enlarged with 266 illustrations. Pp. 820. Edinburgh and London: Young J. Pentland, 1895.

The second edition of Mr. Thomson's text-book from the outset impresses itself on one more favourably than the first. For the illustrations have been greatly improved; many new drawings have been added and they appear in the text in their appropriate places. Some of them are still inadequate. Thus, in the transverse section of the earthworm, the cœlomic epithelium is omitted; the mass of chloragogenous cells in which the dorsal blood-vessel is embedded is exhibited as a mysterious, unnamed structure, different in appearance from the similar cells surrounding the intestine; the nephridia are omitted entirely and they are not figured elsewhere. Again, in the drawing of the reproductive organs of the same animal (after Hering) the ovaries are incorrectly represented. In the figures of the urino-genital organs of the frog, the male represented is *Rana esculenta* and does not show the characteristic seminal vesicles which the student is bound to see in the *Rana temporaria* he is more likely to dissect; in the female, the ovaries are quite incorrectly represented; the characteristic plicated appearance of these, when they are not entirely obscured by a mass of discharged ova, is not shown. In the diagrams of the similar organs of the rabbit the uterus masculinus is not visible in the case of the male, while, in the female, the relations of the bladder to the uterus are quite inadequately represented. We have pointed out such slips perhaps more carefully than their intrinsic importance warrants; but they all relate to animals that a student is certain to dissect. And nothing is more harassing to a good student or more apt to harden the heart of a careless, than to find his dissections incongruous with the figures of his text-book.

For the rest we think Mr. Thomson's text-book one of great merit. It is weak in palæontology; but as practical palæontology hardly comes the way of the student, this matters less than in many books of wider aim. It is unusually and strikingly excellent in that it deals with the animals as living things as well as materials for the scalpel. To each section there are appended notes on what Professor Lankester has called bionomics, and many students, whom the details of anatomy would repel, may find that there are "observables" (to use the phrase of Robert Boyle) concerning animals as interesting, and, from the point of view of abstract knowledge as important, as laboratory work.

From one point of view, however, we have something to say against the book. To a certain extent it is based upon the Scotch courses of natural history. These, in the brave days of old, before modern science had been developed into its present encyclopædic character, were designed to impart to the perfervid talent of Scotch youth a complete account of the natural world. They used to begin with cosmogonies and end with the marvels of design as exemplified in the structure of the human frame. Into this old bottle is poured the new and full-bodied wine of modern biology. Consider Mr. Thomson's 820 pages, which will be absorbed, index and all, by many a gallant young Scot. Are you interested in karyokinesis and polar bodies? You will find an account of them here. Do problems of heredity absorb you? Here is Mr. Thomson with a table telling you what is to be inherited and what not; with an excursus upon germ-tracks and the early separation of sexual cells. Perhaps the origin of sex itself troubles your waking hours? Mr. Thomson presents you with a pemmican of himself and Professor Geddes. You are a student of variation? Mr. Thomson has a table for you. Or an organic chemist? Read Mr. Thomson upon Lipochrome and Zoonerythrin. Or, excited by the "Challenger" number of Natural Science, you would know about Plankton and Nekton? Mr. Thomson has discussions and diagrams, admirable and up-to-date. Or is it the grander problems of evolution? Consult the last chapter and bend over the many-twigged tree on page 2. Would you know about physiology? Here is one whole chapter and a half chapter on that neglected subject, Comparative Physiology. Are you a pathologist? Mr. Thomson is ready for you with half a chapter. And the whole book deals with comparative anatomy and embryology, not omitting the relations of *Rhabdopleura* and *Cephalodiscus*, the relation of ganoids to teleosteans, the morphology of the auditory ossicles, the pedigree of cœlenterata, the nephridia of amphioxus, the larval twisting of the same animal, the pineal eye and the homologies of the cranial nerves.

Frankly, the thing is impossible. It would take not 820 pages but 820 volumes to deal with the mass of subject-matter represented in Mr. Thomson's book. It could have been written only by one of great knowledge and greater diligence: by one who has consulted the works of John Hunter and the latest issue of the *Jahresbericht*. But we would willingly take it for granted that Mr. Thomson knows more than any Scotch professor, or, for the matter of that, than any English, German, French, or Dutch professor, and we would have from his charming and luminous pen a volume of which the contents were more congruous with the bulk. P. C. M.

African Diseases.

On the Geographical Distribution of Tropical Diseases in Africa. By R. W. Felkin. 8vo. Pp. 79, with folding table and map. Edinburgh: W. F. Clay. 1895. Price 3s. 6d. nett.

African diseases are now acquiring a somewhat extensive literature, which is, unfortunately, often as irritating as the diseases themselves. From Dr. Felkin we had expected something much better than the average, for he is a lecturer on tropical diseases at the Medical School of Edinburgh, and has had great experience and done most useful work in Equatorial Africa. There is, of course, no comparison between his book and such a production as Père Etterlé's "Les Maladies de l'Afrique Tropicale"; but still many unfortunate errors occur in it. Thus we are told that "the rainfall at the equator is pretty evenly distributed throughout the year," which is certainly not the case except locally; then the author informs us that the vegetation becomes generally richer, proceeding from west to east, which is, perhaps, a misprint for *vice versâ*. On p. 63 the Leprosy Commission is reported to have concluded that leprosy is neither contagious nor hereditary. On p. 78 the Cape is said to be free from malaria, and is so coloured on the map; whereas malaria of a very bad type is prevalent in some places, as at the back of Port Elizabeth.

Then it comes rather as a shock to read of an "*isobar* of 58°–60° F." (p. 70). The book is, moreover, not always up-to-date: thus the statement on p. 62, that the cause of elephantiasis is unknown, overlooks the work of Dr. Manson; while the conclusion on p. 34 that bilious remittent fever, blackwater fever, hæmaturia, endemic and typhomalarial fever are all "simply malarial fever distinguished by some prominent symptom," seems to us to be contrary to the latent evidence on the subject. In other cases the author's conclusions seem a little too previous. Thus on his map he leaves two blanks to the north-east of the Victoria Nyanza, thus indicating that they are free from malaria. Only one European expedition has been to one of these, and Count Teleki, its leader, nearly died of fever there. The other and larger oasis has been practically unvisited. A few men have crossed its southern margin and found that fever is exceptionally severe there. On p. 78 it is explained that malaria is reported to be absent from these areas "because the altitude—over 3,000 feet—is too great for its production." The author adds that this is a general statement, and that local conditions may modify it, but the results of recent investigations in German East Africa oppose it; and as the author colours as malarial nearly all the districts in Africa over 5,000 feet high, we do not quite understand how to reconcile his statement and his map.

The best part of the book is that between pages 51 and 75, in which short sketches are given of the principal diseases and the remedies recommended. The map is constructed on a new design, but as it is on too small a scale to show local conditions, its value is doubtful. Its topographical information is, moreover, not above suspicion, as when it runs a river from the southern end of the Albert to the Victoria Nyanza, and places Kavali on Tanganyika, instead of on the Albert Nyanza.

Botany for Teachers.

Object Lessons in Botany from Forest, Field, Wayside and Garden. Being a Teacher's aid to a systematic course of one hundred lessons for boys and girls. By Edward Snelgrove, B.A. Pp. 297, with 153 figures in the text. London: Jarrold & Sons (no date. Received June, 1895). Price 3s. 6d.

Mr. Snelgrove begins his book with a quotation from Natural Science, in which a reviewer insists that the most successful book for education or instruction will be that which "leads its readers along the same paths as the discoverers of the science must have followed." Facts must, as it were, be rediscovered, steps *made*, conclusions *drawn*, and definitions *led up to*. These ideals, says the author, have been before him in planning the object lessons. We congratulate him on their successful realisation. There is no dearth of elementary botanical books, but a really good one is a rarity. If the arrangement is satisfactory the text is often full of errors, or *vice versâ*. In the case before us, however, the writer has been careful as to facts, and there is no fault to be found with their arrangement. Plenty of fresh specimens of leaves, flowers, or fruits are given to the children, and they are led to make out for themselves, step by step, the points of interest. If the teacher carefully leads his little students according to the directions given he will ensure for them a very fair grounding in the first elements of botany, and also instil in them a love of plants and a longing to find out more and more about them. The book is divided into four sections. The first, on leaves, stems, and roots, is adapted for Standard III.; the second, on flowers, for Standard IV.;

and the third and fourth, on fruits and seeds and classification respectively, for the still more advanced Standard V.

The figures will be found useful as copies for blackboard elucidation of various structural points.

THE DISTRIBUTION OF PLANTS.

MANUEL DE GÉOGRAPHIE BOTANIQUE. Par le Dr. Oscar Drude traduit par Georges Poirault et revu et augmenté par l'auteur. Livraisons 4–5. Pp. 129–224. Paris: Klincksieck.

THE date 1893 on the cover of the issue refers to the year in which the first part of this work appeared. It is a matter for regret that the succeeding parts, which were promised in rapid succession, should be so long delayed, as at the present rate the earlier pages will be antiquated ere livraison 12 or 13 reaches us. The work is a valuable one, and much needed, and it is to the interests of both translator and publisher to hasten its completion.

The 96 pages now in question are occupied with the completion of Part II. on plant areas, the whole of Part III. on the distribution of the chief plant groups in the various floral regions, with a note on distributional maps (pp. 140-197), and the commencement of Part IV. on the association of plant forms to give a botanical facies.

THE INDEX TO PERIODICALS.

INDEX TO THE PERIODICALS OF 1894. By Miss E. Hetherington. Vol. v. 4to. Pp. x., 182. London: *Review of Reviews* Office, 1895. Printed by Mackay, Chatham. Price 5s. nett.

WE have nothing but praise for this new volume. In the first place, because it is as good as the last, and in the second, because it is much better, and shows the steady improvement that finally ends in perfection. Now we possess our yearly index it is somewhat singular that we managed to do so long without it. It is pleasing to gather from Mr. Stead's opening sentence that the work is not a failure from the public point of view; but the sale needs to be very large to repay the outlay.

It is well to insist at once that this is not a mere reprint of the monthly lists issued with the *Review of Reviews*, nor is it in any way compiled from those lists, but is an entirely separate publication, separately compiled under Miss Hetherington's direction. This year new journals are included, and practically everything that is of any use to anybody is catalogued. The value of such a list as this is extraordinary. The public can find by a mere reference the latest views on the most diverse subjects, as, for instance, geology (160 entries), Egyptology, marriage, lunacy, scorpions, wills, savings banks, bacteriology, and bagpipes. A rigid line is drawn at newspapers, and one not quite so rigid at publications of learned societies. These two sections are, however, so perfectly distinct from periodicals that the rejection is a wise one. The guide to the periodical literature of the world, which appeared in vol. iv., has been omitted, as it would have been a pity to occupy space with a mere reprint, and the headings have been printed in black type, a great improvement on previous issues. No library can possibly afford to do without this patiently and industriously compiled volume, and the individual who has once bought a copy will purchase all the rest. To compile such a list of literature and issue it only six months after date is a feat of which anyone might be proud, and we congratulate Miss Hetherington on her judgment and success.

OBITUARY.

CHARLES CARDALE BABINGTON.

THE late Cambridge Professor of Botany was born November 23, 1808, at Ludlow, becoming in due course a student at St. John's College, Cambridge, and in 1861 succeeding Professor Henslow in the chair of botany at the University. Though he retained this professorship till his death, on July 22, it is many years since he took any active part in the work of the botanical school, which was, however, raised to a high standard of efficiency by Dr. Vines' efforts, and now flourishes under the direction of the deputy-professor, Mr. F. Darwin. Babington's chief work was on our native flora and its relations, and found its expression in his "Manual of British Botany," the first edition of which appeared in 1843, and the eighth in 1881. For the discrimination of plants, especially of the more critical species, it is unequalled. In connection with his work on the British Flora he devoted much time and care to the elucidation of the Brambles, his "British Rubi," an octavo of more than 300 pages, appearing in 1869. To him we also owe a useful "Flora of Cambridgeshire," published in 1860. In 1846 he visited Iceland, and on his return communicated a list of the plants gathered to the *Transactions of the Edinburgh Botanical Society* (vol. iii.); in 1871 his revision of the flora of the island appeared in the *Journal of the Linnean Society*; localities are given for 467 species of flowering plants and ferns. He also published a large number of separate papers on the botany of Great Britain with Ireland and the Channel Islands, which will be found in the publications of the Linnean Society, the *Journal of Botany*, the *Annals and Magazine of Natural History*, the Edinburgh Botanical Society's *Transactions*, Henfrey's *Botanical Gazette*, and elsewhere. Their number in the Royal Society's Catalogue reaches 131. The "law of priority in nomenclature" even provoked a letter from him to the *Journal of Botany* (1864, p. 94). British insects formed another subject of interest to Babington, and several papers on them will be found in the Entomological Society's *Transactions* and other journals devoted to this branch.

It is evident that the professor's life had been a busy one; his energies, moreover, were not used up by scientific work, for he was well-known in the neighbourhood of Cambridge in connection with philanthropic undertakings. He died on July 22nd.

JOSEPH THOMSON.

Born February 2, 1858. Died August 2, 1895.

THE death of Joseph Thomson adds another name to the list of those who have perished in the exploration of Africa. He was born near Dumfries, studied at Edinburgh University, and at the age of twenty-one years accompanied Keith Johnston's expedition to the Great Lakes. This expedition he successfully carried through, despite the fact that the leader died soon after leaving the coast. His second expedition was one in search of coal, in 1881, to the Rovuma Valley, and his third and most important was the exploration of Masailand, a district inhabited by natives of a particularly dangerous character. But Thomson's tact and patience carried the day, and he was able, by advance and retreat, eventually to reach Barengo Lake, though he had to relinquish a projected visit to Mt. Kenya. In 1885 he entered the Royal Niger Company's service, and concluded various treaties in the Central Soudan, while in 1891 the South Africa Company enlisted his services for an exploration of the Nyasa and Bangweolo region. But his health gave way, and the disease to which he ultimately succumbed was contracted during this period. Mr. Thomson's best known books are "Through Masai Land" (1885); "To the Central African Lakes and Back" (1881); and a "Life of Mungo Park" (1890).

DANIEL CADY EATON.

PROFESSOR EATON died at New Haven, U.S.A., on June 29, in the sixty-first year of his age. For more than thirty years he had held the chair of botany in Yale College, where he previously graduated in 1857. After leaving college he had the advantage of three years' study under Dr. Gray at Harvard. He was the recognised authority in the United States on ferns and fern allies, and supplied the account of these groups for Chapman's "Flora of the Southern United States," Gray's "Manual of Botany" (fifth edition), and Gray's "Botany of Field, Forest, and Garden." His most important work was that on the "Ferns, which appeared in 1879-80, including the Ophioglossaceæ of the United States of America and British North American Possessions," illustrated with coloured plates. He was also the author of numerous other papers, many of which relate to his special group. Professor Eaton inherited a taste for botany, his grandfather, Professor Amos Eaton, being one of the leading systematic botanists of his day, while his father, General Amos B. Eaton, was also given to scientific research.

For several of the facts mentioned in this notice we are indebted to *Garden and Forest*, of which the issue for July 10 gives an appreciative account of Professor Eaton's work and character.

JOSEPH GRANVILLE NORWOOD.

Born December 20, 1807. Died May 6, 1895.

ONE of the last of the older American school of geologists and palæontologists has passed away in the person of Mr. J. G. Norwood. He was born in Woodford County, Kentucky, educated in local schools, and entered a printing office, shortly after publishing a newspaper, a medical journal, and other matters. About 1832 he left business for the pursuit of medicine, and quickly gaining his diploma, secured a large general practice by the end of 1835. His medical career continued till 1847, when he was urged to enter the U.S. Geological Survey. From 1847–1851 he was assistant geologist with David Dale Owen on the survey of Wisconsin, Iowa, and Minnesota; from 1851–1858, State Geologist of Illinois; while from 1858–1860, assistant geologist of Missouri. From 1860–1880 he was Professor in the University of the State of Missouri, holding the chairs of Geology and Chemistry, and in 1871 he held the office of State Geologist of Missouri for a few months, till a person was definitely appointed.

His chief works are "Researches among the Protozoic and Carboniferous Rocks of Central Kentucky," which he published in conjunction with D. D. Owen in 1847; "Geological Report of a Survey of a Portion of Wisconsin and Minnesota," and two "Reports of Progress" while State Geologist of Illinois. Dr. Norwood died at Columbia, Missouri, and we are indebted to an article, with a portrait, in the *American Geologist* for the above particulars of his life.

FREDERICK KITTON.

Born 1826. Died July 22, 1895.

ALL students of Diatomaceæ will learn with regret of the death of Mr. Kitton, who was, we believe, born at Cambridge. He settled in Norwich about forty years ago as a retail trader, but his shop became a rendezvous for men of scientific interests, similar to that of John Morris and the London Clay Club. Kitton worked hard at his favourite subject, and made numerous discoveries, many of which were named after him. He was a frequent contributor to the *Microscopical Journal* and the *Quarterly Journal of Microscopical Science*, and his more recent labour is well-known to our readers as a "Challenger" Report, which he produced in company with Count Castracane. Apart from his science, Kitton had acquired a mastery over Anglo-Saxon, and in 1883 he prepared a catalogue of the Library of the City of Norwich. His eldest son, Mr. F. G. Kitton, is known as the successful authority on the life and portraits of Charles Dickens.

GUSTAV VON NORDENSKIÖLD.

IT is with great regret that we record the death of Gustav von Nordenskiöld, which occurred at Stockholm on June 26 last from consumption, at the early age of twenty-seven. He was an explorer and observer of considerable merit, as may be gathered from his magnificent work on the cliff-dwellers of Mexico, his exploration of Spitzbergen, and his investigation of the minute structure of snow crystals, which was beautifully illustrated by photographs taken by himself. Unfortunately, his early death deprives the Swedes of an intrepid leader in their projected Antarctic expedition.

The terribly sudden death of Mr. Francis E. Brown, the energetic and accomplished clerk to the Geological Society of London, has robbed that Society of a man whose tact and resourcefulness had often proved valuable. Mr. Brown died on August 2, at Shepherd's Bush, from the breaking of a blood-vessel. His good nature and courtesy had endeared him to the fellows, many of whom feel that they have lost a personal friend.

Among other deaths which it is our misfortune to chronicle, are those of Julien Deby, the eminent diatomist, whose collections were recently acquired by the British Museum; Professor P. A. S. Verneuil, the surgeon, who died at Paris on July 12, aged 71; Dr. George Marx, archæologist and entomologist to the U.S. Department of Agriculture, whose death occurred at Washington on January 3; H. Witmeur, Professor of Geology and Mineralogy in the Brussels University; Sir John Tomes, the dental physiologist and surgeon, who passed away at Caterham on July 29, aged 80. Dr. Hermann Knoblauch, the distinguished head of the K. Leopoldinisch-Carolinische Academie of Halle, died on June 30, aged 76; Isaac Sprague, the botanist, at Wellesley Hills, Mass., on March 15 last; Professor Pellegrino Strobel, the geologist and conchologist of Parma, on June 9; C. E. Adolf Gerstaecker, Professor of Zoology in Greifswald University, on July 20; Dr. W. Voss, the mycologist, recently at Vienna; Dr. R. Peck, Director of the Natural History Museum at Görlitz; Dr. Norton S. Townshend, Professor of Agriculture in the Ohio University, at the age of 79; and Ernst Henri Baillon, the eminent botanist, an obituary notice of whom we shall endeavour to print next month.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments have recently been made: G. S. Corstorphine, as assistant in charge of fossils and minerals in the S. African Museum. He has begun by reporting on the meagre state of the collections and their want of arrangement. Dr. Carl Barus as Hazard Professor of Physics in Brown University; J. H. Tyrrell, to be Professor of Geology and Mineralogy in Toronto University; H. F. Bain, as Assistant State Geologist to the Iowa Geological Survey, succeeding Dr. Keyes, who becomes State Geologist of Missouri; C. P. Sigerfoos, as assistant in charge of the Marine Laboratory of the Johns Hopkins University, to be stationed at Beaufort, N.C., during the summer of 1895; Messrs. A. L. Lamb and H. L. Clark, to occupy the Johns Hopkins table in the U.S. Fish Commission Laboratory at Woods' Holl during the present summer; Dr. Beyschlag and Dr. Th. Ebert, to the Berlin Geological Survey; Dr. Reinitzer, of Prague, as Professor of Botany at Graz University; Dr. Robert Scheibe and Dr. Fritz Köller, as Professors in the Bergakademie of Berlin; Dr. Rex and Dr. Steinbach, as assistant Professors of Anatomy and Physiology in Prague University; Dr. A. Rolossov, as Professor of Histology and Embryology in Warsaw University; Dr. Franklin Dexter, as assistant Professor of Anatomy at Harvard Medical School; Dr. Alfred Schaper, of Zürich, as Demonstrator of Histology and Embryology at the same place. Dr. J. Buchwald, of Berlin, has been placed in charge of the Botanico-Agricultural Station founded at Usambara in German East Africa; Professor Church and Dr. Fream have been appointed Honorary Professors at the Royal Agricultural College of Cirencester; and Dr. H. Lenk, Professor of Geology at Leipzig University.

THE *South African Review* states that Roland Trimen has resigned his position as Curator of the South African Museum, and is returning to England.

PROFESSOR J. W. JUDD has received the honour of C.B., and has been appointed by the Lord President of the Council to succeed the late Professor Huxley as Dean of the Royal College of Science.

DR. RUDOLF S. BERGH, the eminent Danish zoologist, has been elected corresponding member of the French Academy of Sciences, in the room of the late Professor Huxley; Professor Sir William Flower, a correspondent in the Section of Anatomy and Zoology, in the place of M. van Beneden; Professor Ferdinand Cohn, a correspondent in Botany, to the chair vacated by the death of the Marquis de Saporta; and Professor G. Retzius as a correspondent in Anatomy and Zoology, in the room of Carl Vogt, deceased.

IT is proposed to celebrate in December next the fiftieth anniversary of the doctorate of Dr. Rudolph Leuckart. A bust of the eminent zoologist is suggested, and Dr. Carl Graubner, 8, Johannesgasse, Leipzig, is empowered to receive the names of those who desire to honour the Professor. Professor Sir Joseph Lister is to be similarly honoured, as a number of his colleagues intend to offer a portrait of the great surgeon to the Royal College of Surgeons, to be placed side by side with that of John Hunter and other benefactors of the human race.

The men of science who have entered the lists as candidates for Parliament in the recent elections have not on the whole been especially successful. Sir John Lubbock returns to represent his old constituency of the University of London, though after an unfortunate wrangle with some of the supporters of the Gresham Scheme, who, perhaps, have not sufficiently allowed for the fact that an election address is an election address. Sir John Colomb will be welcomed back, thanks to Yarmouth, and Sir Henry Howorth has retained his seat.

The losses, however, have been serious. Chief among these is that of Sir Henry Roscoe. Geographers will regret the failure of Major Darwin to hold the seat he rather unexpectedly won in 1892; they will, however, be glad of the success of Mr. Stanley. African problems seem destined to come much to the front during the next few years, and so much ignorance of the subject was shown in last session's debates that Mr. Stanley ought to prove one of the most useful of the new members. Sir E. J. Reed's defeat at Cardiff is a serious loss to the interests of mechanical science, which has lost another representative in the defeat of Mr. Moulton.

The Institute of France will celebrate its centenary in October. The occasion will be marked by a series of fêtes and receptions, followed by a banquet on October 25; the Comédie Française will give a special performance, and the President of the French a special reception. A visit to Chantilly will conclude the observances.

The Senate of the Smithsonian Institution has voted the Hodgkins prize of 10,000 dollars, in equal proportions, to Lord Rayleigh and Professor Ramsay, in recognition of their discovery of argon. One thousand dollars has also been voted by the same body to H. de Varigny, of Paris, for the best popular essay on the properties of the atmosphere.

The attendance at the British Museum (Natural History) during 1894 numbered 413,572, showing an excess of over 5,000 on the previous year. This gives a daily average of about 1,300. We learn that the construction of a special gallery for Cetacea is now in progress, the foundations having already been laid down.

The Royal Society will continue to issue its *Philosophical Transactions* in the present quarto form, but they have resolved to alter the size of the *Proceedings* to that of royal octavo, a change to be made at some early convenient time.

The State of New York has set aside 16,000 dollars to be spent, under the direction of Professor L. H. Bailey, of Cornell University, in experiments in horticulture, the remedy of plant-diseases, and similar objects. The work, which should yield results of value to the botanist as well as to the cultivator, is to be confined to the fruit-growing region of western New York, north and west of Lake Cayuga.

According to the report read on August 10 before the annual meeting of the Royal Botanic Society, the opening of the grounds, even to a paying public, has its disadvantages. The admission of the public to a gardens, even by payment, entails the employment of a large additional staff to collect the litter made by the elders, and to check the damage done by children to flowers and shrubs. It seems singular that those who can afford to pay 6d. or 1s. for a pleasure have not, as a body, sufficient intelligence to conduct themselves properly, or to prevent their children from injuring property. It is, however, to be hoped that the Society will see its way to continue its policy, for after a while the rush of idle sightseers will pass, and a steady, though perhaps small, income may be derived from those who really desire to visit the Botanic Gardens for the love of its beauties.

The collections of Dr. F. Stephani, consisting of 10,000 specimens of Hepatics, including his types, have been acquired by the British Museum. The Paris

Museum has received a further collection of birds from Mr. Adolphe Boucard. Dr. Jousseaume, who has lately returned from Obock, has placed his collections of mollusca, crustacea, and other marine animals at the disposal of the same Museum. Professor J. G. Agardh has presented his collection of algæ to the University of Lund.

THE Boston Society of Natural History offers two prizes, under the Walker Bequest, for original papers on "The Area of Some Foliated Rock in the United States," "A Study of some Appalachian Valley," "A Study of some Points in the Physiology of any Animal except Man," and "The Cross-Fertilisation of a Plant." These are for 1896. For 1897, the subjects are "Peculiar Phenomena associated with the close of the Glacial Epoch," "Chalazal Impregnation of any American Plant (*Angiosperms*)," "Contributions to the Knowledge of Bacteria," and "Experimental Investigation in Cytology." The prizes are of sixty and fifty dollars.

MR. SAMUEL CHADWICK, Honorary Curator of the Malton Museum since its foundation, has left Yorkshire for New Zealand, where he will for the future reside. The Malton Field Naturalists' Society held a special meeting on the 19th ult., under the presidency of Professor L. C. Miall, and presented him with a farewell address.

DURING the visit of the Geologists' Association to Co. Antrim, those members in Belfast had an opportunity of inspecting the fine collections made by Mr. Joseph Wright. These consist chiefly of Carboniferous and Cretaceous fossils, but the best things are to be found in Mr. Wright's collections of Chalk Foraminifera, which is probably unique. Mr. Elcock was also to be seen at Mr. Wright's, and his beautiful drawings of the microzoa largely assisted the interpretation of his friend's collections. The excursion was most successful, only one day of the six being wet. The members had an excellent opportunity of seeing the amount of damage done by the sea in a single storm (December, 1894), during the ride along the coast from Larne to Cushendall, and again at Ballycastle, Torr Head, and Murlough Bay. Mr. Alexander McHenry and Mr. Praeger conducted the excursion, which was arranged by Miss Thompson and the Belfast Club.

THE seventh meeting of the Australian Association for the Advancement of Science will be held from January 3–10, 1897, at Sydney, under the presidency of Professor Liversedge. Captain Hutton will preside over Geology; Professor T. J. Parker over Biology; Mr. H. S. W. Crummer over Geography; Mr. A. W. Howitt over Anthropology.

THE eleventh Congress of Americanists will meet at Mexico from the 15–20 October. Among the subjects interesting to readers of NATURAL SCIENCE, the following will be discussed:—Origin and progress of the Caribs; Different forms and uses of arrows among the Indians of Central America; Researches on the date of the first arrival of man in America; Relations between the Esquimaux and other indigenous races of North America; Prehistoric man in Mexico; Cliff dwellers. Letters should be addressed to Sr. Trinadad Sanchez Santos, Biblioteca Nacional, Mexico [D. F.]. The President will be Sr. Lic. Joaquin Baranda. The third International Congress of Agriculture will be held in Brussels from September 8 to 16; the second Italian Geographical Congress will be held in Rome at the end of the same month. Particulars of the latter can be obtained from the President, Via del Plebiscito 102, Rome. The third International Congress of Physiologists will be held at Berne, September 9 to 13.

AMONG the papers to be read at the third International Zoological Congress are the following:—A. Milne Edwards, on the resemblances between the fauna of the Madagascar group and that of certain islands in the Southern Pacific; A. Giard, on parasitic castration and Weismannism; A. Sedgwick, on cellular theories; V. Hensen, on his Plankton studies; Bowdler Sharpe, on the classification of birds;

N. Zograf, on the origin of the lacustrine fauna of European Russia; J. Büttikofer, on the fauna of Borneo; E. Dubois, on *Pithecanthropus;* W. Leche, on development of the teeth; N. Zograf, on the odontography of the chondrostoid Ganoids; R. Semon, on the embryology of the Vertebrata; C. W. Stiles, on the Cestodes of American rabbits; R. Blanchard, on the Leeches of the Netherland Indies and Indo-Malaya; S. J. Hickson, on the classification of the Alcyonaria; Selys-Longchamps, on the geographical distribution of the Odonata; E. Wasman, on the Myrmecophilæ; A. Fritze, on the season-dimorphism of the butterflies of Japan and the Liu-Kiu. Canestrini will discuss the Acari; Korotnev, the development of the Tunicates; E. Perrier, the classification of the worms; J. W. Spengel, new researches on *Enteropneustes;* Herdman, the Tunicates; and Weismann will give an opening address. Dr. Field's scheme for recording zoological literature will be fully discussed on the first day.

A SCHEME for a card catalogue of Scientific Literature has been described in *Science* for July 19, by Mr. F. B. Weeks. Mr. A. G. S. Josephson, of the Lennox Library, has a letter in the same publication advocating an International Congress of Bibliography.

WE have received nos. 5 and 6 of the *Revista de la Facultad de Agronomia y Veterinaria,* of La Plata, which contains, among other matter, a paper on the external form of the horse, by Dr. G. J. Bernier, Professor to the Faculty. There is also an interesting paper on the agronomy of Parana by Professor Antonio Gil.

THE *Zeitschrift für angewandte Mikroskopie* is a new octavo monthly of thirty-two pages, edited by G. Marpmann, published by R. Thost in Leipzig, Hospitalstrasse 10. It deals chiefly with the technique of microscopy, and partly with its scientific results. It contains original articles, reviews, notes and correspondence; and as a supplement is given a dictionary of terms that should be useful to English readers of German biological papers. The annual subscription is ten marks.

THE *American Naturalist* has started a new section, "Vegetable Physiology," under the editorship of Dr. Edwin F. Smith. The *Botanical Gazette* pertinently remarks that the first article is on nomenclature, and has nothing particular to do with physiology.

A VALUABLE atlas has just appeared in Penck's *Geographische Abhandlung.* It deals with the Austrian alpine lakes, and is the work of Penck and Richter. Contours are given of the lake depths and the heights of the land surrounding them. The work is similar in many respects to Geistbeck's "Seen der Deutschen Alpen," published by the *Vereins für Erdkunde* in Leipzig in 1885. Dr. Mill's work on the lakes of our own country is, of course, well known to all our readers.

IN the *Quarterly Journal of the Geological Society* for August 1 will be found a full description of the human remains from Galley Hill, referred to in NATURAL SCIENCE for June last. There is also Dr. Gregory's paper on the Palæontology and Physical Geology of the West Indies, containing a detailed description of the corals of the Barbados reefs with a remarkable and important synonymy. This is clearly the most valuable portion of this section of the paper, and will help to clear up the mysteries of coral nomenclature to a large extent, and, although we cannot agree with him in the rejection of *Porites porites* (Linn.), he is justified in adhering to the British Association rule. Another paper, the importance of which it is hardly yet time to estimate, is Mr. Buckman's "Bajocian of the Mid-Cotteswolds."

DR. DÖRFLER, of the Hof Museum, Vienna, is compiling a directory of botanists. He will be glad of information concerning names, addresses, and special subjects, as well as of gardens and institutions whose employés ought to appear in such a work. Address Burgring 7, Vienna, I.

CORRESPONDENCE.

Botany and the Science and Art Department.

Our reference to the Science and Art Department's examinations in botany in the August number of Natural Science has evoked more correspondence. If we accept the principle that, given endowments, examinations are necessary for their distribution, there will always be heartburnings and dissatisfaction at the results. On one point our correspondents all agree, and that is unless the plant given for description is correctly referred to the natural order, it is impossible to obtain a first class in either the advanced or honours stage. We can hardly believe that the mere "spotting" of a plant can make all this difference, though the candidates' evidence certainly points in that direction. We presume students understand that a much higher standard is required for the attainment of a first than of a second class; but we must assume that the standard is one of general proficiency, and not dependent on an almost unattainable excellence in one branch. For such would be the case according to a candidate for honours last May, who, having been sorely puzzled by the specimen given for description, made a point of asking the examiner, during the practical examination, the name of the order to which the plant really belonged. "The examiner then acknowledged that the plant was a very difficult one, and that not one candidate had referred it correctly!—the majority referring it to Scrophularineæ, others to Gesneraceæ. In reality, it was a solanaceous plant belonging to the tribe Salpiglossidæ. The examiner very kindly pointed out a character by which the plant could be separated from Scrophularineæ so similar in structure, and that was by the position in the corolla-tube of the stamens! There was also another character, the examiner added, by which the correct order could be ascertained, namely, by the *anatomical structure of the stem!*

"I certainly think that those candidates who have striven hard to secure first-class passes, and have been awarded seconds, have a legitimate cause for complaint, if their position has been at all affected by their inability to get right a plant of such uncertain affinities as that given on May 31 last."

Poor students! We heartily sympathise with you. It may be some little consolation to "the majority who referred it to Scrophularineæ" to know that they are in the same boat with some of the highest authorities on systematic botany, including the illustrious Bentham, who, in the greatest work on systematic botany in existence, De Candolle's "Prodromus systematis naturalis regni Vegetabilis," includes the tribe in Scrophularineæ, while in a work of almost equal importance, in which he was associated with Sir Joseph Hooker, the classic "Genera Plantarum," they will find the following note (vol. ii., p. 882): "The tribe Salpiglossidæ, by its didynamous stamens, with or without a fifth smaller one, often straight embryo and other characters, comes very near several Scrophularineæ, and is included among them by very many authorities." The authors, however, decided to keep it in Solanaceæ. *Hinc illæ lachrymæ!*

The Teaching of Systematic Botany.

Sir,—Will you allow me, in reference to the Note and Comment in the last number of Natural Science, to make a protest against the method in which candidates' knowledge of systematic botany is tested at the Science and Art Department's examination? It is practically impossible to set a plant which shall be equally fair to the candidates in all parts of the British Isles, and at the same time sufficiently rare to be any test of a student's knowledge. Nevertheless, often the only opportunity given to a candidate to show acquaintance with the systematic part of the subject is in the determination of one plant. The species may be well known to all students in one part of the country, and may be very scarce or altogether absent in another; and thus chance is an important factor in the results. This might easily be to some extent avoided, if one or two questions were asked in the written part of the examination upon the principles of systematic botany, and on the classification and affinities of certain orders.

Another subject upon which an occasional question might well be asked, is the rules of nomenclature. Not one in a dozen of amateur or morphological botanists understands these rules; without some knowledge of them, the frequent changes of name are unintelligible, and botanists are using a scientific instrument which they do not understand. If this were done, systematic botany might not be so systematically neglected in England as is now the case.

August 15, 1895. A. R. F.

ERRATUM.

P. 117, line 23, for *Gymnurus* read *Gymnetrus*.

NOTICE.

To Contributors.—*All communications to be addressed to the* Editor *of* Natural Science, *at* 22, St. Andrew Street, Holborn Circus, London, E.C. *Correspondence and notes intended for any particular month should be sent in not later than the* 10*th of the preceding month.*

To the Trade.—Natural Science *is published on the* 25*th of each month; all advertisements should be in the Publishers' hands not later than the* 20*th.*

NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

No. 44. Vol VII. OCTOBER, 1895.

NOTES AND COMMENTS.

The British Association and the President's Address.

IN England we are very civil to political reputation. Last year the brilliant phrases and epigrammatic eloquence of Lord Salisbury caused a tendency to overrate the scientific value of his address. The president of this year is not a famous politician, and his name is associated with no scientific work that has tickled the ears of the leader-writers; and so in the newspapers, from which most of us take our daily prejudices, there is a tendency to underrate the Association. We are inclined to think, however, that Sir Douglas Galton's quiet review of the history of the British Association is a document of considerable value. It is true, as the newspapers say, that there are many congresses now, and that the Association is but one among them. Still, it is the parent of most of them, and it has played a large part in directing the attention of a lethargic public to the progress and advantages of scientific inquiry. Moreover, as the president showed, the Association has had a direct influence upon the progress of inquiry by the reports it has issued from time to time. These have systematised work in hand and have had great influence in directing the course of its progress. Sir Douglas Galton has had so long an experience in the working of the Association that he could speak of its history and achievements with an intimate authority possessed by few.

Ether.

The president of the mathematical and physical section dealt with some of the ultimate problems of science. At present, our knowledge of matter and motion consists of little more than a series of empirical laws. "A statement of a law," said Professor Hicks, and his words cannot be pleasant reading for the good Duke of Argyle, "is either a confession of ignorance or a mnemonic convenience. It is the latter if it is deducible by logical reasoning from other laws. It is the former when it is only discovered as a fact to be a law." The highest goal of science is to reduce ultimate laws to one or two, the necessity for which lies outside the sphere of our cognition. The ultimate laws are the dynamical relations of matter to number, space, and time. The ultimate data will be number, matter, space, and time themselves. If, as Professor Hicks apparently expects, it turn out that all phenomena are manifestations of motion of one single continuous medium, then the notion of force will be unnecessary, and the study of dynamics will be replaced by study of the equation of continuity. So, in the far future, all the ultimate problems are to be for mathematicians.

Even in the meantime the constitution of atoms and the constitution of the ether are problems chiefly for mathematicians. For, although we may take these to be seeable things, they are unseeable to us "because our senses are too cross-grained to transmit impressions of them to our mind." "The ordinary methods of investigation here fail us; we must proceed by a special method, and make a bridge of communication between the mechanism and our senses by means of hypotheses. By our imagination, experience, intuition, we form theories. We deduce the consequences of these theories on phenomena which come within the range of our senses, and reject or modify, or try again." The special theories with which Professor Hicks was dealing were the vortex-atom theory of matter and the vortex-sponge theory of the ether. The older theories, those which most of us were taught, held that atoms were rigid and that ether, although of extreme tenuity, was an elastic solid. The great difficulty of the rigid atom theory was that it gave no explanation of the apparent forces that hold atoms together. The elastic, solid ether broke down when confronted with reflection and refraction. Professor Hicks shadowed forth how the vortex-atom theory could be applied to the chemical combinations of atoms. Similarly he sketched a possible constitution of a spongy ether consisting of applied vortex-systems. These are matters entirely for mathematical treatment. But it seems that difficulties like the old theoretical action at a distance would vanish under the new theories. Light, electricity, and magnetic fields are in process of being reduced to mathematical properties of the spongy ether; and, most fascinating suggestion of all, Professor Hicks indicated that gravity itself may be turned from a law "observed as a fact" to a mathematical inference.

The Synthesis of Organic Compounds.

In his presidential address to the chemical section, Professor R. Meldola discussed the fascinating subject of structural chemistry, a subject which no doubt will receive its ultimate explanation on the lines suggested in the mathematical section, but which at present is considerably more advanced than the structure of the atom and of ether. Incidentally Professor Meldola stated that he was preparing a catalogue of the so-called organic substances that have been synthesised. It seems that alcohol was the first organic substance formed by chemists in the laboratory. At the time, however, it was not recognised that alcohol was a substance really formed by the agency of living things, and, consequently, the synthesis of it by Henry Hennell, in 1826, attracted little attention. It was when Wöhler, in 1828, prepared urea from ammonium cyanate that the current conceptions of organic chemistry were shaken, as urea obviously was a product of the living animal. Even this synthesis, however, may not be regarded as complete, for at that time ammonium cyanate had not been prepared from inorganic elements. This, of course, has now been done, and not only urea but a large number of other substances have been built up in the laboratory from inorganic elements. "From the time of Wöhler and Hennell, the course of discovery in this field has gone steadily on. The announcement of a new synthesis has ceased to produce that excitement which it did in the early days when the so-called 'organic' compounds were regarded as products of a special vital force. The interest among the uninitiated now rises in proportion to the technical value of the compound. The present list of 180 odd synthetical products comprises, among the latest discoveries, gentisin, the colouring matter of the gentian root (*Gentiana lutea*), and caffein."

But Professor Meldola is not certain that it is an adequate idea of synthesis to restrict the word to the building up of compounds from lower substances. He doubts, for instance, and many physiologists will agree with him, whether in the vital laboratory of the plant the formation of compounds is often one of synthesis in the strict sense of the word. Like Bunge, the great German physiological chemist, and like many English physiologists, he insists on the part played by protoplasm in all these processes. He suggests that the first stage to be explained is the nature of assimilation, and hints that in many cases assimilation may be the formation of a compound between protoplasm or some of the proteids in protoplasm and the foreign substance. The subsequent formation of the organic substances in the cell might then be, not a true synthesis—a building up from low to high, but the formation of a lower compound from the complicated union of protoplasm with other bodies. And in this connection he recalls Sachs' opinion that starch itself is the first visible formation in the assimilating processes of the green cells. "The future development of vital chemistry, however, rests with the chemist and physiologist conjointly; the isolation, identification, and analysis of the products of vital activity, which has hitherto been the task of the chemist, is only the preliminary work of physiological chemistry leading up to chemical physiology."

Underground Geology.

The President of the Geological Section, Mr. W. Whitaker, devoted the greater part of his address to a discussion of the underground geology of East Anglia. The underlying geology of this district is, in the first place, obscured by Drift; but the well-sections, which Mr. Whitaker has always been so indefatigable in recording, have enabled the lines to be drawn with far greater precision than was formerly the case; especially have the older Tertiary beds been found to have a greater northward extension than is depicted on the older maps. Our knowledge of the deeper palæozoic rocks has likewise been greatly increased, partly from borings made for water, partly from borings with the direct object of investigating those rocks, often with the ulterior motive of searching for coal. Reasoning from the southern outcrops of the British Coal Measures, Mr. Whitaker cannot see why we should expect anything but a like occurrence of Coal Measures, in detached basins, in our vast underground tract of old rocks. He therefore urges fresh trial-borings. "The long gap between the distant outcrops of the Coal Measures near Bristol and Calais has been lessened very slightly by the working of coal under the Triassic and Jurassic beds near the former place, but much more by our brethren across the narrow sea," who have not only proved, but actually worked coal beneath their Jurassic and Cretaceous beds. The one trial that we have made, the Dover boring, has succeeded in proving the presence of coal under eastern Kent. But there is no reason why we should stop with this one boring, or even along this one line. In this case we cannot say that "one trial will suffice." It is our duty to seek, in East Anglia and elsewhere, for the other basins that so probably exist. Nor should we be discouraged by one or two failures. Among other reasons, the apparent absence of coal from a boring that strikes rocks older than the Coal Measures may be due to overthrust faults; such have been actually proved to occur in the adjacent Coal Measures of the Continent. "Our trial-work does not yet lead us to consider such disturbances. We have at first to assume a normal succession of formations, and not to carry on explorations in beds that can be proved to be older than the Coal Measures; but the time may come when it will be otherwise."

Subsequently, in the same section, Mr. F. W. Harmer made a plea for the systematic exploration of the subterranean geology of Great Britain and Ireland. He pointed out that at present our knowledge of the structure of the rocks below the surface is due either to isolated and occasional borings, such as that of the Ipswich Syndicate in search of coal, or to deep wells sunk by mercantile firms. He urged that the discovery of new mineral beds enriches, not only the lucky landowners, but the whole State. Apart from the increased employment and general prosperity of the district, he calculates that for "every £100 of yearly unearned increment the State is benefited in one way or another by £25, or one-fourth of the amount." His practical suggestion is that, with the consent of Parliamentary and local authorities, a royalty should be charged on any minerals obtained below a certain depth, while landowners might defray a part of the cost of borings upon their estates.

Murray's Mud-line.

In the Zoological Section, Professor Herdman discussed chiefly problems of oceanography, problems with which his own great experience in dredging rendered him specially familiar. After paying a high compliment to Dr. John Murray, a compliment which must have echoed in the minds of every naturalist who heard it, he discussed at some length the existence of what Murray has called the "Mud-line" around coasts at a depth of about one hundred fathoms. "It is the 'point at which minute particles of organic and detrital matters in the form of mud begin to settle on the bottom of the ocean.' He (Murray) regards it as the great feeding ground, and a place where the fauna is most abundant, and from which there have hived off, so to speak, the successive swarms or migrations which have peopled other regions—the deep waters, the open sea, the shallow waters and the estuaries, fresh waters and land." In fact, to this region Murray assigned the importance that, it may be remembered, Professor Moseley assigned to the shore generally.

Professor Herdman thinks that the limits of the mud-region are much more variable and its fauna much scantier than Murray's view requires. "In the Irish Sea mud may be found at almost any depth, but is very varied in its nature and in its source. There may even be mud laid down between tide-marks in an estuary where a very considerable current runs. A deposit of mud may be due to the presence of an eddy or a sheltered corner in which the finer particles suspended in the water are able to sink, or it may be due to the wearing away of a limestone beach, or to quantities of alluvium brought down by a stream from the land, or to the presence of a submerged bed of boulder clay, or even, in some places, to the sewage and refuse from coast towns. Finally, there is the deep-water mud, a very stiff, blue-grey substance, which sets, when dried, into a firm clay, and this is, I take it, the mud of which Dr. Murray writes. But in none of these cases, and certainly not in the last-mentioned, is there, in my experience, or in that of several other naturalists I have consulted, any rich fauna associated with mud. In fact, I would regard mud as supporting a comparatively poor fauna as compared with other shallow water deposits."

Dr. Herdman supported his view by a large quantity of evidence, all of which went to show that the "Coralline" zone, and especially the "Laminarian" zone, have much richer faunas than those of the muddy regions.

Myology as an Aid in Classification.

In future numbers of Natural Science we hope to deal with a number of the interesting communications made to the Zoological Section—notably, for instance, with the question of oysters and typhoid. We are glad, however, to select for immediate notice a short paper read by Dr. Parsons upon the value of muscles in classification. Owing to the technical nature of the subject and the limits of time, it did not excite so much discussion as the subject requires. Muscles are structures rather neglected by most zoologists, and there is a general impression that they are too variable to be of much use from a systematic point of view. As we have repeatedly urged, however, we believe this view to be erroneous, and that zoologists will find in muscles a material as rich, from every point of view, as bones.

Dr. Parsons reviewed some of the reasons which have induced systematists to place little reliance on the study of muscles. He proceeded to give some account of the muscles in the Order of Rodents, a subject on which he has contributed numerous important memoirs to the *Proceedings* of the Zoological Society. He showed how closely the muscles correspond in animals nearly related, and how little the different modes of life of their possessors affect them. We hope that Dr. Parsons' paper will shortly be published in full in Natural Science.

Tunicata.

One of the first debates over which Professor Herdman found it his lot to preside in Section D was, appropriately enough, a discussion upon the classification of the group the study of which he has made his own speciality. In a group of animals in which budding and the formation of colonies has been carried to so high a degree as in the Tunicata, it is not surprising that the tangible characters, which these processes of growth supply, should have been largely employed in the earlier schemes of classification. Professor Herdman's own scheme, as set forth in his "Challenger" report, and recently revised, is, perhaps, the most complete of these apotheoses of budding, a fact which is none the less remarkable because the Professor has himself acknowledged that his classification of the group involves an unnatural separation of forms admittedly allied.

Mr. Garstang, in an interesting paper, insisted upon the importance of the *Pyrosoma*-stage discovered by him in the development of various fixed Ascidians. He thinks this instance of recapitulation remarkably complete, and holds that it furnishes in itself ample evidence for the contention that the fixed Ascidians have been derived from a *Pyrosoma*-like ancestor, and not *vice versâ*. The remaining pelagic types of Tunicata also agree with *Pyrosoma* in possessing a single row of undivided gill-slits (or protostigmata), so that the outlines of the suggested system become clearly marked. The following subdivisions were proposed, and were based by Mr. Garstang upon the scheme of Mr. Lahille:—

Perennichordata .. .. Appendicularians.
Caducichordata.
I. Thaliacea. Protostigmata undivided; cloaca posterior. Pelagic.
i. Myosomata. Musculature in bands; lateral atria small; internal longitudinal bars absent.
e.g., *Doliolum*, *Salpa*, *Anchinia*.
ii. Pyrosomata. Musculature diffuse; lateral atria large; internal longitudinal bars present.
e.g., *Pyrosoma*.
II. Ascidiacea. Protostigmata subdivided into rows of secondary stigmata; cloaca dorsal. Fixed.
i. Stolidobranchia. Internal longitudinal bars present; bars solid and ribbon-shaped,
e.g., *Botryllus*, *Cynthia*, *Goodsiria*.
ii. Phlebobranchia. Internal longitudinal bars present; bars tubular.
e.g., *Perophora*, *Ascidia*, *Diazona*.
iii. Aplousobranchia. Internal longitudinal bars absent; horizontal membranes present.
e.g., *Clavelina*, *Distaplia*, *Amaræcium*.

In the discussion which followed the reading of this paper the president genially acknowledged his conversion as to the relationship and position of *Pyrosoma*, but was still doubtful whether the time had come for discarding the old and convenient subdivision of the Ascidiacea into "simplices" and "compositæ" in favour of the system now advocated.

The subject was continued in a paper on Budding in Ascidians by Professor Ritter, of California. It was again shown that several compound Ascidians are less closely related to one another than to certain simple Ascidians which are themselves widely different from one another in internal organisation. But the paper was chiefly interesting as a contribution to the controversy concerning the bearings which budding in Tunicata has on the germ-layer theory. Professor Ritter's observations have led him to the conclusion that "in embryonic development the ectoderm produces the matrix of the test, the peribranchial sacs, and the central nervous system and hypophyseal duct, while in the bud we see these four parts of the animal produced by the inner or so-called endodermic vesicle." In this phenomenon we have what Professor Ritter calls an excellent case of "developmental opportunism." The effect of influences bearing upon the bud in its development has overcome all the hereditary tendencies and scruples of its tissues; though it is rather the means than the end which has undergone modification. According to a theory of Seeliger's, which Professor Ritter revives, this derivation of primarily ectodermal organs from endodermal tissues may possibly be due to the fact that the ectoderm is already specialised as a test-producing organ at the time of bud-production.

Botany.

Mr. Thiselton-Dyer, the Director of the Royal Gardens at Kew, was the natural President of the new Botanical Section of the Association. His address ranged over many topics, and its notable feature was its crisp, pungent, stimulating quality. Discussion of half the questions he raised would fill many numbers of Natural Science, and, indeed, might fill them profitably. Using a just and enthusiastic appreciation of Henslow, the friend and teacher, and, in many respects, the inspirer of Darwin, as a text, he made a timely comparison between the old and new schools of Botany. The old school was essentially a school of Natural History. It contented itself with simple appliances: Robert Brown used only a simple microscope, and, acting upon his advice, Darwin had no compound microscope with him on the "Beagle." Its great feature was the observation of things alive in their natural surroundings. The modern school equips itself with the most elaborate appliances: it employs most complicated methods: it is much more a technique than an observation. But Mr. Thiselton-Dyer is possessed of too much insight and too much humour to be of those who

> "Compound the sins they are inclined to,
> By damning those they have no mind to,"

and he made his comparison, not to exalt one method at the expense of the other, but that the modern school might remember the merits of their predecessors. We have no doubt but that the young men "trained at Cambridge" will take his agreeable frankness in the spirit in which it was meant.

Civilisations.

Professor Flinders Petrie, addressing the Anthropological Section, strongly urged the necessity of a neglected practical side of Anthropology. The English people, by accident or by the genius of their race, are brought in contact with a large number of other civilisations. In dealings with these other civilisations we are apt to attempt the imposition of our own standards and customs upon peoples to which these are alien. "The foremost principle which should be always in view is that the civilisation of any race is not a system which can be changed at will. Every civilisation is the growing product of a very complex set of conditions, depending on race and character, on climate, on trade, and every minutia of the circumstances. To attempt to alter such a system, apart from its conditions, is impossible. For instance, whenever a total change is made in Government, it breaks down altogether, and a resort to the despotism of one man is the result."

He believes that "the average man cannot receive much more knowledge than his immediate ancestors," and that the attempt to force such knowledge upon him ruins him mentally and physically.

Speaking from his own experience of Egyptians, he declares that the attempt to teach them reading and writing, which for us seem the beginning of all education, turns them into useless idiots. They cannot make use of such accomplishments, which are utterly incongruous with the past conditions of their race, and this erroneous so-called education prevents the development in them of the "great essentials of a valuable character—moderation, justice, sympathy, politeness and consideration, quick observation, shrewdness, ability to plan and pre-arrange, a keen sense of the uses and properties of things." It is quite otherwise with the Copts, whose ancestors have been scribes for hundreds of generations.

This particular instance is one of the most general application. It is necessary that the rulers of foreign races should understand that the civilisation of these Western islands in the nineteenth century is but one among many civilisations, or statical conditions of society. From the Andaman islanders to the Parsees each community of men has its own standards and traditions crystallised into a code that is stamped upon their brains. He urges that those who are being trained to be rulers of foreign races should be made to study other civilisations, if only in anthropological museums and in translations of literatures. Formerly, when classical education was supreme, every educated young man had, in addition to his own habit of civilisation, a knowledge of the kind of ideas of Greeks and Romans, and from the Old Testament of polygamous and patriarchal peoples. Now, other subjects of study—perhaps more valuable in other ways, are usurping the place of the older studies, and young men are going out to become Satraps, who may be experts in the mathematics, in the sciences, or in modern languages, but who regard the customs and religions of other races from the narrow outlook of the civilisation of Bayswater, the religion of a rural parish, or of a Presbyterian household.

We hope that Professor Flinders Petrie's weighty advice, which we have roughly paraphrased, will receive due attention.

WEISMANN AND SPENCER.

IN the *Contemporary Review* for September Professor Weismann, after a considerable lapse of time, returns again to the controversy in which Mr. Herbert Spencer engaged him. We have no space to enter into the laborious details of the controversy, and, to be frank, the disputants seem to us to have abandoned empirical arguments for the arid regions of speculative metaphysic. But those who have bravely followed the controversy, not only in the essays of the main disputants, but in the innumerable writings of others, must be familiar with attempts to ridicule Weismann because he has set forward his theoretical construction of the germ-plasm as a real thing. He himself, with a reiterated modesty, has offered it merely as a working hypothesis. "If anyone is inclined to reject my explanation because it leads into the obscureness of the germ-plasm, of the structure and vital processes of which we can learn nothing directly, let him remember that the origin of the variations cannot be found anywhere else, and that we must, therefore, form some conception of the germ-plasm if we wish to penetrate deeper into the riddle of phylogenesis at all. I simply submit my conception of the structure of the germ-plasm as a working hypothesis. Let it be tested by facts; let it be improved according to the results thus attained; let it be overthrown should it in the end prove unsatisfactory; but do not let us say in advance that such a thing cannot be!"

Many writers have confused the actual existence of a germ-plasm with Weismann's hypothetical conception of its structure. No one having the smallest acquaintance with the results of modern embryology doubts that there is a material contributed by each parent in parts of equal valency. In the same fashion as the properties of an amœba are resident in its protoplasm, the inherited qualities of an organism are resident in the portion of germ-plasm from which it sprung. Dr. Oskar Hertwig, who has been the most weighty critic of Weismann's hypotheses, agrees with Weismann, and, indeed, with everyone else worth considering, that the germ-plasm must be a material of extraordinary complexity. Weismann has endeavoured to interpret the observed phenomena of heredity into terms of a hypothetical structure of the germ-plasm. As he says himself, his interpretation may have to be enormously modified or abandoned as knowledge increases. But to object to it, as it seemed to us and to Weismann himself that Mr. Herbert Spencer objected to it, that it cannot solve a number of problems of heredity that as yet are insoluble upon any hypothesis, is special pleading for a verdict, and not helping to advance thought.

Life-History of the Foraminifera.

In Natural Science for November, 1894, we called attention to the abstract of a paper by Mr. J. J. Lister on the above subject. The full paper is now before us (*Philosophical Transactions*, vol. clxxxvi.) and is illustrated by four plates dealing with *Polystomella crispa*, *Calcarina hispida*, *Rotalina beccarii*, *Orbitolites complanata*, and *Cycloclypeus carpenteri*. The conclusions arrived at by Mr. Lister are as follows: (1) The species of Foraminifera are in a great number of cases dimorphic. (2) The two forms differ from one another in the following features, (*a*) the size of the central chamber, (*b*) the shape and mode of growth of the chambers succeeding the megalosphere and microsphere, (*c*) the character of the nuclei. (3) The two forms differ in the frequency of their occurrence, the megalospheric forms being much more abundant that the microspheric. (4) The megalospheric form arises as a young individual already invested by a shell, which may be found lying in or about the peripheral chambers of the parent. (5) Under certain circumstances active zoospores are produced by Foraminifera. It therefore appears (says Mr. Lister) that we may safely conclude that the microspheric and megalospheric forms are distinct from their origin. What, then, is their relationship? When two forms of a species are met with in animals or plants they generally either belong to different sexes or they are members of a cycle of recurring generations. The hypothesis that the two forms of the Foraminifera represent the two sexes appears to be disproved by the fact that in *Orbitolites complanata*, Lam., both megalospheric and microspheric forms are found with the young of the megalospheric form (primitive discs) in their brood chambers. Other genera furnish analogous though less complete evidence. Hence it is impossible to regard either form as male. We turn, then, to the other hypothesis, namely, that the two forms are members of a recurring cycle of generations.

Mr. Lister goes on to show that in the reproduction of the microspheric form the whole of the protoplasm of the parent is divided into the young, and that these all belong to one form, the megalospheric. The fact that the whole of the protoplasm of the parent is used in the production of the young, and that these are all of one form, supports the view that the two forms of the Foraminifera belong to different generations. A fuller account of the process of reproduction is promised by Mr. Lister in a further paper, which we await with great interest.

The Structure of *Heliopora*.

Mr. G. C. Bourne's communication to the Royal Society upon *Heliopora* has now been published (July, 1895), and worthily maintains the Oxford traditions of the study of Cœlenterates inaugurated by Moseley. Professor Moseley himself made a notable contribution to our knowledge of *Heliopora*; but recent advances in knowledge of other alcyonarians made a re-examination advisable. Indeed, it was Moseley who, before his death, urged Mr. Bourne to undertake the investigation. The work was done in the Linacre Laboratory at Oxford upon Moseley's original material, with the addition of collections made by Mr. Bourne at Diego Garcia, Professor Hickson in Celebes, and Professor Haddon in the Torres Straits.

The chief point of general interest relates to the origin of the skeleton. By careful examination of young growing points Mr. Bourne was able to make out that, as G. von Koch suggested, the skeleton is truly ectodermal. The mesoglœa, or gelatinous middle layer, is formed by ectoderm cells, which either gradually become gelatinous at their internal edges, or losing continuity with the external layer migrate inwards, and first becoming surrounded by a layer of discharged gelatinous material, 'melt' away into mesoglœa.

Into the mesoglœa hollow outgrowths of the endoderm grow, and form a definite system of cavities. Externally to this, the layer of mesoglœa is formed by intruding cells from the ectoderm. Outside this again another definite layer of cells of ectodermic origin forms a well-marked layer of what Mr. Bourne calls *calicoblasts*, and it is this layer that gives rise to the skeleton. An examination of *Xenia* and *Heteroxenia* led Mr. Bourne to think that probably in a large number of alcyonarians the skeleton is ectodermal.

The matter on which we have touched is only a small part of Mr. Bourne's memoir. He discusses at length the nature of *Heliopora*, of the "animal" and the coral; but these are subjects too technical to be summarised here.

The Temperature of the River Nile.

We have received from Dr. H. B. Guppy a reprint from the *Proceedings of the Royal Physical Society of Edinburgh*, containing Part II. of his work on River Temperatures. This second instalment deals chiefly with the temperature of the waters of the Nile and its relation to the temperature of the air at different points and in different seasons, and is obviously the result of considerable labour and research. Observations of the temperature of the Nile are remarkably scarce, the pencil manuscripts of Mr. Robert Hay, which Dr. Guppy has unearthed in the British Museum, containing one of the most valuable series extant. The leading conclusions of the paper are accordingly based on comparisons with air temperature rather than on the actual water temperatures, a method which has recently been found very successful. We cannot do better than give the propositions stated by Dr. Guppy and ably supported by the discussion of the observations. During its course below the second cataract the Nile is in summer markedly cooler than the air; but the relative coolness diminishes as the river flows north, and the diminution is almost entirely due to the fall in the air temperature. In winter the Nile is still colder than the air between the first and second cataracts, but the difference of temperature is much less: between Assouan and Minieh the water is nearly two degrees (Fahr.) warmer than the air, and the excess is greater at Cairo. The approximation and crossing of the air and river temperatures is again mainly due to the fall of air temperature. It is remarkable that during the four seasons there is no great contrast in temperature between the water of the Nile and the surface waters of the Mediterranean.

Dr. Guppy further compares the thermal *régime* of the Nile with those of other great rivers. While pointing out that further acquaintance with the Brahmaputra and the Yangtse will probably disclose points of similarity, Dr. Guppy shows that the Nile is in strong contrast to the Congo and the Amazon, which flow east and west, and to the Mississippi, flowing south. The comparison with the last-named is specially interesting. It is shown that, judging from monthly means, the range of temperature of the Nile water is less than that of the air, while in the Mississippi it is considerably greater : that the Nile is true to the climatic conditions of its latitude only in winter, and the Mississippi only in summer, or, to put it otherwise, that the influence of the higher courses is displayed in contrary seasons : that nowhere below the second cataract does the Nile attain so high a summer temperature as the Mississippi : and that in contrast to the Nile the temperature of the Mississippi waters is often widely different from the surface water in the Gulf of Mexico.

The paper concludes with the statement of a number of other points, and suggestions for further observations. We are glad to notice that Dr. Guppy promises to treat other great rivers of the world in the same detailed manner.

Toads in Holes.

No doubt it is the silly season, when editors are so put to it for copy that they have little time to revise what matter comes to hand ; but our esteemed contemporary, the *Daily Chronicle*, surely had no need to fall back upon the exceedingly ancient error concerning the vitality of toads. Under the title "A Remarkable Release," they recount how some workmen in Bedfordshire, cutting up the trunk of a large oak uprooted during a recent storm, came across a toad "embedded in the heart of the trunk, about eighteen feet from the root." "The imprisoned creature, which must have subsisted for some years upon the sap, was about half the size of a fully-developed toad, and readily swallowed the worms, earwigs, and beetles which were given to it." It should be needless to recall the old experiments of Dean Buckland and others. By adopting the expedient of burying toads so sealed up that they could obtain moisture and air but no food, they found that toads were unable to live more than a few months without food. As a matter of fact, toads habitually conceal themselves in crevices and holes. In cases where they are found in tree trunks, stones, and so forth, either the hole by which they entered has been entirely overlooked, or they got in when they were very small and grew healthily upon earwigs and other insects that had sought similar concealment. We have no doubt but that if the workmen had examined the inside of this particular toad they would have found the remains of a more nutritious diet than the sap to be obtained in a hollow trunk.

Adders Again.

The holiday season has not yet brought into our hands a set of adders carefully preserved by the observers after they had swallowed their young. But there has come into our hands a pamphlet on the subject by Mr. H. Tootal Broadhurst. This consists of reprints of a number of letters from various sporting papers relating how the writers saw young adders issuing from the mouths of old adders, or, in rarer cases, how they had seen or heard of their going in. Unfortunately, the pamphlet establishes no more than that there is a strong belief among gamekeepers, countrymen, and sportsmen. The pamphlet ends with a letter from Brusher Mills, of Clayton Hill, Lyndhurst, who declares that he has seen hundreds go in and out of the old adder's mouth, and offering to "show this to any gentleman who likes to come and see him in the last week of July or first week of August." We ourselves know Brusher Mills and know well that he has seen as many adders as anyone, and has caught more than anyone else. But, unfortunately, he was unable to win the reward of £5 offered by the *Field*, or of £1 offered by Mr. Tegetmeier.

A Botanical Station in Central Africa.

The Foreign Office Report C. 7829–2 contains some interesting information on the botanical and agricultural resources and prospects of the Shiré-highlands. The writer, Mr. Alexander Whyte, who is head of the Scientific Department, gives an account of his successful effort to establish a botanical garden at Zomba. The results seem to show that Zomba is eminently suited for the experimental cultivation of food-plants and other plants of economic value. English potatoes grown from seed turned out remarkably well. By constant selection, several large, well-formed, mealy varieties were obtained, equal in flavour to any English potatoes. Happily, too, they show no sign of disease. Barley and oats from English seeds were successful, while wheat grown from seed obtained from the missionaries at Tanganyika yielded at the rate of nine bushels to the acre, without manure. A series of conifers, cypress, thuja, and the Milanji *Widdringtonia* grew to an average height of five feet in two-and-a-half years, while some eucalypti shot up forty-five feet in the same period. A large terrace flower-garden made a brilliant display; balsams, phlox, zinnia, mignonette, and others seeded so freely that they became garden weeds. Geraniums grew to the height of hedges, and sunflowers and dahlias shot up into tall, shrub-like plants. Petunias, pinks, carnations, and, in fact, most of the plants experimented with were successful.

Mr. Whyte strongly advises extensive cultivation of indiarubber and gutta-percha yielding plants. The cheapness of land and labour would make the former at any rate a most remunerative venture. Fibre-plant cultivation would also admirably suit the natives. Unfortunately, the formidable tsetse fly will seriously interfere with the introduction and rearing of domestic stock, while a gad fly (*Tabanus latipes*) the size and shape of a large blue-bottle fly, is also most harassing to horses and cattle. Though said to be a great scourge in East Africa, the latter is seldom met with in Nyasaland.

As regards the tsetse fly, smearing the animals with a mixture of kerosene oil and cow-dung is suggested as a most effectual preventive. The West Indian jigger, a burrowing flea, has also just reached the districts round Lake Nyasa and the Upper Shiré, having slowly migrated eastwards from the West Coast, where it was introduced with ballast from Bahia in 1873.

The Ascent of Sap.

Why does sap overcome the attraction of the earth and rise to the summit of high trees? One explanation is that the root-hairs, by the vital action of their protoplasm, as well as by simple osmosis, absorb water from the soil and force it upwards through the stem. It has been shown that when the upper part of a vigorously growing plant is cut off and replaced by a tube containing mercury, the sap continues to ascend with force enough to raise the column of mercury. But even in the absence of "root-pressure" ascending currents are maintained: a shoot out from a stem will continue to absorb water and force it upwards. In a recent communication to the Royal Society (published July, 1895), Mr. Henry H. Dixon and Dr. Joly support the view that the 'suction-force' of the leaf is the "all-sufficient cause of the elevation of the sap, not, however, by establishing differences of gas-pressure, but by exerting a simple tensile stress on the liquid in the conduits." Meniscuses are formed in the exceedingly minute membranous meshwork of the evaporating cell-walls, and these are capable of supporting a tension equivalent to many atmospheres pressure, while the columns of liquid in the conduits of the plant supply the loss by evaporation. They support their simple mechanical view by ingenious experiment and inference; but they admit that the results may be complicated by osmotic processes in the leaf. We should add that they certainly are complicated by the vital action of the protoplasm. We know now that the protoplasm in all the cells of a plant forms a continuous net-work only incompletely divided by the cell-walls; and we should hesitate to accept any theory which did not allow for the direct 'vital' action of this net-work of protoplasm.

A Polemic from Victoria Park.

We have received from Messrs. Swan Sonnenschein & Co. a copy of a pamphlet entitled "Microbes and Disease Germs, the Truth about the Anti-Toxin Treatment of Diphtheria," by Edward Berdoe. The question of anti-toxins is of surpassing interest both from the general scientific point of view and from the clinical point of view. As a scientific review we are prepared to give the most careful attention to any serious scientific treatise, and we are ready to make large allowance for rhetorical violence in the treatment of a burning topic. But there must be some evidence that ability to take a serious view of a serious topic underlies the rhetoric. Dr. Berdoe incorporates in his argument a leader from the *Star*, in the *Star's* happiest "Knock 'em in the Old Kent Road" vein. He talks about the anti-toxin, which he pretends to be discussing seriously, as "filth," and, with regard to the question of hydrophobia, he says he "would as soon believe the savages as he would M. Pasteur." For our part, we would as soon deal with the *Star* at first hand as a scientific treatise as we would with Dr. Berdoe. And we make our apologies to the *Star* for the comparison.

Count Solms-Laubach, Professor of Botany at Strasburg, has contributed to our Linnean Society, of which he is a foreign member, a Monograph of the Acetabularieæ (*Trans. Linn. Soc.*, vol. v., part i.). Of the four genera included in this sub-family of siphonaceous green algæ the largest, *Acetabularia*, contains fifteen species, seven of which are now described for the first time. Of these, five come from the seas of tropical Asia, especially the far east, five from the neighbourhood of the Gulf of Mexico, three from the Australian Coasts, and one from Mauritius. *Halicoryne* has two species, inhabiting the Loo-Choo and Philippine Islands and New Caledonia respectively. *Chalmasia* is a new genus with one species from the West Indies, while *Acicularia* contains one recent species from the West Indies and tropical South America and three fossil ones from the Miocene of the Crimea and Austria, and the Eocene of the Paris basin.

In our notice of the *Index to Periodicals* in our last issue (p. 214) we omitted to mention a suggestion which appeared in the *Review of Reviews* for August. Several letters have been received by Mr. Stead from readers, asking that certain magazines and periodicals of occasional service, not preserved in public libraries, should be stored at Norfolk House for the use of those requiring them. The idea further is that such should be available for loan and return. This is no doubt a good suggestion, but we fear even Mr. Stead would find it an overwhelming charge. It seems more to the point to suggest that Mr. Stead should present to some big library (say Guildhall, for instance) at certain intervals those periodicals received by him but missing in that library, rather than that he should start another library for their special housing.

I.

The Sixth International Geographical Congress.

THE Royal Geographical Society, as the hosts of the International Geographical Congress, may be congratulated on having scored a great success. The numerous Government delegates and representatives of foreign societies from all the ends of the earth have come and gone, and they have all expressed pleasure and satisfaction, alike with the serious work accomplished and with the entertainment provided for them. The responsibility of so large a gathering seems a heavy burden to lay on a Society like the Geographical, especially as it has not received any visible support from either the State or the Municipality, and has even had to pay a large sum for accommodation in the Imperial Institute. But the credit of success becomes thereby all the greater, as this is the first occasion on which the hosts of the Congress have been so thrown on their own resources.

Perhaps the secret of success in these meetings is that, like the British Empire, they have no definite constitution. Each city visited by the Congress is at liberty to make what arrangement it pleases, and so to make the best of itself; and the burning questions of geography can be discussed and settled in the manner best suited to the time and place of meeting. Compared with former Congresses, we should say that the sixth was remarkable for the just balance of its different parts, and for their mutual independence: when the Congress met in solemn conference it worked hard at the question in hand, undisturbed by a feeling that the Exhibitions were, after all, the most important feature; and when the deliberations were over there was still energy left to enjoy the round of gaiety.

Popular, as well as scientific, interest centred in the general meetings, which were convened each morning for the discussion of some important branch of geographical science, and usually continued, after adjournment, in the afternoon. The Sections, of which there were never more than two, and sometimes only one, did not usually meet till the afternoon, and devoted their attention to more technical matters. Antarctic Exploration was the feature of the first day. The subject was introduced by Geheimrath Professor Dr. Neumayer, the veteran chief of the Deutsche Seewarte. Various shades of scientific opinion were represented in the discussion by such authorities as Sir Joseph Hooker—now the only survivor of Ross's Expedition in the "Erebus" and "Terror" in 1843—Dr. John Murray, Mr. de Lapparent, and General Greely. It was unfortunate that Mr. C. E. Borchgrevink did not reach this country in time to read his paper on the same day; but he was enthusiastically received at a later meeting, and it was felt that his description of the neighbourhood of Cape Adare removed one of the most serious difficulties which has hitherto stood in the way of Antarctic exploration—the want of a place suitable for wintering. We hope that the strong expression of opinion on the part of the Congress as to the results to be expected from an Antarctic expedition will help to bring this country to the sticking point; for if we do not undertake the work soon, somebody else assuredly will.

There was a general disposition to reserve judgment as to schemes for Arctic exploration until something is known about the expeditions at present in those regions. Mr. S. A. Andrée's scheme for sailing from Spitzbergen across the Pole in a balloon was rather severely criticised; but so far as appeared there was no fatal objection to the methods proposed. It takes a good deal of faith to believe that the wind will carry a balloon to the Pole and bring it back again to civilised latitudes; but if Mr. Andrée is willing to risk it, no one can prove it to be impossible, and a stroke of luck might realise the dreams of ages in a few days.

The other great field-day was over the colonisation of tropical Africa. Mr. Stanley to the contrary notwithstanding, it seemed to be clearly brought out that in tropical Africa, more than anywhere else, we must have a sound basis of scientific geographical knowledge of the country to go on before we can really know how to make the most of it. The acquisition of that knowledge will be costly enough, but not so ruinous in lives and capital as the methods we have been accustomed to adopt in the past. After the general discussion, to which Sir John Kirk, Count Pfeil, Mr. Stanley, Mr. Ravenstein, Mr. Silva White, Mr. Lionel Dècle, Slatin Pasha, and other authorities contributed, General Chapman read a paper on the Mapping of Africa. A resolution was afterwards drawn up on this subject by a committee, which recommended, among other things, the accurate determination of a number of fixed points from which travellers could take their "departures," and advised travellers to sketch areas rather than mere routes. We may be permitted to express the hope that similar excellent advice in other branches of science may be formulated for the benefit of explorers, who cannot be experts in every department, any more than people who stay at home. It seems a pity, for example, to burden a traveller, whose main object is to cover ground as quickly as possible, with a complete set of meteorological instruments and the maddening worry of observing with them. Rain-gauges and thermometers are excellent in their place, which is necessarily fixed, but on a journey a full record of wind direction and force, and of cloud types and movements, with "weather notes," would be infinitely more valuable, and not half the trouble to keep. And yet few travellers know how to make the observations.

In the matter of geographical education, which only came before a Section, the discussion was more one-sided, this country being so far behind most of the others represented at the Congress. It was evident, however, that we have begun to move in the right direction, and the speed may increase geometrically; for it is only by geographical education we can learn that what is for the most part at present taught as such, is *not* geography, and, until we learn that, geographical education will probably remain more or less defective.

Another general meeting considered ancient maps, and for the benefit of future congresses an excellent resolution was passed pointing out to all cartographers and map-publishers that the value of their productions was greatly increased when they bore the date of their publication. Historical maps were rather a specialty of the Congress, by reason of the quite exceptional merit of Mr. Ravenstein's exhibition illustrating the rise and progress of cartography. This collection contained specimens of no less than thirty of the fifty-three known editions of Ptolemy, beginning with the "Geographia in terza rima," published at Florence in 1478, besides such treasures as the Queen's Leonardo da Vinci maps, the Mollineux globe from the Middle Temple Library, the "Henry II." map belonging to the Earl of Crawford, and endless others.

In the sectional meetings one had, of course, more opportunity of seeing "how it was done," and of being impressed with the variety of special subjects which legitimately fall within the range of geography. Surveying, like everything else, has become indebted to photography. Dr. Schlichter's application of it to the measurement of lunar distances is already well-known, and a modification of his method, which Captain Hills described, excited some interest. In drawing maps the uses of photography promise to be endless, and several very ingenious instruments have already done practical work, notably a combined theodolite and camera described by Mr. Schrader, and a "panoram" for producing photographs of the whole horizon, invented by Colonel Stewart and exhibited to the Congress by Mr. Coles. If we bear in mind, as Mr. de Dechy pointed out, that photography must always be *auxiliary* to triangulation, there seems no reason to suppose that a map constructed from a few fixed points and a number of photographs should contain serious errors. Indeed, Mr. Coles has already proved that it need not, by his map of parts of the Caucasus, founded almost wholly on such data.

Geodesy is one of those subjects in which even a moderate amount of progress represents an enormous quantity of work. The papers by General Walker and Mr. A. de Smidt, late Surveyors

General of India and at the Cape, gave results which could only be achieved after immense labour on the part of their respective departments. They made one regret that so many obstacles may stand in the way of seeing an unbroken line of triangulation stretch from the Cape of Good Hope northwards to the Nile Valley, and thence through Greece to the North Cape; and another from Ceylon, across India and Russia, to the same point.

Many papers of interest were presented to the sections at other meetings; but, for want of space, we must omit even the titles of most of them. One meeting considered the Morphology of the Earth, in which Professor Penck opened the proceedings with a paper on the Morphology and Terminology of Land Forms. We may hope soon to see a translation of his great book, which will give this subject its proper position in this country. In the Section on Oceanography a feeling of satisfaction, mingled with regret that the work of the "Challenger" Expedition Commission had come to an end, was distinctly observed; but there was evidence of plenty of work going on in building on that great foundation. The Prince of Monaco sent an account of recent work on board the "Princess Alice," and Professor Pettersson, of Stockholm, propounded a scheme for further work in the North Sea—with the British share in this readers of NATURAL SCIENCE are already familiar—a scheme which afterwards received the unanimous approval of the Congress. Some progress was made towards a reformed system of geographical spelling, of which even the outsider, who finds that Venezia, Venise, Venice, and Venedig are all the same place, may well appreciate the need, even when he is not concerned with place-names in Central Africa.

There seems little doubt that the International Geographical Congress, as a body, has found its work, and we may confidently expect that when it meets in Berlin in 1899 it will have great achievements to show, especially as it has decided that its present officers are to retain their posts during the interval.

H. N. DICKSON.

II.

The Rôle of Sex.

Part II.

The Utility of Conjugation.

AS already mentioned, there are two methods of reproduction, asexual and sexual. In the former case, a portion of an individual, generally a reproductive cell, grows and develops into an adult. Thus, in certain times of the year the aphides produce fresh brood without sexual assistance, and tubers and cuttings can be used in the propagation of potatoes and roses. In the case of sexual reproduction, matter, generally in the form of reproductive cells, is mingled by two individuals, and from the resultant mass development proceeds. Now, it appears that there are some material advantages to be gained by the second method, for we find that long-continued asexual reproduction leads to deterioration and final extinction. Thus, trees and plants produced for many years by tubers or cuttings, show marked deterioration, or become subject to disease, an indication of some hereditary weakness. The ciliated infusoria observed by Maupas pass through periods where sexual conjugation does not occur, but finally, if life is to continue, they must conjugate with individuals of other stocks. Conjugation, and especially conjugation between different stocks of the same species, is, therefore, in some way advantageous, even necessary, and we have now to ask in what way it is advantageous.

Many naturalists affirm that the process of conjugation is a rejuvenescence, and are content with this. But this is no explanation, and cannot be viewed even as an attempt at one. It is a fact that plants or animals deteriorated by long-continued asexual reproduction may make a new and vigorous start if permitted to conjugate with other individuals; but to say that this is rejuvenescence merely expresses, by a metaphor of very superficial application, the fact which we are called to explain.

According to Weismann, sexual reproduction is of utility, inasmuch as he supposes that it "gives Natural Selection a choice of innumerable combinations of the most diversified variations to act upon."[1] "I am convinced," he says, "that the conjugation of

[1] *The Germ Plasma, a Theory of Heredity.* Translation by W. N. Parker; London, 1893; pp. 413, 431, and 463.

unicellular, and the sexual reproduction of multicellular organisms, are means of producing variations. The process furnishes an inexhaustible supply of fresh combinations of individual variations which are indispensable to the process of selection." Here is a definite scientific hypothesis which can be examined in the light of such facts as we possess.

Weismann, we must observe, does not affirm that variation is primarily due to conjugation, but agrees with Darwin and most others in thinking that the power to vary lies in all protoplasm independent of conjugation. In support of this, we know that no two cells of the body are quite similar to each other, and many are very unlike, yet these have arisen from the original fertilised ovum by asexual division, without conjugation. By repeated division the fertilised ovum gives rise to cells which at once begin to vary, and finally change into what we call the cells of epithelium, muscle, cartilage, etc. In plant life we constantly come across variations in which sexual union has played no part; such, for instance, as eccentric leaves and branches which may suddenly arise during the life of a growing tree.

The use of sexual conjugation is, according to Weismann, to give to natural selection a *greater* choice, to present to it an *increased* number of variations. Now, at the outset, this explanation of the utility of sexual conjugation appears to me to be unsatisfactory, because in natural selection alone we have the means of bringing about any degree of variability we require. If some of the individuals of a species are not variable enough, natural selection will preserve the more variable ones, thus increasing the variability of the species; for variability, like everything else, can be transmitted by heredity. The extraordinary power of selection in modifying variability may be appreciated when we study in contrast wild and domesticated or cultivated animals and plants. In the wild condition most types remain practically unchanged for long periods of time, they have become adapted to their conditions of life, and these as a rule remain pretty uniform. Natural selection will operate largely in destroying any marked variety, and those strains will be perpetuated which evince little tendency to produce variation. When, however, we cultivate or domesticate these types, and when we encourage variations by selecting them in preference to forms of the original type, we preserve variable strains, and the breed under domestication may become very variable. Weismann's theory of the use of conjugation assigns to it a function possessed in marked degree by natural selection, and we are tempted to believe that it will have a function peculiar to itself.

Let us examine a little more closely the facts of sexual and asexual reproduction, contrasting these with each other. It is generally acknowledged, and it was strongly emphasised by Darwin, that among plants a variation can be propagated with certainty by the asexual method alone. If we try to perpetuate it by seeds it tends to revert to the original type, and on this account it is the custom to perpetuate suitable varieties by means of grafts and cuttings. In the case of the ciliated infusoria passing through several generations of asexual reproduction, we find progressive changes terminating in debility and death. In reproduction without conjugation an individual is cut off completely from the rest of the species, and gives rise to an isolated line of descendants. If the individual is a variety its progeny will almost to a certainty be varieties too, subject always to fresh and changing variation. In its line of descendants every fresh individual starts again on a fresh line, and so it goes on like a tree, the branches of which never touch. Sooner or later every living individual will be found to have deviated in all possible directions from the ancestral form.

Now, in the case of reproduction with conjugation, the facts differ widely from the above. The progeny of two parents tends to what we may term, after Galton, the mid-parent [1]—nay, it tends even more to approach the mean average type of the species than the mid-parent itself. In plants, as Darwin has shown, much the same thing occurs, the progeny being either intermediate between their parents in all points, resembling one parent most in one point, and another in another point, or the influence of one parent may predominate over the influence of the other. To take two concrete cases, the branch of a tree which differs from the rest by having variegated leaves, may be propagated again and again by cuttings, but a six-fingered man, although he may pass on this variety to some of his more immediate progeny, will not permanently impress the race. In the latter case, each crossing will enable the influence of more typical members of the species to assert itself, and so by degrees the variation will, as it were, be overpowered. Conjugation previous to reproduction tends therefore to bring the offspring of varieties more towards the mid-type of the species; it works in distinct opposition to variation, and the latter can never establish itself unless it is useful and external circumstances are peculiarly favourable, preserving only those of the offspring which continue to show in some degree the parental variation.

Now, it appears to me a matter for some surprise that, with the facts so clearly stated by Darwin, Galton, and others, and accepted by Weismann himself, biologists have not accepted these as establishing very fully the *rôle* or function of conjugation. It has this *rôle*: it brings the offspring of the act of conjugation nearer the mid-type than even the mid-parent itself, while the cutting from the variegated branch deviates as markedly from the mid-type as the branch itself. I venture, therefore, to bring forward this explanation of the *rôle* of sex, not as a theory, but as a fact, resting on a solid basis of experimental evidence hitherto ignored in this relationship.

I imagine that Weismann, and the many biologists who follow

[1] *Natural Inheritance.* By Francis Galton, 1889.

him, have been led aside by the very natural claim upon the attention which the results of variation must present. We have in nature thousands of species and varieties living lives as diverse as are their bodily constructions. These are the objects of interest to the naturalist, and the chief aim of his study is to discover how they arose and what was the story of their development. But we have to remember that, although to us variations are of great interest, they but occasionally establish and transmit themselves—one to a million as against the transmission of more typical individuals.

For a thousand years the bird which has white plumage or the sheep which has short legs will die of hunger or fall a prey to foes before even sexual maturity is reached. Only when it finds itself in a land of snow will the white bird have a chance, and the sheep with short legs is only safe when taken under the protection of the farmer. But this establishment of a variation is not an everyday circumstance in the life of a species, it occurs only now and then: for a hundred to one, a thousand to one, or even a million to one, the best thing is to be typical of the species, to be a conservative, a true chip of the old block. Many species, like the housefly and cockroach, have come down to us practically unaltered since geological times, and the changes occurring in most species only occur with extreme slowness.

Living forms are, therefore, not only capable of variation, but by sexual conjugation these variations tend, as it were, continually to be brought back into the fold. By sexual conjugation we have the possibility of the long continuance of a type when it has adapted itself fully to its environment; by variation we have a means of adaptation to a new or changing environment. Were it not for conjugation we should not find living forms existing in genera and species. With asexual reproduction we should have an infinite number of varieties, each of these giving rise, in course of time, to new ones. With conjugation we have the inter-action of individuals upon one another, with the formation of progeny which, on the whole, tends to a mean; and among individuals capable of thus conjugating, the resemblance between them is maintained, and they form a group recognisable by common characters.

I am convinced by many personal conversations that the facts relating to chemical combinations have greatly influenced the minds of biologists, and have led them to accept increased variation as the *rôle* of conjugation. The facts of chemistry are better established and more easily understood than the facts with which we have to deal; and not unnaturally we frequently turn to them and try to arrange and interpret our facts by the side of these. Much good may come of this method provided we remember that living matter exhibits phenomena which non-living matter does not, for a phenomenon in chemistry may sometimes lead to the discovery of a similar one in biology by setting us to look for it. We have, however, no warrant for assuming that we shall find all chemical phenomena repeated in biology. No clear-thinking biologist will, when it is thus put to him, assert that because element A and element B produce a compound C, totally unlike either A or B, that two conjugating individuals will do the same. This is obviously not the result, and the biological facts must therefore be taken and studied by themselves. These facts show that when two individuals conjugate, their offspring tends to blend their qualities, as when the cross between the negro and the white man gives rise to offspring of an intermediate shade. Even where a quality appears, like the colour of the eye, to be transmitted altogether or not at all, Galton remarks that in these cases the tendency to blend is never absolutely excluded.[1]

The plant or animal grows from the fertilised ovum, or from the cutting, and in the case of some animals from an egg which has not been fertilised at all. Here by asexual cell-division arise two cells, which in the case of many animals vary slightly from each other; their progeny continue this variation again and again, until as a result such cells are reached as those of the brain, the blood, the skin, the liver, and a hundred others. Embryology is a study of deviating lines of variation from the fertilised ovum, from which, by asexual reproduction, in the course of a few weeks, and in some animals in a few days, we may obtain types totally dissimilar to each other. This has always appeared to me to be the most striking example of variation in existence, and we note its occurrence in association with asexual reproduction.

It is generally admitted that conjugation between members of the same family fails to produce as vigorous a stock as crossing between members of different families. Animals that interbreed are proverbially delicate and wanting in physique, and this condition reminds us of the infusoria of Maupas, which were kept from conjugating with infusoria of other families and which perpetuated themselves asexually. Now, I do not see how this lack of vigour, which is an outstanding feature of asexual reproduction and inbreeding, can be explained on Weismann's theory. Although the environmental conditions of life in a warren are the same to-day as they will be in twenty years, yet the interbred progeny of a pair of rabbits will seriously deteriorate and probably die out during that time.

There must be something conservative in the act of crossing, something which keeps up that vigour and vitality which is lost without it. Now, this is easily explained if we consider the question a little more closely, and it may assist us if we examine the family histories of those of our acquaintances with which we are most familiar. We know more as to the causes of lack of vigour in our own species than in any other; human pathology has advanced with wonderful strides, and we have many facts to go upon. We learn that there are very few families without some constitutional weakness. Some are consumptive, others have a tendency to gout, etc.

[1] *Op. cit.*

We know as a fact, that if a consumptive marries with one of another family without that tendency, the chances are far better for the children than if he married, say, a first cousin. The same applies to insanity, and, as far as we know, to every constitutional weakness. It follows from this that what we may term pathological variations will tend to perpetuate themselves either by asexual reproduction, or, what comes to the same thing, by inbreeding. Crossing preserves the progeny, but does so by approximating the progeny to the mid-species. Whereas a scrofulous or a neurotic family inbred for several generations would suffer absolute extinction, even two such unfavourable types might manage to survive by crossing, for some of the progeny would probably so far approximate the mid-species as to be neither insane nor scrofulous. It is reasonable to suppose that when we know more of pathology, we may have something definite to say about the weakness which causes the potato to fall a prey to disease, and the infusoria to perish, unless crossed with other races. In the meanwhile, we recognise that there is a weakness, and we know of its existence in higher types, where we have studied it more fully.

May we not sum up the argument in a few words as follows? Variation is a function of all methods of reproduction, and the most marked cases of variation are seen in the ontogeny of a single individual, where the diverse tissues all arise by asexual divisions of a single cell. Conjugation, or sexual reproduction, brings the progeny to the mid-type, so that a thousand pugs, cats, mice, or men all more or less resemble each other, and their qualities may be plotted out in simple curves. This is not the case with asexual division, for here each product parts company with and is uninfluenced by the rest of its relations. This conservation of the type brought about by sexual conjugation is an outstanding character of undeniable importance, and preserves a species where the environment is uniform.

J. B. Haycraft.

University College, Cardiff.

III.

The "Exposition de Madagascar" at the Jardin des Plantes.

THE Professors at the Jardin des Plantes have taken the opportunity of the present enthusiasm of the French about their "new Colony" of Madagascar to put together a collection of the natural history of that island which well illustrates its many strange and peculiar features. The "Exposition de Madagascar" has been arranged in two rooms in the new gallery of the Musée d'Histoire Naturelle, under the supervision, we believe, of Mr. Alfred Grandidier, whose name is well known as that of our chief scientific authority upon the island.

Commencing with the mammals, the first object that claims attention is the splendid series of lemurs—one of the most characteristic families of the Malagasy mammal-fauna. All the numerous species of this group are illustrated by one or more specimens, and the exact range of all the species, which are in most cases representative of each other in different districts, is shown in a small map attached to it. The carnivores and rodents succeed, and are treated of in a similar manner. The collection of birds, which follows next, is also very complete, the French National Museum being unrivalled as regards its wealth in this branch of the Madagascar fauna. It is arranged according to the system and nomenclature of the splendid volumes on the birds of the island which Mr. Grandidier has published in his great work. Among the reptiles, the chameleons claim particular notice, as specially characteristic of the animal life of Madagascar. Of these strange arboreal lizards, of which some fifty or sixty are known to science, thirty-one are found in various parts of Madagascar and its adjacent islands. All are here exhibited, from the gigantic *Chamæleon oustaleti*, with its body a foot long, to the minute *Brookesia tuberculata*, scarcely an inch in length. With the fresh-water fishes, which follow the reptiles, are concluded the series of Madagascar vertebrates, and then come the land-shells, insects, and other invertebrates.

The extinct fauna of Madagascar, in which so many important discoveries have recently been made, is not less well illustrated in the "Exposition" than the modern phase of life. In the first place may be noticed a nearly complete mounted skeleton of the former hippopotamus of Madagascar, *Hippopotamus lemorlei*, which betrays perhaps more than any other known object the ancient connection of Madagascar with the African Continent. Splendid specimens of the extinct gigantic tortoises, *Testudo grandidieri* and *Testudo abrupta*, are likewise shown, and numerous other fossils. A large series of the remains of the Aepyornithes—the extinct ratite birds of Madagascar, and several of their enormous eggs attract our attention. Diagrams of the restored skeletons of two species of these gigantic creatures show us that *Aepyornis ingens* must have been about nine feet high, and *Ae. mulleri* about six feet. But we believe these species were not quite the largest of this wonderful Order of birds. It appears that the bones of the Aepyornithes are mostly found in the interior, while the eggs are dug up in the sands of the seashore. This would seem to indicate that these birds, like some of the Megapodes, resorted to the seashore to lay their eggs, and probably left them to be hatched out in the hot sand. This theory will perhaps account for the eggs being so much larger in proportionate size than those of any other known birds. It was advisable that the chick, deprived of parental care, should come to a full degree of development before it issued from the egg-shell.

Besides the objects that have been particularly noticed there will be found in this exhibition sets of plants, native costumes, numbers of photographs of the various tribes of Madagascar and of its scenery, and a large selection of plates and drawings taken from Mr. Grandidier's great work. No naturalist who goes to Paris should fail to pay a visit to the "Exposition de Madagascar."

P. L. Sclater.

IV.

On the Relation of Philosophy to Natural Science.[1]

IN explanation of the above title, I may mention that a prize for the best essay on the subject was offered by the Philosophical Society of Berlin in 1891. The question not being personal, but purely scientific, is, however, open to independent enquirers at any time.

Some forty years ago Mr. Herbert Spencer commenced a "System of Synthetic Philosophy," and in a comparatively modern edition (the fifth, 1887) of the "First Principles," chapter i., part ii., p. 127, under the heading "Philosophy Defined," he has done good service in attempting to give a definition of Philosophy. After some preliminary remarks, he says:—

"The truths of philosophy thus bear the same relation to the highest scientific truths that each of these bears to lower scientific truths. As each widest generalisation of science comprehends and consolidates the narrower generalisations of its own division, so the generalisations of philosophy comprehend and consolidate the widest generalisations of science. It is, therefore, a knowledge the extreme opposite in kind to that which experience first accumulates. It is the final product of that process which begins with a mere colligation of crude observations, goes on establishing propositions that are broader and more separated from particular cases, and ends in universal propositions. Or to bring the definition to its simplest and clearest form, Knowledge of the lowest kind is un-unified knowledge; science is partially unified knowledge; Philosophy is completely unified knowledge." ("First Principles," pp. 133, 134.)

According to this definition, it appears that philosophy purports to be a development of science up to complete unification; or that a system of philosophy is understood to include science as an integral part of itself; and, therefore, the relation of philosophy to science simply represents the relation of knowledge completely unified to knowledge partially unified. It appears, then, that the answer to the prize essay in question is given in these few words, in terms of Mr. Spencer's definition of philosophy.

Certain fundamental intuitions, Mr. Spencer remarks, that are

[1] "Das Verhältniss der Philosophie zu dem empirischen Wissenschaft von der Natur."

"essential to the process of thinking" must be assumed as true *provisionally*, leaving the assumption of their infallibility to be justified by the "congruity of the results reached through the assumption of them," or by showing that there is an agreement between the experiences they lead us to anticipate and the actual experiences. These ultimate intuitions constitute the "Data of Philosophy"; and they are, first, that fundamental relation between Subject and Object "taken for granted in every act of daily life, and assumed as beyond question in scientific investigations of all orders," secondly, and connected with the foregoing, the primary truth of the "Persistence of Force." Such, then, is the foundation of Mr. Herbert Spencer's System of Philosophy, which he defends against the adverse views of some philosophical authors[1]; and the same basis is adopted by science.

In respect to the "fundamental intuitions" mentioned above, it may be observed that these "intuitions" themselves are, according to Mr. Spencer, derived from ancestral experiences, or inherited from the collective experiences of the whole line of organised beings from whom (on the hypothesis of evolution) man is descended. Therefore they are ingrained in the organism, and are ineradicable.

The careful tracing of one general formula of evolution applicable to the changes undergone by all orders of existences appears to be the chief contribution to the unification of knowledge which Mr. Spencer makes in the "First Principles." The processes of development which evolution follows in the several realms of inorganic, organic, and super-organic existences, comprising even art and science, are, says Mr. Spencer, analogous in their main stages. Wolff and Von Baer are mentioned as contributing the germ of the formula which Mr. Spencer has developed and applied to existences of all orders, consistently with a previous conviction of the prevalence of "unity of method throughout nature." ("First Principles," pp. 337, 359, etc.)

Mr. Spencer's first communication on the subject was in the form of an essay published in the *Westminster Review* for April, 1857, under the title, "Progress: its Law and Cause." The formula as given in the "First Principles," p. 396, may be appended: "Evolution is an integration of matter and concomitant dissipation of motion, during which the matter passes from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity, and during which the retained motion undergoes a parallel transformation."

The condensed shape in which this formula is presented may at first sight convey an inadequate idea of its import, in the absence of examples of its application. It will not, of course, affect the validity of the doctrine of evolution itself, even if some should doubt whether the applicability of the above formula is so universal as is contended. It may be superfluous to remark that the doctrine of evolution merely

[1] "Principles of Psychology," vol. ii., pp. 312 et sqq.

teaches that processes take place according to natural laws. Although the broad and general terms in which the above formula is worded may make its precise application to detail a thing scarcely to be expected, it may none the less be viewed as a valuable contribution to the coördination of the procedure of natural processes, where we should otherwise be left in the dark. That the author also uses his formula as an aid to organise, classify, and integrate the subdivisions of his works into a coherent system is manifest, philosophy being a super-organic product in a certain sense "evolved."

How is it, it may be asked, that while the formula of evolution implies that heterogeneity or complexity is a concomitant of progress, nevertheless in the invention of machinery, simplicity and not complexity is made the object of study? Here at least simplification is one phase of progress, and simplicity being unique of its kind, is not easy to discover.

An analysis may, however, remove this apparent contradiction. A modern machine, such as a locomotive or a steamship, is more complex or heterogeneous than that of an older type; not, however, that simplification is less studied than formerly, but that the machine has to fulfil additional functions, for which, of course, additional mechanism is required. It does not, however, follow that the mechanism itself is wanting in simplicity, or that the simplicity aimed at has not been gained. The complexity or heterogeneity here consists in the variety of machines, some subsidiary, not in the complication of any particular piece of mechanism. In fact any suggestion for simplifying the mechanism is always welcomed. Machines, like the higher animals, have advanced in heterogeneity on account of the multiplication of the separate functions attendant on a higher degree of civilisation. Hence it appears that the formula of evolution applies, provided all the conditions are allowed for.

Referring to the proposed definition of philosophy, Mr. Spencer observes:—"Science means merely the family of the sciences—stands for nothing more than the sum of knowledge formed of their contributions; and ignores the knowledge constituted by the *fusion* of all these contributions into a whole. As usage has defined it, science consists of truths existing more or less separated, and does not recognise these truths as entirely integrated." ("First Principles," p. 132.)

This seems to imply that although between philosophy and science no sharp line of demarcation exists, yet the distinctive name "Philosophy" is convenient for indicating the contents of a volume bearing that title. If the volume form part of a "System of Philosophy," it will constitute a unit in a collective treatise, whose main object is the complete unification of the knowledge partially unified by science; the more abstract reasoning required for extreme generalisation tending to become a specialised field of investigation, even if the method involved be the same as in science.

This pursuit of scientific investigation under a different name, "Philosophy," without any change of method, has probably been the cause of some confusion as to what "Philosophy" is; and to define its relation to Science was, in fact, the motive for giving it as the subject of the prize essay, and the incentive to the thoughts of which this paper is the outcome.

It might be said that if philosophic authors appear less precise, and possibly more bold, in their inferences, they are freer from certain prejudices. No "battle" should have been required over evolution surely, in order to introduce it to the scientific world. Evolution teaches no more than that facts take place in accordance with natural causes. There is no supposition of supernatural interference in order to maintain the theory of gravitation or the movements of the planets, even if Kepler conjectured something of the kind. Why, then, suppose supernatural interference in molecular movements, or in connection with evolutionary phenomena? Here experiment is obviously not excluded; the evolutionary changes converting wild animals into domestic ones have been produced by ourselves. Why imagine, then, that the effects generally classed under evolution should be exceptional, in the respect of possibly deviating from the laws of nature?

Some of the scientifically cultured may be unacquainted with Hume's investigation concerning the limits of scientific enquiry, developed with greater precision in Mr. Spencer's analysis respecting the question of origin and the mystery surrounding the universe ("First Principles," pp. 30–36). The researches of philosophy are certainly an excellent school for the elimination of any (possibly partly inherited) bias, which physics, chemistry, or analogous studies would leave untouched. It will probably be conceded that some philosophical Reviews (or "Addresses") have not been without service in this direction.

The late Professor von Helmholtz once observed that in some respects the modern telescope surpasses the eye in optical qualities. To endorse this does not necessarily imply that the adaptation of the eye is unfitted for its purpose. Nevertheless, it is possible to understand how art can occasionally surpass nature, especially when science and art combine, they being, in the case of the telescope, the natural product of an unbroken process of evolution—where the evolution of the human brain was a preliminary stage. The telescope, therefore, represents a super-organic product, a secondary or more advanced stage of the evolutionary procedure. Consequently, it appears that a superior refinement in some directions may be expected, where the eye itself might be left behind.

Super-organic evolution seems to be of some importance as an idea, since nature, depreciated by ignoring this point of view, may thereby come to be esteemed in a higher degree. By the conception of super-organic evolution, we realise, for instance, how the great achievements of science, art of various kinds, poetry, music, etc., constitute part of nature, and we ourselves part of the universe, comprised under nature, which we raise by our endeavours and by this view.

By omitting to realise the fact of Man being a part of the universe, not merely situate there, we lose sight of a lever, by which intelligence—from its dynamical[1] side—operates upon the universe. In this sense Man becomes independent (*i.e.*, not dominated tyrannically by the universe, without reciprocal powers of action), acquiring all the privileges attached to membership of the community of nature.

It appears accordingly that free-will exists in the only sense conceivable. Those who contend that more freedom than this is desirable would do a service by trying to define that condition they would wish in preference to see prevailing. We receive our existence gratuitously, evolved out of the universe without pay or cost; and we may expect to rough it a little with the chance of contributing to the dignity of nature by our career. In the past rise of man through a long train of progressive evolution, as in the case of life generally, the "inner relations" being evolved from the "outer relations" (environment), are thereby made best adapted for the "outer relations," or brought into accord with them by the most fitting method conceivable.

Hamburg. S. Tolver Preston.

[1] The material side of intelligence is, of course, represented by the brain, the constituent matter of which is in a state of active motion, pervaded by the light-conveying ether.

V.

Morphology at the National Museum.

WHEN, in 1862, Professor Owen, afterwards Sir Richard Owen, published a scheme for the erection of a National Museum of Natural History at South Kensington, he designed that in the centre of the building there should be a lecture theatre, and above it a circular domed museum of 100 feet diameter, which would " serve for the reception of an Elementary Collection, illustrating the characters of the Provinces, Classes, Orders, and Genera of the Animal Kingdom." The series of specimens proposed to be there displayed were to be of such a nature as would be most profitably shown to, and studied by, the wage-classes after the hours of work. The specimens were to be accompanied by instructive labels, and, where necessary, diagrams ; and this, he urged, " would best fulfil the wish of the Legislature as expressed by the 'Report of the Select Committee on Public Institutions' of 1860, and reiterated by honourable members in successive annual debates on the British Museum."

Later, it was decided to dispense with the lecture theatre, but the idea of an introductory or index museum was firmly adhered to, and the recesses or bays on the east and west sides of the entrance hall were to be reserved for the purpose. The first steps were taken towards the realisation of this project as soon as the cases were ready to receive specimens, and in 1882 a " Guide to the Index Museum, Aves," eight pages in length, was issued and sold in the Museum. This guide is very interesting as showing what were the exact lines on which Owen intended to elaborate his scheme of an introductory series. The pamphlet begins in very popular language, but as soon as technical terms are introduced the character of the text changes, and such passages, for instance, as the description of the brain of the bird are certainly not adapted to the intellect of the general public. Although the conception of the idea of an Index Museum occurred as far back as 1860, the collection cannot be said to have received actual shape until Sir William Flower succeeded to the directorship of the Museum. The first real impetus to the work was given when, in 1884, he appointed Mr. R. S. Wray, B.Sc., who unhappily succumbed to pulmonary phthisis in 1889, to assist him in this work.

The present scope of the Index Museum may be gathered from the "General Guide to the British Museum, Natural History," in which it is stated that the whole of the specimens contained in the museum are arranged in three sections,—a reserve series, not exhibited, but accessible to specialists and investigators, a systematic series exhibited in the various galleries of the museum, where the visitor can identify and name his own specimens without recourse to assistance from the officials, and, thirdly, an introductory or index series, in which the leading features of structure and development are demonstrated, and the terms used in systematic works are explained by means of illustrative examples. The five bays or recesses on the west side of the hall are devoted to vertebrate morphology, while, on the east side, three bays are set apart for botanical collections, and the remaining two for invertebrate animals.

Although the work of forming this Index Collection has been progressing continuously for the past eleven years, there is still a large amount of space unoccupied in the cases, which not only points to the great care that is exercised in the selection and preparation of the specimens, but also shows what an extraordinary length of time pioneer ventures of this kind require for their completion. It is only natural to suppose that during this long time improvements have constantly suggested themselves, and have been adopted, and this accounts, to a large extent, for the slight want of uniformity which may be observed between the earlier and the later series of preparations. Not only is it necessary to admit that the present Index Collection is adapted to the requirements of the student rather than to the edification of the wage-classes as Owen had intended, but also that the more recent additions to the collection appeal to a more advanced type of student than the earlier preparations.

This is especially apparent in the wording of the labels. Thus, as examples of some of the earlier labels, we read "The heart is the central organ of the circulation, and acts as a suction pump in collecting blood from all parts of the body, etc.," and "The skeleton is a system of hard parts forming a framework which supports and protects the softer and more delicate organs and tissues of the body, etc.," whereas in descriptions of the later series, *e.g.*, that of the tendons of the bird's foot, the language is far more technical.

This studying of the interests of the student rather than of the general public has been adversely criticised by more than one educational authority, on the ground that the student can find all the facts here illustrated mentioned in his text-books, and that the Index Museum, instead of constituting an introduction to the systematic collections in the galleries, is developing into a "college museum."

That the latter statement is not without foundation is evident from the fact that educational museums are now being modelled on the same plan in different parts of the country, at the Tonbridge School Museum, for instance, and even abroad, as at the Columbia College, New York; and on somewhat similar lines Professor Ray

Lankester is reörganising the zoological collections in the Oxford University Museum. Yet an assemblage of specimens designed to illustrate only those characters at present employed for purposes of classification would, while assisting the tyro-systematist in the identification of genera and species, fail to suggest in what directions the sphere of taxonomic observation might be extended. Systematic zoology and botany are very largely mechanical, and are based on the combinations of a limited number of characters which are found to differ sufficiently for the purpose in the various families, genera, and species. The ultimate aim of the zoologist and botanist, however, is, or should be, not the description of so many new species in a lifetime, but the grouping of animals and plants according to their natural affinities, and for this purpose a wider knowledge of morphology is necessary. Limitation of the number of diagnostic characters is fatal to the advancement of systematic work. There are, it is true, many organs—the viscera of animals, for instance—which will probably never be made use of for the identification of species, because type-specimens are usually disembowelled before finding their way to a museum; but, at the same time, no systematist would be justified in issuing a new system of classification while ignoring the evidence of natural affinity to be afforded by internal organs. With regard to the former objection, there are surely very few who would maintain that the student derives no more benefit from the examination of a collection of anatomical preparations than he would from a text-book, however well illustrated. A figure, whether woodcut or coloured plate, always falls far short of the original by the loss of the third dimension of space: the examination of a prepared dissection is in educational value second only to the dissection of the parts by the student himself.

In such an educational collection, not only do the several classes of animals call for different methods of treatment, but the amount of space to be allotted to any one system of organs varies very considerably in the different classes. Thus, while a whole table-case is occupied by preparations of mammalian teeth, a few square inches suffice for the same organs in birds, and whereas the exo-skeleton of Amphibia is efficiently represented in an area of less than two square feet, the corresponding system in Mollusca, constituting as it does the basis of that special branch of science, conchology, calls for an inordinate amount of space. In the case of Amphibia, no one system of organs requires an exceptional amount of space for its due exposition, and the recently completed series of osteological and anatomical preparations illustrating the morphology of the Amphibia may therefore be regarded as typical and representative of the whole Index Collection.

This series is contained in a wall-case in the fourth bay on the west side of the entrance hall. The preparations are fixed to a board or facia, three feet high and seven feet wide, placed vertically so as to be parallel to the glass. It is a distinct advantage, under all circumstances, to have the front and back of a case parallel, but more especially is this desirable when wet preparations are to be exhibited. The case is of considerable depth, but, since there are no large specimens in the series, the facia is brought forward quite close to the glass, and every specimen is thus within convenient distance of the spectator. (Plate xix.)

The preparations are arranged in eleven upright columns, the broadest of which is ten inches and the narrowest five inches in width. The columns are marked off from one another by narrow strips of polished mahogany, and in each column the four orders of Amphibia are separated in a similar manner.

The tablets on which the specimens are mounted are covered with a neutral grey paper, and, since osteological preparations show to so much better advantage on a dark background, these are placed on rectangular black papers cut to such a size as to leave a $\frac{5}{8}$-inch grey border. The value of the grey border in relieving what would otherwise be a continuous black surface cannot be over-estimated; the total effect is not only more attractive and pleasing to the eye, but that feeling of depression which a large expanse of black surface engenders is removed.

Since the study of morphology involves palæontology quite as much as zoology, as regards those parts of the body which can be preserved to us as fossils, the remains of extinct Amphibia are treated in exactly the same manner as the hard parts of their living relatives.

The collection owes a great deal of its completeness to the fact that the practical difficulties of exhibiting spirit specimens and dried preparations side by side have been overcome in a manner which, if not perfect, marks a distinct advance on the methods of museum exposition previously in vogue. The distressing refraction which was so great a disadvantage in the use of oval or cylindrical bottles is avoided by the employment of rectangular glass jars, which are manufactured now far more neatly than when, not many years ago, they were first introduced into museums. The preservative employed is in all cases 70 per cent. alcohol. Great advantages have recently been claimed for an aqueous solution of formic aldehyd, but having regard to the chemical instability of this substance it is deemed prudent to wait, before employing it as a preservative, until more is known about its behaviour when exposed for any length of time to bright sunlight. The background of each spirit specimen is white or black according to the predominance of dark or light colours in the dissection. Specimens dissected from the dorsal or from the ventral surface are mounted with the snout uppermost, but in side dissections the head points to the left.

Every specimen is exhibited for a definite purpose, which is explained either in the label of the preparation or in that of the series of which it forms part. In the dry preparations each of the more important structures is pointed out by a narrow strip of paper, to the outer end of which a label bearing the name of the part is attached. A difficulty is experienced when applying this method of demonstration to spirit specimens. If the paper pointer attached to the label is to actually touch the structure which it is desired to indicate, the label must be sealed up in the spirit with the dissection. This method has been adopted in the preparation of the portal veins of the frog, in the last column but two; but, even disregarding the practical difficulties of so affixing the labels to a flexible dissection that in the finished preparation they may be perfectly horizontal (and it will be observed that nowhere in the series is the eye offended by obliquely sloping labels), the transparency of the paper in spirit and the subsequent discoloration render the labels less striking than those attached to osteological and other dry preparations. In all the dissections, with the exception of that just mentioned, the labels are affixed, not to the dissection, but to the front surface of the glass jar in which it is mounted, and, although the paper pointers cannot touch the part indicated, yet in very few cases is there any uncertainty as to what is specially intended to be shown, blood-vessels being injected, and nerves and small ganglia being made more conspicuous by strips of black paper placed beneath them. In all cases the free extremity of the pointer is exactly over the structure pointed at when the axis of vision is normal to the surface of the glass at that point, that is to say, when the free end of the pointer is in the centre of the reflected image of the one eye to which, for this purpose, the observer must limit himself.

Not the least important aim of the educationalist is the attainment of such methods of imparting instruction as shall enable the student to assimilate information with the least possible conscious effort. Any measure which is calculated to reduce the mental wear and tear is an important step towards the perfecting of our system of education. It will be noticed that in this series there are no long labels likely to weary or disgust the student. The labels are kept as short and concise as is consistent with accuracy, since it has been observed that, while a visitor will seldom take the trouble to read through a label of twenty lines, he will not hesitate to do so if that label be divided into four or five parts interspersed among the specimens.[1] The information furnished by a label at the top of a tablet is of a general nature and applies to the group of specimens below, whereas the label beneath each specimen has particular reference to that preparation only.

Specimens, whether dry or in spirit, too small to be labelled in the usual way, are accompanied by an enlarged drawing, and the

[1] In the August number of this Journal Mr. S. F. Harmer, reviewing the Fifth Annual Report of the Proceedings of the Museums Association, very justly condemns the employment of lengthy labels in museums, and furnishes one or two sound arguments in support of his position.

labels are affixed to the several parts of the drawing. When fossil specimens are either not obtainable on account of their rarity, or are too large for exhibition in the series, their place is taken by labelled drawings; and when the outline or position of any structure is not sufficiently obvious, *e.g.*, the sutures of bones, the teeth of small skulls, and the organs of the lateral line, recourse is had to the judicious application of a little bright colour.

It will be noticed that the classification adopted is alternately systematic and anatomical. Thus, the Vertebrata are first divided into the classes, Birds, Reptiles, Amphibians, etc., and the preparations illustrating Amphibian morphology are arranged according to the different systems of organs, Integument, Skull, Respiratory System, etc. The specimens in each of these divisions are grouped under the ordinal heads Anura, Urodela, etc., and in many cases structural peculiarities serve once more for the arrangement of the preparations in each order.

INTEGUMENT.—The first column is devoted to an exposition of the characters of the integument: the glandular nature of the skin is alluded to, and the periodic shedding of the outer layers of the epidermis is illustrated by the slough of a newt mounted in spirit. 'An epidermal exoskeleton is absent except in the Japanese Salamander (*Onychodactylus*) and in the Cape Toad (*Xenopus*), which are provided with claws.' Examples are therefore furnished of the feet of these two amphibians. 'The dermal exoskeleton is also but little developed in living Amphibia. In *Ceratophrys* among the Anura there is a bony plate behind the skull and in some of the Cæcilians there are small cycloid scales imbedded in the skin.' A complete skeleton of *Ceratophrys* shows the form and position of this dermal ossification; and a portion of the skin of *Ichthyophis*, a few isolated scales mounted on black paper, and an enlarged drawing of one of these scales illustrate the second form of dermal exoskeleton. 'In the Labyrinthodontia bony scutes are frequently present on the ventral aspect of the body,' a statement which is illustrated by a drawing of the ventral scutes of *Cricotus*.

VERTEBRAL COLUMN.—'The vertebral column of Anura is usually composed of nine vertebræ and an unsegmented urostyle.' The series commences with two vertebral columns of *Rana guppyi*, one showing the ventral surface and with the vertebræ articulated, the other disarticulated and with the articular surfaces of the centra coloured brown and those of the zygapophyses green. 'The vertebræ of Anura are mostly procœlous and devoid of free ribs, but in the *Discoglossidæ* and the *Aglossa* they are opisthocœlous, and in the former family the anterior vertebræ are provided with distinct ribs.' Examples: *Discoglossus* and *Xenopus*. Then follow a series of five vertebral columns of Anura showing the various degrees of expansion of the sacral diapophyses. The short vertebral columns of the Anura are mounted whole, but in the other orders selected vertebræ only are shown. *Molge watlii* is chosen to illustrate the opisthocœlous vertebræ of the Salamandridæ, and as examples of amphicœlous vertebræ those of *Menopoma* and *Siren* are exhibited. The amphicœlous character of the vertebræ of the Apoda and the two-headed nature of the ribs are shown by selected vertebræ of *Ichthyophis.* 'The vertebræ of Labyrinthodontia may be fully ossified and amphicœlous, or may consist of a neural arch and a ring-like centrum and intercentrum (such *embolomerous* vertebræ occur chiefly in the caudal region), or may be composed of a neural arch, a pair of pleurocentra, and an intercentrum (*rachitomous* type, found mostly in the trunk region).' Drawings of restored vertebræ of *Loxomma* and *Eryops* illustrate these two types.

Pectoral Girdle.—'In the Anura there is a coracoidal fenestration between the precoracoid, the epicoracoid and the coracoid. The epicoracoid cartilages overlap in the *Arcifera*, but fuse in the ventral median line in the *Firmisternia.* Closely applied to the precoracoid cartilage is a membrane bone, the clavicle.' 'In the Urodela a scapula, a coracoid and a precoracoid can be distinguished. The coracoids overlap in the ventral median line and the sternum is unossified.' 'In the Labyrinthodontia there is a dermal thoracic buckler composed of a median plate (interclavicle) and two lateral plates (clavicles). The pectoral girdle proper is probably largely cartilaginous.' The examples furnished are, for Anura, *Rana*, *Bufo*, *Discoglossus*, *Callula*, and *Xenopus;* for Urodela, *Salamandra* and *Menopoma*; and for the Labyrinthodontia, a drawing of a partly-restored pectoral girdle of *Actinodon.*

Pelvic Girdle.—'In the Anura the ilia are greatly elongated and backwardly rotated. The pubes are usually unossified. As in other Amphibia there is no obturator foramen.' 'In the Urodela the ilia are set at right angles to the vertebral column; the pubes are usually cartilaginous and there is an epipubic cartilage.' 'In the Labyrinthodontia the ilium is vertical as in Urodela. The pubis is ossified but does not enter into the formation of the acetabulum.' As illustrations are given, *Rana* as representing the Anura, *Salamandra* and *Menopoma* as examples of the higher and lower Urodela, and a drawing of a restored pelvis of *Mastodonsaurus* to represent the Labyrinthodontia.

Limb Skeleton.—'In the forelimb of Anura the radius and ulna are fused, the pollex is rudimentary, there are two centralia in the carpus, and the intermedium and carpale 5 are absent.' Examples: *Rana guppyi*, *Discoglossus*, and *Rhacophorus*, the latter to show the so-called supernumerary phalanx. 'The hind-limb of Anura is elongated and modified for leaping or swimming. The tibia and fibula are fused, the astragalus and calcaneum are elongated, and the intermedium and tarsalia 4 and 5 are absent. There is a prehallux of two or more segments.' Example: *Rana guppyi.*

'In the majority of Urodela the fore-limb is tetra- and the hind-limb penta-dactyle, but the number of digits may be reduced. The carpus and tarsus either remain cartilaginous or are but slightly ossified.' Examples: *Salamandra* and *Amphiuma*. In the Labyrinthodontia the limbs are usually pentadactyle and the pectoral shorter than the pelvic. The carpus and tarsus are usually cartilaginous, and in some cases three centralia can be distinguished.' Example: drawing of fore-limb of *Eryops*.

SKULL.—' In the Anura the skull is short and wide and the mandibular articulation is thrown far back. As in other Amphibia there are two occipital condyles and the basioccipital and supra-occipital are small and unossified. The parietals are confluent with the frontals and the palatines are set transversely to the axis of the skull. Mentomeckelian bones are present in the mandible in many families of the Anura.' 'Cartilage in the skull of Anura is largely persistent, but ossifies to form a median sphenethmoid and a paired proötic and exoccipital containing the membranous labyrinth of the ear. The palato-quadrate cartilage is complete and the pterygoid, which arises as a membrane bone, invades the subjacent cartilage.' The former label is illustrated by two exceedingly fine specimens of the skull of *Rana guppyi*, each not less than three inches across, the latter by a spirit preparation of the chondrocranium and Meckel's cartilage of *Rana esculenta*. Then follow skulls of *Hyla* and *Alytes*, showing the frontoparietal fontanelle, a skull of *Calyptocephalus*, showing the roofing-in of the supratemporal fossa, and the skull of *Pipa* with the following description: 'The cranium is excessively flattened, and contains but little cartilage. There is no sphenethmoid, the quadrate is well developed and the squamosal is small.'

'In the Urodela the parasphenoid is of large size and the palatines are parallel to the axis of the skull. The quadrate is more or less ossified, the quadrato-jugal is absent and the lower temporal arch incomplete.' The skulls exhibited are those of *Salamandra*, *Menopoma*, *Amphiuma*, and *Siren*. 'In the Apoda the skull is remarkable for the completeness of its roof and the large size of the bones. The chondrocranium is greatly reduced.' Example: *Ichthyophis*. 'In the Labyrinthodontia the temporal region of the skull is completely roofed over by the postorbital and supratemporal bones. There are large and distinct epiotics, a parietal foramen, and paired dermo-supra-occipitals. The surface also is sculptured and channelled by mucous grooves.' A plaster cast of the skull of *Bothriceps*, presenting the palatal surface, does duty here, and attention is called to the cast of the skull of *Loxomma*, on the shelf below, the parts of the dorsal surface of which are labelled.

VISCERAL SKELETON.—' In the Anura the hyoid arch is slender, and confluent anteriorly with the large basi-hyo-branchial cartilage. Of the four branchial arches of the tadpole the fourth persists in the adult as the thyrohyal. In *Pipa* and *Xenopus* the fused first and second branchials also persist, and the thyrohyal is intimately connected with the enlarged larynx.' The examples furnished are *Rana guppyi* showing the thyrohyals alone ossified, *Bombinator* with a paired ossification in the basi-hyo-branchial, *Pipa* showing the absence of the hyoid arch, and *Xenopus*. It is intended to add to this series the branchial skeleton of a tadpole of one of the commoner Anura. 'In the Urodela the hyoid arch consists of a large ceratohyal and a hypohyal. There are usually four branchial arches, the first two only of which persist in adult Salamandridæ. The median elements consist of a basi-hyo-branchial and a second basi-branchial.' The series comprises *Salamandra* and *Amblystoma*, larva and adult, showing the disappearance of the last two arches during metamorphosis, *Cryptobranchus* showing the hyo-mandibular cartilage, *Amphiuma* and *Siren* with four branchial arches, and *Proteus* and *Necturus* with only three.

Teeth.—'In the tadpoles of most Anura and in *Siren* the jaws are covered with a horny sheath. Teeth are rarely present in the lower jaw of Anura. The premaxilla, maxilla and vomer are usually dentigerous, and in the Urodela the palatine also. In many Labyrinthodontia the teeth are marked by longitudinal folds, which in some genera give a very complicated pattern as seen in transverse section.' The specimens in this series consist of the horny teeth of an *Alytes* tadpole, the skull of a toad showing absence of teeth, that of a frog with upper teeth present, *Salamandra* showing the vomero-palatine teeth parallel to the axis of the skull, *Amblystoma* showing how the vomero-palatine teeth are parallel to the maxillary series in the Axolotl, but are transverse to the axis of the skull in the gill-less form, the skull of *Spelerpes* showing teeth on the parasphenoid, and two teeth of *Mastodonsaurus*, with an enlarged drawing of the transverse section.

Respiratory System.—'The larvæ of almost all Amphibia are provided with gills. These coëxist with lungs in the adults of *Siren*, *Proteus* and *Necturus*, but are lost in other forms, although in *Cryptobranchus* and *Amphiuma* the fourth branchial cleft remains permanently open. The lungs are elongated in some of the Urodela but are short in the Salamanders and in the Anura. Bronchi are present in *Pipa* and *Xenopus*, and a trachea in *Cryptobranchus*, *Amphiuma* and the Apoda. The skin of Amphibia plays an important part in respiration, especially during hibernation.' By way of illustration are shown tadpoles of the frog with external and with internal gills, preparations of the lungs of *Rana* and *Xenopus*, a dissection of *Spelerpes* showing absence of both lungs and gills, preparations of *Proteus* showing presence of both lungs and gills, a larva of *Salamandra atra* with external gills, a preparation of the lungs of an adult *Salamandra*, and the head of a small specimen of *Amphiuma* showing the persistent branchial cleft.

Tongue.—'The tongue in most Anura is large and fleshy, and is attached to the floor of the mouth anteriorly while the posterior part is free and can be rapidly protruded from the mouth. In *Pipa* and *Xenopus* however the tongue is wanting. In some Anura (*e.g.*, *Discoglossidæ*) and in the salamanders the tongue is not protrusile, and in the lower Urodela and the Apoda it is rudimentary.' Examples: *Rana*, *Bombinator*, *Bufo*, *Xenopus*, *Salamandra*, and *Spelerpes*.

Digestive System.—'The alimentary canal is simple and nearly straight in the Apoda and lower Urodela, but, in most cases, cardiac and pyloric divisions of the stomach can be distinguished, and the intestine is thrown into coils. The rectum is short and opens into a cloaca, to the ventral side of which a urinary bladder is appended. There are no definite salivary glands. The liver is usually two-lobed, and the left lobe is subdivided in Anura. The liver is elongated in the Apoda and in the more slender-bodied Urodela.' Then follow dissections of the isolated alimentary canal of the frog and salamander, and preparations of the liver of the frog, salamander, and *Proteus*. 'The larvæ or tadpoles of the Anura feed on vegetable matter, whereas the adults live on insects, worms, etc. In relation to this difference in diet the alimentary canal is not only relatively but absolutely longer in the tadpole than in the adult'; a generalisation which is illustrated by dissections of the alimentary canal of a tadpole and an adult of *Alytes*.

Vascular System.—'In the heart of Amphibia the ventricle is single but the auricle is divided by a more or less complete septum. Of the four vascular arches of the larva, the first gives off the carotid arteries and the fourth the pulmo-cutaneous arteries; the second arch persists as the aorta, while the third is lost in most cases but frequently persists in salamanders. A post-caval, an anterior abdominal and a pair of renal-portal veins are always present, but the post-cardinal veins of the larva usually atrophy in the adult.' Injected specimens of the frog and salamander, and preparations of the heart of *Rana*, *Amphiuma*, *Siren*, and *Cryptobranchus* serve to illustrate the vascular system, while a pair of dissections of the subcutaneous spaces and lymph hearts of the frog show the exceptional development which the lymphatic system attains in the Anura.

Nervous System.—'The brain of the Amphibia is elongated and without any marked flexure. The olfactory lobes are sessile and the cerebral hemispheres are large and elongated. The optic lobes are larger and more clearly marked off from one another in Anura than in Urodela. The cerebellum is a transverse bridge of variable breadth, but always small in size. The hypoglossal is usually the first spinal nerve. The dorsal and ventral nerve roots unite outside the neural arch, and the spinal ganglia are surrounded by calciferous glands.' Then follow three dissections of the nervous system of the frog, and preparations of the brain of the frog, salamander, axolotl, and *Cryptobranchus*.

Lateral Line.—'The sensory organs of the lateral line occur in all the aquatic larvæ of Amphibia, and persist in those Urodela which lead an aquatic life, *e.g.*, *Proteus*, *Molge*. They are lost in adult Anura, except *Xenopus* and some Pelobatoids, and in those Urodela, *e.g.*, *Salamandra*, which are terrestrial when adult.' Examples: *Pelodytes* tadpole and adults of *Xenopus* and *Molge*.

Development.—'The Anura are oviparous, and the larvæ or tadpoles, when hatched, soon develop a tail provided with a fin. A pair of suckers are in some cases developed on the ventral surface behind the mouth, which latter is provided with horny teeth. Respiration is at first effected by means of three pairs of external gills, and later by internal gills, developed on the walls of the four branchial clefts. An atrial membrane grows back over the gill-clefts and, on the closure of the exhalent aperture, pulmonary respiration is definitely established. The limbs are formed comparatively late, and the tail, which is supported by a notochord and not by vertebræ, is gradually absorbed.' Below this label is a gradational series of twenty tadpoles of the common frog, showing the development from the egg up to the completion of the metamorphosis. 'The spiracle or exhalent aperture of the branchial chamber is, in most tadpoles, situated on the left side of the body, but in *Xenopus* it is paired, and in the *Discoglossidæ* it is situated on the ventral surface.' Examples: tadpoles of *Alytes*, *Rana*, *Pelobates*, and *Xenopus*.

Then follow five skeletons of *Pelobates* at different stages of development, and attention is called to the following points of interest:—'Vertebræ are not formed around that portion of the notochord which supports the large swimming tail of the tadpole, and this caudal notochord is gradually absorbed as the tail becomes reduced in size in the metamorphosis from the tadpole to the adult form. The greater part of the urostyle of the adult is formed from a splint of bone developed on the ventral surface of the notochord behind the last vertebra. There is a gradual increase in size and in the extent of ossification of the skeleton of the limbs and the limb-girdles, and the pelvis becomes connected with the vertebral column. There is also an increase in the breadth of the skull and the size of the mouth, and the branchial skeleton becomes greatly reduced.'

'The larvæ of Urodela possess external gills, which may be retained by the adult (*e.g.*, *Proteus*) or lost (newts and salamanders). The tail persists and develops complete vertebræ.' Example: larva of *Salamandra maculosa* at birth. 'The larvæ of Apoda possess external gills and a tail which is absorbed more or less completely during metamorphosis.' Example: larva of *Ichthyophis* showing external gills, tail, and yolk-sac.

At the foot of this column the dimorphism of *Amblystoma* is illustrated by the exhibition of a typical Axolotl and a perfect or gill-less form of about the same size, with the following description:—'This Amphibian is dimorphic, a condition very uncommon in vertebrate animals. The larva is possessed of three pairs of external gills and a crested swimming tail. These larval features may be retained and the animal remain aquatic for the whole of its life (Axolotl form), or under certain condition sa metamorphosis may be passed through, and the animal, destitute of gills and with a rounded tapering tail, becomes terrestrial in habit.' The close relation existing between developmental metamorphosis and the dimorphic metamorphosis of *Amblystoma* finds for this preparation a fitting place at the close of the developmental series.

The plate illustrating this article has been prepared from a couple of photographs taken by Mr. A. Gepp, of the Botanical Department of the Museum. I offer him hearty thanks for the trouble he has taken.

W. G. Ridewood.

VI.

Oceanic Deposits Ancient and Modern.

I.—The Foraminifera.

RECENT deep-sea researches, by enabling us to understand more fully the present distribution of the oceanic faunas, have revealed many facts of the highest interest, and have supplied materials which are invaluable to the stratigraphical geologist. In a recent paper,[1] "The Genesis of the Chalk," I endeavoured to apply a few of these results to a consideration of one of the great oceanic deposits of the past, "the Chalk," and on this basis of comparison submitted conclusions of a definite character, both as regards the depth at which it was formed and the general nature of its deposition.

In an article (*Science Progress*, February number) Mr. Philip Lake thus briefly summarises the main objections to the course adopted, and says, "In questions of this kind, when the argument is based upon the assumption that fossil forms lived and flourished under the same conditions as their recent allies, it must always be borne in mind that such an assumption is open to grave doubt. There is nothing to prevent an animal from adapting itself to live under a new set of conditions (for instance, at a different depth of the sea) without becoming so much altered as to constitute a new genus." I have, therefore, thought it would be interesting to examine the various conditions step by step, to ascertain if the above objection is of such vital importance that it must necessarily paralyse the whole argument, and neutralise the method of research pursued.

1. *Faunal Distribution.*—It will readily be admitted that any genus (whether plant or animal) may adapt itself to a change of condition without undergoing change of form. It may be even that two such forms will alter their circumstances without metamorphosis of type and character; but if a whole group of organisms retains precisely the same aspect throughout long ages, it may well be asked whether similarity of conditions during long periods should not be regarded as a determining factor in such a conservation of structure, and whether, therefore, the onus of proving objections to suggestions based on such identities should not lie with the objectors.

If we take the Upper Cretaceous strata on the one hand, and present deep-sea deposits on the other as principal terms of com-

[1] *Proc. Geol. Assoc.*, xiii., p. 221, May, 1894.

parison, it may, at first sight, appear that the existence of any uniformity in faunal character in the two cases must be absolutely impossible. The period of time which has elapsed should have been sufficient to alter and vary every specific type, and obscure any relationship which might help to guide the student. Such preconceptions, however, break down at the very outset, and though as a rule in the higher Vertebrata and Mollusca only generic resemblance can be traced and compared, yet in the lower forms of life, more especially among the Foraminifera, the identity of specific character becomes striking and significant.

The first analysis of a sample of Chalk Marl carried out by me brought the matter very prominently under my notice; for after the removal of all the clayey and calcareous material, an insoluble and heavy residue remained, which revealed itself as being largely made up of the tests of arenaceous Foraminifera.

A comparison of these with recent forms showed that most of the species still exist at the present day. This resemblance would be of little value if the same types were simply distributed far and wide in the oceanic waters; but if it can be shown that only certain localities are specially favoured, reasons should be sought to explain the occurrence.

Three *Textularia* (*T. turris*, *T. trochus*, and *T. agglutinans*) occur in the Lower Chalk Marl. Only at Culebra Island, in the West Indies, at a depth of 390 fathoms, do these same three species occur together at the present day; one of them, *T. turris*, has only been met with here and off Pernambuco, at a depth of 350 fathoms. Three species of *Verneuilina* have been determined by Mr. Chapman from the Taplow Chalk (*V. pygmæa*, *V. spinulosa*, and *V. triquetra*); these same three species have also been met with at Culebra Island, *and nowhere else do they occur together*. *Gaudryina pupoides*, *Bulimina presli*, *Haplophragmium latidorsatum*, and *Ammodiscus incertus* all occur in the Chalk Marl. They are also present at Culebra Island. I am in a position to still further multiply the cases of identity between the two, but these coincidences should be sufficient to give rise to careful thought.

Which, then, represents the line of logical hypothesis? Is it the conception that, *owing to accidental circumstances*, all these ancient specific forms have become associated unchanged in certain restricted areas? or, is it that identity of circumstances has led to their preservation, and to the similarity of distribution they display both in the Cretaceous deposits and at the above-mentioned localities at the present day?

What, then, do these circumstances appear to be? It will be noticed that Culebra Island possesses the following distinctive characteristics. It is situated close to the eastern boundary of a continental area, in a region of considerable insular development, having a sub-tropical climate, and not far removed from the line of a great current.

We are further led to inquire whether there are any other regions where similar assemblages occur, in which old Cretaceous species are still found to play an important part. The greatest interest undoubtedly attaches to Raine Island, off the north coast of Queensland, near the Torres Straits, owing to the fact that this is the only locality where, at a depth of 155 fathoms, *Tritaxia tricarinata*, so common in the Chalk Marl, is known to exist at the present day. In addition, the presence of the delicate *Spiroplecta annectens*, of *Gaudryina rugosa*, and *Frondicularia archiacana*—all Cretaceous species—shows that this is not a mere isolated occurrence, but represents another example of the preservation of Cretaceous forms under certain special conditions. An examination of the geographical position of this island likewise demonstrates that it lies not far from the south-eastern boundary of a region of insular development, which includes New Guinea, Borneo, etc. It is also on the northern boundary of the Australian continent, and, further, its climate is of a distinctly subtropical character. It is therefore significant that, although so far removed from one another, we should find these two localities to have these remarkably striking features in common, and at the same time to possess between them some of the principal arenaceous species occurring in the lower part of the Upper Cretaceous beds.

The general resemblance of these localities to probable early Upper Cretaceous conditions will at once be obvious. The materials of the Chalk Marl and Upper Greensand appear to have been derived from the western regions of our own island, so that it may be fairly argued that these deposits were laid down on the eastern boundary of a land, if not of a continental, area. Few will be inclined to dispute that the result of the Cretaceous depression would be the production of a number of insular areas, and there is much evidence to support the theory of the existence of a sub-tropical climate at that period.

Hitherto no sharp delimitation of distribution has been attempted by writers on this subject. The Foraminifera obtained from the various zones of the Upper Cretaceous have been dealt with *en bloc*, and but little attention has been paid, or reference made, to variations arising from physical alterations, bathymetric or otherwise.

The result of a preliminary study of the zones in definite order has led me to the conclusion that this wide classification tends to hide many interesting facts, and that, in order to arrive at a more complete understanding of the subject, such questions as quantity, size, specific abundance, position in the stratigraphical scale, and the character of the rocks in which the forms occur, must all be carefully noted, observed, and compared with the existing fauna and the general sequence as displayed at the present time.

For example, foraminiferal distribution depends, in many important particulars, on physical characters. The arenaceous species, more especially the coarser varieties, build up their tests of sand-grains, for the distribution of which off-shore currents are indispensable. At the present day, the coarse arenaceous Foraminifera are found at depths rarely exceeding 400 fathoms, and the terrigenous deposits bordering true continental areas (as, for example, from the north of France to the south of Africa, or throughout the whole South American coast-line) rarely extend to a distance from the shore-line of more than 200 miles. The depression having apparently been very gradual in Cretaceous times, the coarsely arenaceous species might have occurred in shallower water than at the present day if the currents were weaker, or in deeper water if currents were stronger. For our purpose, it is only necessary to prove that the width of the border of terrigenous deposits was not less at that time than it is at present.

The deep-sea researches have shown that at points where the continental areas meet the oceanic, there is to be found a band composed of terrigenous deposits varying but little in breadth, and rarely extending more than 100 miles from the present coasts. This appears to be of almost universal occurrence, it having been traced from the north of France to the south of Africa, and it differs but little in width round Australia and South America. The evidence to hand points rather to this band having been wider in Cretaceous times, seeing that the Gault, occurring as a sandy deposit in the Blackdown Hills in Devonshire, is not represented by limestones till 170 miles from that locality, viz., in the north of Norfolk. Similarly, the Upper Greensand belt has a width of over 150 miles ere it becomes merged in the limestones of the Hunstanton district. Further, if we compare these with the width of the terrigenous belt in the Gulf of Mexico, the resemblance between the past and present conditions is very close. If, then, it be granted that the currents in those times did not greatly differ in strength from those of the present day—and, in my view, specific identity should point to similarity of condition—is there any marked parallelism in the sequence of these protozoan forms? That is to say, is there any resemblance to be observed between the upward stratigraphical sequence in foraminiferal distribution, and the variation due to bathymetric change in those species existing at the present day? My own studies lead me to the conclusion that such a resemblance not only exists, but is of a most striking character.

In the Chalk Marl and Lower Grey Chalk, the Textularian and Tritaxian fauna is very abundant; but in the upper strata of the Lower Chalk a marked change takes place, only certain species—*Textularia agglutinans* and *Haplophragmia*—of finer texture being obtained, the Bulimines now playing the most important and prominent part. In the lower zones of the Middle Chalk all the more coarsely-tested forms have entirely disappeared, and only the minutest Bulimines—a most delicate little *Textularia*, and the ammonitoid-looking shells of *Ammodiscus incertus*—survive to represent the arenaceous species; while still higher in the scale, and running throughout the Turonian and Senonian zones (with but one exception), *Ammodiscus incertus* remains apparently the sole representative.

Turning now to the modern distribution—what is its nature and special character? The Textularian fauna is well marked up to a depth of 400 fathoms, but beyond that depth the number of species diminishes with remarkable suddenness, few being found at greater depths, though those that occur have a very wide distribution. What are the principal species which thus continue? They are *Textularia agglutinans* and *T. quadrilatera;* the former, as we have seen, a form which passes into the Grey Chalk, whereas the species, now restricted to a depth of less than 400 fathoms, are mainly found in the Chalk Marl or lower part of the Lower Chalk.[1]

The species, however, which are associated with the above *Textularia* give evidence of equal significance. -Certain forms of arenaceous Foraminifera continue beyond the 500 fathoms. For example, of those obtained by me, *Haplophragmium agglutinans*, which ranged from the Cenomanian (Lower Chalk) into the Turonian (Middle Chalk), has been obtained eight times beyond that depth. On the other hand, it must be admitted that *Haplophragmium latidorsatum*, which has an equal distribution to-day, was only found by me in the lowest zone of the Lower Chalk. According to my own investigations, *Gaudryina pupoides* was similarly restricted, but from the Richmond boring Professor Judd obtained this species associated with *Textularia agglutinans*, in far higher beds of the Lower Chalk. This species has been met with at the present day eleven times at depths exceeding 500 fathoms, while *Ammodiscus incertus*, which I have found in almost every Chalk zone examined (it being absent only in the lowest zones of the Lower and Upper Chalk), occurs five times at similar depths.

The occurrence of the genus *Ammodiscus* is, in fact, a marked feature in all modern deep-sea soundings, it having been reported no less than twenty-two times from these greater depths, represented mainly by three species, *A. incertus*, *A. charoides*, and *A. gordialis*, all of which are constituents of the two upper divisions of the Chalk series, though the first at present remains the sole representative of its kind in the lower.

What, then, are the broad results to be adduced from these somewhat detailed considerations?

1. Many of the Cretaceous species of arenaceous Foraminifera are specifically identical with those of the present day.

2. Those species which are restricted to the Chalk Marl and Lower Grey Chalk are those which occur to-day at depths of less than 400 fathoms.

[1] At a depth beyond 500 fathoms one or both of these forms were obtained in "Challenger" soundings eight times, other species only three times, and these were of types unknown or exceedingly rare in the Upper Cretaceous.

3. Those that pass upwards into zones higher than those of the Lower Grey Chalk are precisely those which at the present day have a wide distribution at depths exceeding 500 fathoms.

4. The more shallow-water types of these ancient species occur together at the present time, in certain well-defined areas, notably off the West Indian Islands, and between Australia and the Papuan Islands.

5. These regions are characterised by insular development, sub-tropical climate, and are situated, in the wide sense of the term, on the eastern side of a continental area.

6. We therefore infer that the conditions were similar during Chalk Marl times, greater depression and climatic change causing alterations in physical conditions, and, consequently, variations in the characteristic fauna.

Bulimines are no exception to the sequence here laid down, for, commencing in the Chalk Marl as very coarse-tested forms, they diminish in size, until in the *Belemnitella plena* zone, at the base of the Middle Chalk, only very minute examples are as a rule met with. Their species, however, not being comparable, I have not included them in this discussion. Notwithstanding, these also have a region of maximum development ranging between 345 and 675 fathoms, and, although beyond these limits a single, or at most two, species may occur in any one sounding, the fact of the genus having been found no less than eighteen times beyond the 700-fathom limit in no way invalidates the general principle presented in no. 3 of the summary.

Certain exceptional conditions are, however, to be met with, presenting facts of great interest, and well worth consideration and study.

Thus, in the Taplow Chalk, in the centre of one of the highest zones of the Upper Cretaceous, a number of these forms reappear. This chalk is now generally accepted as a current-formed deposit, and, consequently, the Foraminifera of our Chalk Marl must have been in existence in another part of the Anglo-Parisian Basin, only requiring favourable conditions to enable them to extend their range; while current agency, as I hope to show in subsequent remarks, has had a great influence in determining local distribution.

From evidence of a lithological character, it appears probable that the above-named fauna retreated in Upper Chalk times to France, and was existing there in much shallower water, it being a noticeable fact that those species of *Textularia* which occur in our Lower Chalk (Cenomanian) are described by D'Orbigny, not from these lower beds, but from the Upper Chalk (Senonian).

In the *Proceedings* of the Geologists' Association (xiii., p. 370, Nov., 1894), Mr. Chapman has recorded the Foraminifera from the Chalk of Swanscombe. Fifteen of these species, including such ubiquitous forms as *Rotalia soldanii*, *Pulvinulina micheliniana*, *Cristellaria cultrata*, as also types of *Globigerina*, *Anomalina*, *Truncatulina*, *Bolivina*, and *Bulimina*, are described as frequent or common associations which can be paralleled to-day from most of the deep-sea soundings, though they are not to be found grouped together at depths beyond 1,000 fathoms.

At this depth in the North Atlantic the above-named three species occur together, accompanied by all the above-named genera, except *Anomalina* and *Truncatulina;* though off the Azores these latter have been obtained at the same depth. Off Pernambuco, at a depth of 675 fathoms, every one of these genera is found grouped, two of the three species being again present.

The same holds good of the particularly rich ooze off Culebra Island, a centre where the deep-sea and shallow water forms seem to become most intimately intermingled. Below the depth of 1,000 fathoms no such associations have been discovered, and, taking into account these facts and the general aspect of the commoner fauna of this chalk, I am led to venture the opinion that it has been laid down at a depth over 400 and under 1,000 fathoms.

Again, of the rare species which have already been mentioned as very common in the Chalk Marl, a few reappear which are usually absent in the higher zones, viz., *Textularia turris, Spiroplecta annectens,* and *Tritaxia tricarinata;* but, in addition, there are a number of others specifically identical with forms now occurring at depths greater than 400 fathoms.

A consideration of these various facts seems to force upon us the conclusion that events had occurred resulting in the reappearance of a shallower fauna, but that Chalk Marl conditions had never been absolutely reëstablished. Mr. Chapman is of opinion that the Swanscombe specimens probably came from the *Micraster cor-testudinarium* zone, at whose base is the Chalk Rock. This latter shows in its character such evident traces of change in the direction of elevation that the faunal peculiarities observed may be regarded as additional proof of upward movement at this period. Thus we may conclude that during periods of elevation shallow water faunas extend their range, the extent of such range being the measure of such elevation.

Hitherto we have been dealing with a fauna which, however interesting in itself, might by many be considered as too minute in character for general study, demanding, as it does, not only painstaking research, but the direct aid of an expert in specific determination. We will, therefore, next turn to the evidence of a richer and larger fauna as represented in the Mollusca; and although parallelism by species is out of the question, yet some idea of sequence may be gathered from its study.

W. F. Hume.

(*To be continued.*)

SOME NEW BOOKS.

CRYSTALS: THEIR SHAPE AND STRUCTURE.

CRYSTALLOGRAPHY: A TREATISE ON THE MORPHOLOGY OF CRYSTALS. By N. Story-Maskelyne, M.A., F.R.S. 8vo. Pp. xii., 521. 398 text figures and 8 plates. Oxford: The Clarendon Press, 1895. Price 12s. 6d.

THE appearance of a treatise on crystallography from the pen of Professor Maskelyne, the *doyen* of English Crystallography, has been expected for many years. The present volume deals only with a very confined branch of the subject, *i.e.*, that which concerns the relations between the various planes bounding a crystalline individual; a succeeding volume treating of the physical properties of crystalloid matter is, however, promised. Two proofs of most of the propositions are given, a trigonometrical and an analytical one; the former are, in many cases, those contained in Miller's classic "Tract," and although very simple and elegant, are often long and possessed of all that cumbrousness which so frequently characterises trigonometrical demonstrations. The analytical proofs, many of which are new, are extremely neat, and have the great merit of brevity. It is, perhaps, to be deplored that the author should have confined his attention so closely to the Millerian methods of demonstration, as many crystallographic problems can be treated with greater ease by other methods; thus, the long arguments at pp. 58 and 70 respecting the anharmonic ratios of four tautozonal planes would surely be well replaced by the short proof recently given by Cesaro.

Not the least valuable portion of the volume is that dealing with the methods of representing a series of crystalloid planes, in which that crystallographic *pons asinorum*, the stereographic projection, is elaborately treated. The chapter relating to the types of crystalline symmetry is also one of extreme interest, owing both to the simplicity and originality of the treatment adopted. Professor Maskelyne has here exercised his peculiar faculty for the invention of new and significant terms, a faculty which is so freely employed in the later part of the book as to make it a matter of regret that a glossary has not been appended. The description of the crystalline systems is clear and concise, and the characteristics of each are logically deduced, thus eliminating that flavour of empiricism which taints most of those dry-bone hashes known as text-books of crystallography. The method employed is, however, in our opinion, not logical enough, as it is now comparatively easy to deduce the thirty-two possible crystalline systems by the rational process devised by Gadolin, or to briefly indicate how this number is arrived at by the discussion of point-systems and space lattices. This part of a crystallographic treatise would thus be relieved of such a defect as that on p. 345, where milk-sugar is described as crystallising in an impossible system. The important, but usually much neglected, subject of crystal twinning is adequately treated, and a good description is given of the rather human property of crystalline mimicry, by virtue of which crystals so frequently pretend to higher symmetry than they really possess. Considerable space is devoted to the methods of crystal calculation, but no reference is made to the important applications which the method of least squares has received in this connection at the hands of Beckenkamp, Hecht, and others.

Many of the specific instances which abound in the volume are of specimens preserved at the British Museum (Natural History) at South Kensington. Professor Maskelyne's volume will consequently commend itself as an agreeable companion to the provincial geologist or mineralogist while holiday-making in London.

W. J. Pope.

An Introduction to Chemical Crystallography. By Andreas Fock, Ph.D. Translated and edited by William J. Pope, with a preface by N. Story-Maskelyne, M.A., F.R.S. Royal 8vo. Pp. 189. Price 5s.

Crystallography has been such a valuable aid to the study of minerals that it has almost come to be regarded as an integral portion of the science of mineralogy. That this is not the case, however, is sufficiently proved by the fact that many of the numerous products of the chemical laboratory crystallise in forms never met with in minerals. Hence, crystallography would not be complete unless these were included.

The editor of this little work (Mr. W. J. Pope), in preparing the present edition, has been actuated by the desire to make clear to English chemists the great importance of a knowledge of crystallography to their science, it having become generally recognised during the past few years that the most important advances in crystallography are to be expected from the chemical side. Despite the fact that our knowledge of the physical and geometrical properties of crystals is now very complete, their relations to chemical constitution and composition are as yet but little known, although the study of these characters by mathematicians and mineralogists has yielded results which affect some of the highest problems in chemistry. The examination of new crystalline compounds with the aid of a polarising microscope can be accomplished almost as rapidly as the determination of the melting point, and should certainly supplement the latter; inasmuch as such an examination affords an infallible test of the identity or non-identity of two substances.

It frequently happens that translators of German scientific works adhere too strictly to the idiom of the original language, and write sentences which are extremely involved and difficult to follow. This cannot be said of the work under discussion. The language used is so clear that it reads in every way as an original production. If, however, the book is compared with the German edition it is found that many modifications have been made in the text and numerous additions, so that it is brought up to the present day. These, we are told, have been done with the author's sanction. The matter is arranged in excellent sequence, and the propositions are logically argued out. The book is very free from typographical errors.

A perusal of the book can leave no doubt in the reader's mind that Mr. Pope has attained his object. The close connection of crystallography with other branches of physical chemistry is clearly and distinctly brought out, and the book may be confidently recommended as an elementary text-book on the subject to all intending students of chemistry and mineralogy.

A. R. L.

The Evolution of Spots and Stripes.

Studies in the Evolution of Animals. By Dr. E. Bonavia. 8vo. Pp. xiii., 362, numerous process blocks. Constable & Co. Price 21s.

In this volume, which has, we fear, rather a prohibitive price, Dr. Bonavia deals with a variety of subjects, but mainly with the pigmentation of mammals. His views upon this much-debated subject are decidedly novel, but not, in our opinion, reliable as probable explanations. Nevertheless, the author has shown considerable industry in the collection of his materials, which were gathered, not only in museums and at the Zoological Gardens, but from such apparently unpromising localities as the refreshment room at the Army and Navy Stores. When an author has taken so much trouble in the amassing of fact it is churlish not to allow him a little relaxation in the way of theory. Dr. Bonavia steers a middle course between Eimer on the one hand and Darwin and Wallace on the other; but his want of success in clearing up the problems is an instance of the fallacy of the reputed safety of middle courses. Like Eimer, Dr. Bonavia holds that utility has had nothing to do with the evolution of the markings upon animals; if they are useful, it is not much more than a happy accident. He sees in spots the original plan of marking, and holds that stripes have arisen by the flowing together of spots. This is the exact converse of the opinion held by Eimer, who showed some reasons for thinking that a longitudinal striping was the primitive form, which then broke up into spots, and was recombined into transverse stripes. But both authorities are at one in looking upon the self-coloration, as is exhibited, for instance, in the Puma, as the last stage. From this point, however, Bonavia diverges in a direction peculiarly his own, which will not, we think, produce a general conviction in its favour. His view is, in short, that the spots upon carnivorous and other animals are the remains of a former armour-plating, such as is now present in the armadillos. The loss of this hypothetical armour-plating is ascribed by the author to a kind of "lime-famine" produced by too great a demand upon the supplies in the possession of Nature. It follows as an obvious corollary that the Carnivora are the nearest existing relations of the primitive mammal—a conclusion which will not, we think, meet with general acceptance. It is true that our knowledge of the earliest Mammalia is lamentably scanty; they may have possessed an extensive coating of armour-plating, but, on the other hand, the universal opinion is that the existing Monotremata come nearest in structure to the mammals of the Trias and Jura, and that the next nearest are the Marsupialia. Now, neither of these groups has any traces of a *Glyptodon*-like skin, and they are not, as a rule, well off in the matter of stripes and spots. The Edentata, which are largely plated, are admitted to be a specialised group, and in any case there is no evidence of their great antiquity. Still, Dr. Bonavia has the courage of his opinions, and argues with great ability in favour of his ingenious suggestions; and we do not find fault with any man's theories in these days of rapidly-changing views. What we can, without any reservation, congratulate Dr. Bonavia upon are his excellent figures of the skins of various cats.

F. E. B.

The Ardennes.

Walks in Belgium: Cycling, Driving, by Rail, and on Foot, with some Fishing and Boating Notes. Edited by Percy Lindley, with maps and illustrations, and a chapter on the French Ardennes. 8vo. Pp. 94. London [1895]: 30 Fleet Street. Price 6d.

We are glad to notice this attractive little guide to a country so interesting to the English student of Natural History, who, when he wishes to study continental types not to be found in his own country, cannot do better than pay a visit to the Belgian Ardennes. The book contains a great deal both of practical and picturesque information, arranged and indexed so as to be easily found when wanted. The author has a keen sense of the picturesque, and gives much information of a kind often impossible to glean from guide books, but which influences very largely a tourist's impressions of continental towns. We find it mentioned, for instance, whether a building has been much altered in appearance by restoration, and on which days markets are held, with a good deal of very readable information about the towns. There is also very useful advice for travelling and management of expenses. Perhaps it would be easier to use the advice on p. 11, where the traveller is recommended to go to good second-class hotels, if the names of these hotels were systematically given for each town. We think it a pity that two or three pages have not been devoted to saying something about the natural history of the country; but perhaps this would be too much to expect in so small a book.

Decimal Cataloguing.

The Manchester Museum Owens College. Museum Handbooks. A Catalogue of the Books and Pamphlets in the Library arranged according to Subjects and Authors. By William E. Hoyle. 8vo. Pp. xvi., 302. Manchester, 1895. Price 2s. 6d.

In this very practical catalogue Mr. Hoyle devotes 230 pages to a list of titles of books and pamphlets arranged under subjects, and in the remaining pages these papers are placed under authors in alphabetical order. One is thus enabled to find at a glance the work required, and as the press-mark is inserted at each entry both subject-catalogue and author-catalogue are complete in themselves. There is also an alphabetical index of subjects.

Marine expeditions and surveys are catalogued under the name of the ship, a practical method, and one most satisfactory to the weary searcher, who has often to shift from one end of a catalogue to the other. The chief point in the work is, however, the complete adoption of Professor Melvill Dewey's Decimal Classification, which Mr. Hoyle has also applied to the classification and registration of Museum specimens. "It is believed that the present catalogue is the first published in this country in which the method has been fully carried out." Such a lucid work as the one before us is the strongest argument in favour of the Dewey System, which in some form or other is the only possible one in large and rapidly-growing libraries where the ready finding of books is indispensable.

Starch.

Untersuchungen über die Stärkekörner. Wesen und Lebensgeschichte der Stärkekörner der höheren Pflanzen. By Dr. Arthur Meyer. 8vo. Pp. xvi., 318, with 9 plates and 99 woodcuts n the text. Jena: Fischer, 1895. Price 20 marks.

If anything were required to emphasise the extreme specialisation which has been reached in biological science, such books as the present would amply suffice. A good deal has been done within the last ten years on starch, its chemistry, its origin, and its meaning in the nutrition-processes of plants, and although Sachs' idea that it represented the first formed carbohydrate in the cells of the assimilating green leaf is no longer tenable, it is equally certain that as an easily-worked reserve substance it is of the utmost importance in plant-physiology. Dr. Meyer's criticisms and the account of his exhaustive investigations are arranged under five headings. In the first, on the chemistry of starch and diastase, we have an historical and chemical account of the compounds of which the grain is composed, or which are formed by the action upon it of the diastatic ferment. The micro-chemical reactions are also discussed. The second part, on the physical characters, contains arguments and experimental evidence in support of the view that starch grains are sphærocrystals of amylose and amylodextrin, and concludes with an account of the structure and growth of the grains, in which Nägeli's theory of growth and intussusception is severely criticised. Part III., the biology of the starch grain, is a full account of its life-history, *à propos* of which we find a discussion of the part played by the different constituents of the chloroplast. Part IV., "Biologische Monographien," is a series of short monographs on the starch grains of the resting shoots of *Adoxa moschatellina*, the endosperm of barley, and a few other examples. Finally, we have a few pages on starch grains as constituents of living protoplasm. We must not omit a word in praise of the nine plates which, with the wood-cuts, form a very helpful addition.

Botany Books.

Das Pflanzenphysiologische Praktikum. Anleitung zu pflanzenphysiologischen Untersuchungen. By Dr. W. Detmer. Second edition, enlarged and revised. 8vo. Pp. xvi., 456, with 184 wood-cuts. Jena: Fischer, 1895. Price 9 marks.

Professor Detmer's practical exposition of plant-physiology is so well known, and has proved so valuable and trustworthy a guide on the subject, that the appearance of a second edition is not a matter of surprise. Lecturers on the subject and students of the life-processes of plants will welcome the new issue, and rejoice that Professor Detmer has been able to add so much that is new and of interest.

Analytical Key to the Natural Orders of Flowering-plants. By Franz Thonner. 8vo. Pp. vi., 151. London: Sonnenschein, 1895. Price 2s.

If we read his preface aright, Mr. Franz Thonner, who writes from Dresden, has compiled this little book for the use of English colonists, to enable them to run down to its natural order any plant in which they may chance to be interested. It is, in fact, an adjunct to the few and fragmentary colonial floras which we possess, by which, having already found the order, the student will be able to work out the genus and species. We presume this is why he uses the system of Bentham and Hooker's "Genera Plantarum,"—a truly excellent one,—but in several respects not quite on a level with our present knowledge. It seems to us that the colonist who is able to use his "Flora" will also be able to dispense with Mr. Thonner's Key, which on this view seems a waste of effort.

Some Serials.

The Archæologist (Columbus, Ohio) ceases to exist with the September number. It will in future form a department in *Popular Science News* (New York), which will be edited by Mr. W. K. Moorhead, of Ohio State University, the editor of *The Archæologist.*

We are informed that the *Mittheilungen aus dem Mineralogischen Institut zu Kiel* has also ceased to exist. Communications will in future, we believe, be published in a new periodical, *Archiv für Anthropologie und Geologie Schleswig-Holsteins und der benachbarten Gebiete*, of which the first number appeared in August, and contained a valuable paper by Dr. E. Stolley on the curious boulders of Cambrian and Silurian age which are scattered over the surface of the ground in Schleswig-Holstein.

Knowledge has published in the September number a map of the world showing the explored, partly explored, and unexplored regions. This is useful as roughly showing at a glance the great amount of work yet to be done by geographers and geologists. It has been drawn up by Professor Logan Lobley, and is appropriately published at this time of Geographical Congress.

In the same number there is an interesting illustrated paper by Mr. J. E. Quibell on the newly-found race in Egypt. The bodies are not buried at full length as was customary with the Egyptians, but in a contracted position, and usually without the head. Flint weapons, beautifully finished, have been found, as well as rude and painted pottery. Mr. Quibell thinks this previously unrecorded race were the ancient Lybians, and colour is lent to his view by the finding of a small female figure with tattoo marks in one of the graves; the Lybians themselves being of white skin and tattooed, according to the Egyptian monuments.

The Geographical Society of Finland has already issued its "Exposé des travaux géographiques exécutés en Finlande jusqu' en 1895." This communication was made to the Geographical Congress which recently met in London. It forms a volume of 154 pages, is published at Helsingfors, and adds a valuable book to the long series of geographical bibliographies.

We are glad to note the acceleration in the issue of Poirault's translation of the "Manuel de Geographie Botanique," by Oscar Drude, noticed in Natural Science, vol. vii., p. 214. Livraisons 6 and 7, just to hand, include the greater part of the fourth section of the book, which deals with the various plant formations and their characteristic families and genera. Part v., on the regions of vegetation of the globe in geographical order, is now just commenced.

Messrs. Dulau & Co. have sent us their catalogue (No. 14) of Botanical Works, comprising Systematic and Miscellaneous, Medical Botany, Botanical Biographies, and Periodical Publications.

OBITUARY.

SVEN LUDVIG LOVÉN.

BORN JANUARY 6, 1809. DIED SEPTEMBER 3, 1895.

FULL of years and of honours, rich in the reverence and love of his pupils and his friends, the greatest biologist that Sweden has known in this century has at last laid down the work that could cease only with life. Despite an attack of influenza, and again of an inflammation of the lungs some thirteen months ago, his vigorous frame struggled long with death, and sank slowly and peacefully into the final rest.

Lovén's family came from Loshult in Scania, in which fertile province his great-grandfather, Måns Jönsson, was a husbandman. It was the son of that man who first followed after learning, entering the priesthood and taking the name Lovén. His fifth and youngest son, Christian, became a wealthy merchant and shipowner in Stockholm, and to him and his wife, Maria Catharina Nordling, there was born in that city the future leader of Swedish zoology.

Thus Lovén was in a position to receive a first-rate education. Not only did he become conversant with foreign languages, of which he spoke and wrote French, German, and English fluently, but he acquired skill as a draughtsman and musician. His first school education was in the private school of the army chaplain, Fredrik Klingenstierna, and in 1823 he passed from here to the University of Upsala. In the following year, however, he moved to Lund, possibly attracted by the fame of the Professor in Zoology, Sven Nilsson. At any rate he made zoology his main study, and in 1826 accompanied the professor and four other students on a scientific expedition through Norway. At the early age of twenty he took his degree as Doctor of Philosophy.

While in Lund, Lovén nearly died of scarlatina, but recovered with the loss of hearing of his right ear. It was probably this disease that prepared the way for those many severe attacks of ill-health that persecuted Lovén in after life, and that prevented him from publishing as much as his eminent gifts led the world to expect.

After taking his degree, Lovén studied under Ehrenberg at Berlin for nearly a year; but, after the publication of his treatise on the geographical distribution of birds, he was recalled to Lund at the close of 1830 as Docent in Zoology. It was in this year, too, that he began his researches on the marine fauna along the shores of Bohuslän, the western coast of Sweden. For eleven years Lovén remained attached to the University of Lund, carrying out these and similar researches to which we shall recur. In 1841 his reputation was such that, though only thirty-two years old, he was elected Keeper (Intendent) of the Department of Invertebrata (Insecta excepted) at the Swedish State Museum, an appointment that carries with it the title Professor to the Academy of Science, although no teaching duties are connected with it. This post he retained till September, 1892, when increasing infirmity forced him to retire with a pension. At the jubilee of his appointment, in 1891, in recognition of his long and useful labours, the Academy caused a medal to be struck bearing Lovén's portrait and the words "Sveno Loven Musei Zool. Regni Præfectus," and on the reverse the inscription "Socio meritissimo ob officia insignia per decem lustra museo zool. regni præstita Reg. Acad. Sc. Suec. MDCCCXCI."

This mention of Lovén's labours was no mere form. As a member of the Council of the Academy and as inspector of its library, as well as in his post of Intendent, he contributed actively during the greater part of his life to the development of its institutions. Encouraged by Berzelius, by whom his genius was early recognised, in 1844 he started the publication of the *Öfversigt*, and edited its earlier volumes. He drew up the plans for the enlargement of the State Museum, and during the years 1860–1864 superintended their execution. The work of building completed, he devoted several years of intense labour to the arrangement of the specimens in his department, which he made a model for other museums to copy. In their general arrangement, in the artistic display of the objects, no less than in ingenious details of technique, all invented by Lovén, these collections in the Riksmuseum still evoke the enthusiasm of museum experts. Naturally, too, Lovén laboured for the increase of these collections with abundant zeal, not merely collecting himself, but freely giving to the younger generation from his stores of learning and experience, that they might bring him in exchange treasures to enrich his beloved museum. One of these young pupils, now himself a reverend and renowned professor of the Academy, gives me his reminiscences of those days. "As a lecturer in zoology and geology, Lovén was unsurpassed in Sweden, and those who heard his lectures in 1848–49 can never forget the impressions they received. The addresses, too, which he delivered at the anniversaries of the Academy of Science were masterpieces of style. In the days of his strength there was a great charm in his conversation when he spoke of the incidents of his life or characterised the men of science he had met."

Another creation of Lovén's, of great and increasing importance to Swedish science, was the marine zoological station that he founded at Kristineberg, on the coast of Bohuslän, the same place where his earlier researches were carried out. Although a formal station under the care of the Academy was not opened till 1877, still work had been carried on at this place almost continuously since 1835, so that Kristineberg may claim to be the oldest such station in the world. I hope to give, in an early number of NATURAL SCIENCE, a detailed account of the Swedish station, with full illustrations. For the present it need only be said that this laboratory was under the direction of Lovén until his retirement from the Museum, and that he never ceased to give it his most affectionate care.

In the wider questions of education, Lovén also took a lively interest. From 1857 to 1878 he was on the committee of the Nya Elementar Skola (Grammar School) in Stockholm, as its chairman for the last seven of those years. In this position, and also in connection with Stockholm's Högskola (University) he fought with ardour for energetic reforms, especially in the direction of what we call a modern as opposed to a classical training, and for the extension of a sound teaching of natural science. That his efforts reached yet wider circles might be inferred by those who visited the exhibition of educational appliances that was held in Stockholm last August in connection with the Congress of the School-teachers of Scandinavia.

In these and in the other public positions which he occupied, Lovén was always prominent. Another who knew him well writes:— "In the Academy his communications were always listened to with the deepest attention. His words and opinion were often decisive for its concerns. He was one of its most influential personalities."

In connection with his scientific researches Lovén travelled much, visiting amongst other countries Germany, France, and England. But the only journey to which we need here refer is that which he made through Finmark in 1836–7; for it was at the close of this, in August, 1837, that he went on a walrus-steamer to Spitzbergen, Isfjord, Crossbay, and Kingsbay, and thus inaugurated the honourable succession of Swedish arctic expeditions.

So far we have dealt with the relations of Lovén to the development of science in his native country. But he was something more than a great Swede: he was a great man of science. We may consider very shortly the leading lines of his zoological work.

His researches on the marine fauna of Bohuslän, to which reference has already been made, gave rise in 1835 to the valuable paper on *Campanularia* and *Syncoryne*, that on the entomostracan *Evadne nordmanni*, and others. His observations opened many new fields. On the one hand, they served largely as a foundation for Steenstrup's celebrated work on the alternation of generations; on the other, they led Lovén himself to the further investigation of the molluscan fauna in the Scandinavian region of the North Sea. This study occupied him from 1838 to 1860, and his papers on the geographical distribution of the northern Mollusca, on their development, on their lingual armature, and on cognate questions, show how eager he was to elucidate the whole natural history of these animals, although the projected monograph never reached completion. Through these researches a new light was shed on the origin of the marine fauna of Scandinavia, and on the whole time intervening between the Glacial period and our own, during which northern nature was still under arctic conditions. Thus the discoveries of Lovén initiated arctic research in time as well as in space. In other words, they have given rise to a long series of papers by the naturalists of all lands on the relations of modern seas to those of the Glacial period: but in this research it must be admitted that the naturalists of Sweden still take the lead.

But this early work of Lovén has been obscured, not by the mists of time, but by the surpassing brilliance of his later work, in which he deserted the Mollusca for the Echinoderma. The two great memoirs, "Études sur les Échinoïdes" (1875) and "On Pourtalesia, a genus of Echinoidea" (1883) showed at their best both his breadth of view and his unwearied patience. In the whole range of Echinoid literature there is nothing that can compare with these two masterly works. The monograph on *Pourtalesia* gives the result of a searching investigation into the varying structure of the test in the species of this genus. The "Études" is an analysis of the composition of the test in a series of representative genera of sea-urchins. Before this time there had been no means of determining the orientation of the test in the Regular Echinoidea; Lovén discovered a number of almost microscopic characters in the ambulacral plates around the mouth, and these enabled him to determine the anterior segment of the animal. The position of the madreporite (the sieve-like plate by which the water-vessels communicate with the exterior) in the apical system of plates, the distribution of the bands of slender spines known as fascioles, and the slight deviations from bilateral symmetry in the arrangement of the plates, were all made by Lovén's patient researches to yield most valuable aid in the classification of the sea-urchins. His work, however, did more than this. His theory as to the nature of the two zones of plates around the anus of the Regular Echinoidea, and the homologies that he maintained between those plates and certain plates in the other groups of Echinoderma, notably the calycal system of the Crinoidea, may or may not meet with final acceptance. But his views proved a most beneficial stimulus to biological thought, and not least to the labours of our own countrymen, while their services to echinoderm morphology have been incalculable. Here, also, he was the first to draw attention to the minute structures to which he gave the name "sphæridia" and attributed a sensory function. In his later remarkable work "On the Species of Echinoidea described by Linnæus" (1887) Lovén continued his studies on the test of the sea-urchins, especially with reference to that minuter system of ornament which he named "epistroma," and which he believed to be a modification of the membranous envelope of the larva. His last work, "Echinologica," published in July, 1892, was chiefly devoted to the teeth of the sea-urchins and their accessory structures. In the posthumous work of Angelin, the "Iconographia Crinoideorum," the Cystidea were edited by Lovén, but his great work on these obscure ancestors of the echinoderms was never written. The beautiful plates are prepared and lie in the Riksmuseum, but the brain that should inform them with a connected meaning and elucidate them by the garnered knowledge of eighty-six years has left the toil to other and lesser heads.

The published works of Lovén, and, indeed, the non-publication of the others, all bear witness to his extreme caution. He worked slowly and with the greatest care; himself the most severe critic of his own work, he left but little for others to criticise. It is partly this caution, partly the extent of his knowledge, and partly, perhaps, some prophetic imagination, that lend to many passages of his writings their deep suggestiveness, unfathomable except by those that have themselves long studied the questions with which he deals.

The honours that came to Lovén from learned bodies or from Governments, and the societies—including agricultural, literary, and musical—of which he was elected an ordinary or honorary member, cannot here be recounted in full. So early as 1872 he was elected a Corresponding Member of the French Institute in preference to no less than Charles Darwin, while two years ago he received the Prussian order, "pour la mérite," this time in competition with Huxley. "I have had remarkably bad luck," said he, "to be preferred to the very two naturalists whom I myself rated most highly. But it is not my fault." Lovén was also a Foreign Member of the Royal Society of London, and of the Academies of Science at Berlin and Vienna.

Portraits of Lovén have been published. A bust and an oil painting may be seen in the rooms of the Swedish Academy. But all fail to do him justice. Of great stature and of noble feature, he impressed one the rather with the sympathy of his manner and the sweetness of his expresssion. These floating and indefinable shades have been fixed by no artist, but will ever live in the hearts of those that knew him.

I cannot better finish this tribute to a great and a lovable man than by quoting the words with which Professor Gustaf Retzius ended his eloquent and feeling article in the Stockholm newspaper, *Aftonbladet*, on the day of Lovén's death—words with which (may I take it upon myself to say?) all English naturalists will deeply sympathise:—

"Sven Lovén belonged to a family distinguished by personalities prominent both in science and in affairs. Round his open grave, which already holds two of his most beloved children—his daughter Agnes and his son Sigurd, the eminent physician—this numerous family now stands in mourning, and amongst them the nearmost is his aged wife, who with never-tiring love shared with him good and evil, joy and sorrow, and who was his firm support through the trial-times of age as she had been through those of manhood.

"But outside there is seen a wider circle of all the toilers and all the friends of Swedish science, who in this old man that has gone forth had learnt to honour, not merely their Nestor, but one who was great in the land of science, one who by his discoveries and researches had mightily brought knowledge on its way, to the honour of his country, to the profit of mankind.

"And without doubt our tokens of mourning and of homage are shared by many friends of research in other lands. For the name of Sven Lovén belongs to those that have gone out over the world, and his memory will live as long as Science tells her story to the generations that are to come."

F. A. Bather.

HENRI ERNEST BAILLON.

Born 1827. Died 1895.

Like other botanists of repute of the generation now rapidly leaving us, Baillon began his professional life as a medical man, his career as a student having been exceptionally brilliant. In 1863, however, he was appointed Professor of Botany at the École de Médecine, and occupied the chair until his sad and sudden death last July. He was also president of the Paris Linnean Society, which he helped to found in 1866. He was a foreign member of our Royal and Linnean Societies, but, owing to an unfortunate quarrel with those in power in his own country, did not there meet with those marks of recognition which, as one of the first botanists of his day, he had fully earned.

Baillon was a voluminous author. Works like the "Histoire des Plantes" and the "Dictionnaire de Botanique" will be a lasting testimonial to his wonderful energy and power of sustained effort. The former, begun in 1867, was only interrupted by his death, when it had reached vol. xiii., and was nearly finished. It forms one of the best accounts of the families and genera of the plant world, and the many well-executed illustrations are not the least valuable part. The "Dictionary of Botany," occupying four quarto volumes, appeared between 1876 and 1892; many of the articles were contributed by the editor. For nearly twenty years (1860–79) he produced (it was nearly all written by himself) the periodical known as *Adansonia*. The volumes, of which there are twelve, came out at irregular intervals, and represent a large amount of original work in morphology and systematic botany. He started the *Bulletin Mensuel* of the Linnean Society of Paris in 1874, and continued to prepare it during the rest of his life. Here, again, a great number of the original communications are from his own pen; it is especially rich in his descriptive work of the Madagascar flora. He was also responsible for the botanical section of Grandidier's "Histoire de Madagascar," the "Histoire naturelle des Plantes," of which, however, only volumes of plates have hitherto appeared.

In 1884 he provided his students with a text-book, "Traité de Botanique Medicale, Phanerogamique," a thick volume of 1,499 pages, followed, in 1889, by a volume on the Cryptogams.

Nor did he neglect local botany. "Les Herborisations Parisiennes" (1890) is an excellent little guide for those interested in plant-collecting near Paris; while in the "Iconographie de la Flore Française" (1885–94) the flora of the whole country is illustrated by 500 cards, bearing on one side a coloured drawing of a species, and on the other a botanical description and mention of its properties and habitat.

Besides the above, which represents almost a life work, Baillon was the author of more than 200 papers dealing with systematic botany and plant morphology. It is matter for deep regret that so busy and useful a life should not have run a longer course.

JAMES CARTER.

BORN 1814. DIED SEPTEMBER, 1895.

WE regret to announce the death of this well-known student of the decapod Crustacea. Mr. Carter was educated for the medical profession, studying at Guy's, and settled in Cambridge about 1840, where his leisure was spent upon questions of antiquarian and geological interest. His work mainly dealt with the fossil Crustacea, and we learn from the *Athenæum* that the results of his labours upon this group are in a sufficiently complete state for publication. He was M.R.C.S. 1836, F.R.C.S. 1876, and a Fellow of the Geological Society. His collection of local fossils has been for some years in the Woodwardian Museum.

Mr. Carter was a familiar figure in geological circles; his cheery and active presence did not in the least suggest his age, and he will be greatly missed by a large circle of friends.

WE learn from *Naturæ Novitates* that the Spanish entomologist, Dr. L. PEREZ ARCAS, died on September 24, 1894, in Requena, at the age of 70 years. He was not a prolific writer, and one of his last papers dealt with questions of nomenclature.

M. JULES VESQUE, of the Faculté des Sciences, Paris, who died on July 25, in his 47th year, was known as the author of the monograph on the Guttiferæ in De Candolle's "Monographiæ Phanerogamarum." Vesque was a strong supporter of epharmosis, or the use of anatomical characters in systematic botany. He also worked at plant-physiology, and was the author of a "Traité de Botanique."

THE death of MARSHALL McDONALD, which occurred on September 1 at Washington, robs the United States Fish Commission of an able and valued officer. When Professor Spencer Baird died, the post was temporarily occupied by Professor Brown Goode, and subsequently accepted by Mr. McDonald, who was chief assistant commissioner. The appointment was a successful one, and the department over which Mr. McDonald presided has become one of the most important economic bureaus of the Government. Mr. McDonald was the inventor of a stairway to enable salmon to ascend rapids, and his services have been of considerable value to the progress of pisciculture in the United States and elsewhere. The office of Fish Commissioner is now a most important one, and it is hoped that one of Mr. McDonald's assistants will be chosen to succeed so capable an administrator.

AMONG others who have recently passed away, we notice Dr. R. KRAUSE, the anthropologist, at one time of the Museum Godeffroy in Hamburg, who died at Schwerin (Mecklenburg) on July 25; Dr. FELIX HOPPE-SEYLER, Professor of Physiological Chemistry at Strassburg, who died on August 11 at Wasserburg on the Bodensee, aged 70 years; and Dr. THOMAS HENDERSON CHANDLER, dean of the Harvard Dental School, who died on August 27, at the age of 71.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments have recently been made: Mr. A. Vaughan Jennings, Demonstrator in Geology and Botany in the Royal College of Science, Dublin; Dr. Herbert Hurst, Demonstrator in Zoology at the same institution; Dr. Siefert, as Professor of Forestry at the Technische Hochschule of Karlsruhe; Joseph Bissett, of Aspatria, as Agricultural Lecturer to the County of Ayr; Professor Kallies, of Göttingen, to the chair of Anatomy in the University of Tübingen; Dr. Emil Yung, as Professor of Comparative Anatomy and Zoology at Geneva University, in succession to Carl Vogt. Mr. G. E. Grimes and E. Vredenburg, of the Royal College of Science, have entered the Geological Survey of India; and Dr. M. Miyoshi has been appointed Professor of Botany at Tokio University. Dr. Julius Pohl becomes Professor of Pharmacology at Prague University; Dr. R. Metzner, Professor of Physiology at Basle; Dr. J. V. Rohon, Professor-Extraordinarius in Histology at Prague, and Dr. W. Roux, Professor of Anatomy at Halle.

Professor H. F. Osborn has resigned the Deanship of Columbia College owing to pressure of work—he still retains his Professorship; Dr. T. P. Lotsy is leaving the botanical school of the Johns Hopkins University to become assistant under Dr. Treub at the Buitenzorg Botanic Garden.

PARAGRAPHS have appeared in the newspapers recently respecting the changes in progress among the staff of the British Museum (Natural History). Beyond the fact of the retirement of Dr. Albert Günther (by age limit) in October, nothing has been officially announced, and the various notices which have appeared are purely speculative.

PROFESSOR ALBERT KÖLLIKER has been elected a correspondent of the R. Accademia dei Lincei; Professors K. W. von Gümbel, K. A. von Zittel, A. Cossa, and Alexander Agassiz have been elected corresponding members of the Berlin Academy. Baron F. von Mueller and Professor Ferdinand Cohn have been elected to the corresponding memberships of the Paris Academy, vacated by the deaths of Professor Pringsheim and Count Saporta.

WE are glad to hear that a civil list pension of £200 has been granted to the widow of the late Professor Huxley, whose almost quixotic honesty and generosity in money-matters were well-known. The scheme for the Huxley memorial has grown, and assumed an international form.

A COMMITTEE has been appointed for the purpose of commemorating the memory of the late Dr. Valentine Ball. It is proposed to place a marble bust of Dr. Ball in the National Museum, Dublin, and, if the funds admit, to have a portrait painted and placed in some suitable position. Dr. Samuel Gordon, Hume Street, Dublin, is the treasurer. A similar committee has been formed in Halifax to commemorate the educational and scientific work of the late Mr. James W. Davis. The memorial is to take the form of a bust and tablet, to be placed in the new Technical School.

Dr. John Murray has signalised the close of the work of the "Challenger" Expedition in a most pleasing way. He has presented a medal to the naval officers, the contributors of memoirs, and the civilian staff of the Expedition. The medal is of bronze, is three inches in diameter, has been designed by Mr. W. S. Black, and modelled by Mr. Birnie Rhind. On the obverse is seen the head of Athena, with an owl resting on a globe which is surrounded by water, from which Neptune rises holding a trident and a trawl. On the right is a dolphin, while below are two mermaids supporting a riband bearing a legend, "Voyage of H.M.S. 'Challenger,' 1872–76." On the reverse is the badge of the vessel, a mailed warrior who has cast his gauntlet to Neptune, whose trident rises behind the challenger. A riband runs round the margin, returns along the base, enfolds the trident, and bears the words "Report on the Scientific Results of the 'Challenger' Expedition, 1886–1895." The name of the recipient has been engraved around the edge. The medal is of considerable artistic beauty, and recognises in a most fitting way the valuable and exhaustive labours of those who have contributed to the success of the Expedition.

Edinburgh Summer Meeting.—During the ninth session of the Edinburgh Summer Meeting, which was opened by Lord Reay on August 5, and continued throughout the month, the scientific side was represented by Professor Lloyd Morgan (on Evolution Ethics), Professor Haddon (on the Savage Mind), Dr. Irvine (on the Nervous System), Mr. J. Arthur Thomson (on the Biology of the Seasons), Mr. Robert Turnbull (on Applied Botany), Dr. W. W. J. Nicol (on Everyday Chemistry), Elisée Reclus, Professor Geddes, and Mr. Herbertson (on the Evolution of Cities), Mr. J. G. Goodchild (on the Geology of Edinburgh), and so on. The success of this meeting seems to continue to justify its existence—in holiday time.

That the go-ahead policy of our American cousins is sometimes marred by exceptions will be evident from the following quotation. "On account of serious financial difficulties and a distrust of the progressive and enlightened educational policy of President John, the trustees of De Pauw University, at Greencastle, Indiana, have forced the resignation of the President, and set about a return to the old paths. The department of biology, having been founded by Dr. John, was among the first to suffer. It was summarily abolished, the announcement being made, without previous warning, only the day before commencement. From a professor of zoology and one of botany at the beginning of the last college year, the instructional force is reduced to a single tutor, who is expected to give instruction in the elements of both sciences."

We learn from the *Botanical Gazette* (August) that the McGill University is the recipient of a generous gift from Mr. W. C. McDonald, of Montreal, in the form of thirty-five acres of ground for the use of the botanic garden.

Also that Professor Mottier's duties in Indiana University will be undertaken by Dr. G. J. Peirce while the former is absent abroad.

The report of the Curator of the Archæological Museum of the Ohio State University, published in the September number of *The Archæologist*, shows a good record of work done on and among the remarkable mounds of the Ohio State. This department of the University has been in existence but a year and a half, and Mr. Warren K. Moorhead must be congratulated on his success. No less than 25,000 specimens have been accumulated, the bulk of which came from Fort Ancient, while large series are shown from the Scioto Valley and other places of importance in the State. Mr. Moorhead hopes that funds will soon be available for publication of an illustrated and detailed report.

The Mayor of San Francisco, Mr. Adolph Sutro, has offered to the Regents of the University of California thirteen acres of land on which to erect buildings for the affiliated colleges of the University. In addition to this, *Science* says, he offers to transfer to the city another thirteen acres as a site for the Sutro Library. This contains 200,000 volumes.

THE Board of Governors of the Canterbury Museum, Christchurch, New Zealand, have issued a guide to the collections, compiled by Captain F. W. Hutton. This has been written "more for the ordinary visitor who would like to know something about the things he is looking at, but whose knowledge is in another direction. The main object, however, of the guide is to make the museum a real educational establishment, and in writing it the wants of teachers have been kept in view." Captain Hutton has succeeded in doing this admirably.

ATTENTION must be drawn to the remarkably successful case of Bustards recently placed in the British Gallery of the British Museum (Natural History). Among the whole series of taxidermic triumphs at that institution we cannot recall anything better, while as an illustration of the male displaying before the female, it is perfect.

THE statue of Richard Owen to be placed in the hall of the British Museum (Natural History) has during the past month been on view in plaster at the museum. It is a striking likeness and has a satisfactory pose, the hands being especially lifelike. Owen holds a bone of *Dinornis*, on which he appears to be demonstrating to an audience.

As we announced in September last year, the Swiney Lectures to be delivered this year by Dr. J. G. Garson, will deal with "The Geological History of Man." As no arrangements have as yet been made for the lecture theatre at the Natural History Museum, Dr. Garson will speak in the lecture theatre of the South Kensington Museum. The lectures will commence on Friday, October 4, and will be continued on Mondays, Wednesdays, and Fridays during the month. They will be delivered at five o'clock, a considerable improvement for public convenience, and will be illustrated by the limelight lantern, thus marking progress in this department.

THE Natural History Department of the Science and Art Museum at Dublin has received the collection of British insects formed by the Rev. W. F. Johnson of Armagh. Many of his specimens of Coleoptera are record finds for the British Islands, and this gives the collection a peculiar interest.

MR. ADRIEN DOLLFUS announces, in *La Feuille des Jeunes Naturalistes*, that he has succeeded in obtaining promises of voluntary assistance in the naming of specimens for school museums in France. This is a great stimulus to boy-collectors, who are often hindered from pursuing their subject by the difficulty of obtaining advice and help.

THE Report of the Geological Photographs Committee of the British Association shows good progress. One thousand and fifty-five photographs were received and registered up to the month of August, 1894, and 123 have been received during the last twelve months. The collection will shortly be deposited in the Museum of Practical Geology. The Committee issue a circular of recommendations as to suitable apparatus, size of photograph, etc. It is greatly to be desired that the Committee should induce some person in England to devote his attention to the publication of a series of geological photographs, and so render them accessible to the public, as is done by Mr. Welch, of Belfast, whose collection of photographs of geological features in Ireland is remarkable alike for beauty of execution, uniformity of size, and scientific interest.

The attendance at the Ipswich meeting of the British Association was 1,324, and the subscriptions amounted to £1,236. The amount allotted to the grants is £1,160. Among the new grants, the following will interest our readers:—Reprinting Discussion on the Relation of Agriculture to Science, £5; Palæolithic Deposits at Hoxne, £25; Fauna of Singapore Caves, £40; Age and Relation of Rocks near Moreseat, Aberdeen, £10; African Lake Fauna, £100; Oysters under normal and abnormal environment, £40.

The International Congress of Zoologists has appointed an international committee of seven members (Professor S. J. Hickson being the English representative) to ensure the permanence and proper working of the Central Bibliographic Bureau for Zoology. The Congress has unanimously accepted the scheme; but in the Zoological Section of the British Association there was a lively debate on the subject, and the section has appointed a committee to report to it on the value of the proposals.

The *Proceedings of the Croydon Microscopical Club*, 1894–95, have just reached us. The strength of the club is 242, a slight diminution of numbers, which we hope will be made up during the next year. There is also a small deficit in the balance sheet. There is a pleasing reference to the former energetic secretary, Mr. W. Low Sarjeant, who has gone to New Zealand for his health, and who hopes to employ his leisure in photographing details of natural history life. The president, Dr. Frankland Parsons, made a strong case for the establishment of a local museum in the new municipal buildings. The chief paper in the *Proceedings* is the second part of Mr. Whitaker's report on Surrey well-sections.

The Borough of Nottingham Central Free Public Lending Library has issued a "Class-List of Science; with an Index of Subjects and Authors." This is divided into general science, astronomy, biology, botany, chemistry, ethnology, geology, mathematics, metallurgy, microscopy, physics, physiology, and zoology. These subject catalogues should prove of great service to readers. There are twenty of them, and the price ranges from one penny to threepence.

The last number of the *Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein* (vol. x., part 2) contains an interesting paper by R. von Fischer-Benzon on Hildegard's "Physica." Hildegard was a Benedictine, was born at Bechelheim about 1098, and died in 1179 at St. Ruprechtsberg, near Bingen. "Physica" was the first work on the Natural History of Germany.

Dr. H. J. Johnston Lavis has a long and interesting paper on the Geology, Agriculture, and Economics of Iceland in the September number of the *Scottish Geographical Magazine*. This is the result of a journey made in company with Dr. Tempest Anderson, of York, in the summer of 1890. The paper is well illustrated by photographs taken by the author.

Professor John Milne announces in *Nature* that he has established a small station at Shide Hill House, Shide, Newport, Isle of Wight, for the recording of earthquakes having an origin in distant localities. Communications for the *Transactions of the Seismological Society* and the *Seismological Journal* should be addressed to him there.

Dr. E. Selenka has not yet returned to Erlangen from his natural history expedition. Letters have been received stating that Dr. Forsyth Major and his companion were alive and well in July last. News has been received of the Jackson-Harmsworth Arctic Expedition; the "Windward" is at Vardö, the expedition started northwards from Franz Josef Land in July. A Reuter's telegram from Norway of September 17 states that the "Fram" has twice been sighted by Esquimaux in lat. 65° N., off the E. coast of Greenland, embedded in drift ice.

CORRESPONDENCE.

Miocene Man in Burma.

Many of us on reading Dr. Noetling's exceedingly modest paper on "Chipped (?) Flints in the Upper Miocene of Burma" (*Records Geol. Survey of India*, vol. xxvii., p. 101), felt that his case was probably rather understated than overstated. Nor did Dr. Blanford's warning (*Nature*, vol. li., p. 608) in any way alter the importance of the discovery. Mr. R. D. Oldham (Natural Science, vol. vii., p. 201) now gives us a new reading of the observations made in the field; but we have a right at once to ask for an expansion of his statement that implements (presumably similar) are "scattered over the surface of the plateau above." Geologists will be glad to be informed that these implements have been compared, as to form, material, and state of preservation, with those from the weathered surface of the conglomerate; and it is of obvious importance that some portion of the conglomerate itself should be quarried out on the chance of finding chipped flakes within it. Dr. Noetling's case may, of course, prove to be entirely unsupported. All I would now urge is that no authority should write of such a question "that the degree of proof required varies inversely with the inherent probability of the proposition to be proved." Surely the existence in the Pliocene period of a man-like animal capable of making implements is to many of us one of the highest probabilities. Geologists, above all, should be especially careful lest the recording of traces of man in Pliocene or older periods be rendered dangerous to the reputation of the observer, and a check be thus given to discussion and research. The treatment of the magnificent series of skulls of the Neanderthal type as mere sports of nature, of no especial import, has shown how little even professed evolutionists care to admit the mental development of man. The close of the Pliocene period has nothing mystic or magical about it, nor is it likely that man sprang full-armed from glacial furrows. Let us ask ourselves candidly on which side of the question does probability lie.

Grenville A. J. Cole.

Royal College of Science for Ireland, Dublin,
August 27, 1895.

Phosphate Nodules of the Red Crag.

Mr. Reid, in his paper on the Geology of Ipswich and its Neighbourhood, alludes to the "Coprolites" (Natural Science, vol. vii., p. 174). It may interest your readers to know that an account of their discovery will be found in the *Technologist*, vol. iv., p. 111, and in *The Mediterranean Naturalist*, vol. ii., p. 235. It was in 1842–3, when the late Professor J. S. Henslow and myself were collecting fossils from the Crag, that my father, who was a first-rate geologist, and, of course, well acquainted with Buckland's Liassic "Coprolites," at first thought the dark brown rolled nodules of the Crag might be of the same nature, and this was the origin of the mistake in the name. He sent some to Mr. Potter of Lambeth to be analysed, who reported that they contained upwards of 50 per cent. of phosphate of lime. Hearing this, he at once communicated the fact to Mr. (now Sir) J. B. Lawes, who asked for a ton to be sent him. This was soon collected from the fallen cliff and beach. From that moment they became of great commercial value. In 1848 the Professor suggested to Mr. Deck, chemist, of Cambridge, to analyse the nodules from the Greensand of that neighbourhood. These proved to contain from 50 to 60 per cent. This, also, was the origin of the subsequent extensive workings in Cambridgeshire.

In Suffolk the phosphate nodule bed of the Crag was apparently deposited *before* the Bryozoan (Coralline) Crag, as it was detected *below* the "White Crag" in a pit dug at Ramsholt, but long ago filled up. As this earlier Crag is more locally deposited, the phosphate bed is usually between the Red Crag and the London Clay. It has yielded remains of many land animals of the Miocene or Oligocene periods, which would not be represented in our museums had it not been for the discovery of the commercial value of the nodules. The late Mr. Charlesworth was good enough to let me see all that passed through his hands, so that at one time I was able to make a tolerably complete set of water-colour drawings of the mammalian fossils of this bed, including *Hipparion*, *Rhinocercs*, *Mastodon*, and *Cervus*. They have never been published.

GEORGE HENSLOW.

A PLAGUE FOR LOCUSTS.

To supplement the note on this subject (*ante*, p. 152) by Miss Smith on the fungoid destruction of locusts in Natal, I may state that I observed a similar mortality among Orthoptera at the same time in this neighbourhood of the Transvaal, showing that the "locust epidemic" must have covered a wide area between here and the coast.

On this occasion the insects attacked were smaller species of Acridiidæ, belonging to more than one genus, and were only found on the leaves of *Acacia mollissima*, an Australian wattle, the bark of which, as grown in Natal, produces a higher percentage of the tannin principle than it does in its original habitat. These Orthoptera had died clinging tenaciously to the leaves, and were with difficulty detached after death, as was the case with the Durban locusts.

I may add that our last locust swarms here were composed of a different species to the *Pachytylus migratoroides*, Reiche, the ordinary South African scourge, and the one solely constituting the vast hosts observed here previously by myself in 1891. This year we were visited by a larger species with a redder coloration, which I hope to identify on my return to England.

Pretoria, W. L. DISTANT.
August, 1895.

ERRATA.

WE regret that, because the corrected proof went astray in the post, several mistakes appeared in Mr. Carpenter's article "Some Recent Insect Literature" in our last number. The principal corrections to be made are:—

P. 180, for *Gibelbula* read *Libellula*.
,, ,, Planipeunia read Planipennia.
,, ,, Tricoptera ,, Trichoptera.
,, 182, ,, sunflies ,, sawflies.
,, 183, ,, pupillæ ,, papillæ.
,, ,, de Saumere ,, de Saussure.

NOTICE.

TO CONTRIBUTORS.—*All communications to be addressed to the* EDITOR *of* NATURAL SCIENCE, *at* 22, ST. ANDREW STREET, HOLBORN CIRCUS, LONDON, E.C. *Correspondence and notes intended for any particular month should be sent in not later than the* 10*th of the preceding month.*

TO THE TRADE.—NATURAL SCIENCE *is published on the* 25*th of each month; all advertisements should be in the Publishers' hands not later than the* 20*th.*

THE "CHALLENGER" NUMBER.—*In reply to enquiries, we remind our readers that, although the* FIRST *edition of this ran out of print immediately, there are still some copies of the* SECOND *edition to be obtained at the usual price*— ONE SHILLING. *No more will now be printed, so orders should be sent at once.*

NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

No. 45. Vol. VII. NOVEMBER, 1895.

NOTES AND COMMENTS.

Reminiscences of Huxley.

IN *Scribner's Magazine* for October, Mr. George W. Smalley writes a pleasant and intimate paper on Huxley. During the many years Mr. Smalley represented a great American newspaper in London, he became acquainted with nearly all our latter-day celebrities, and he was a private friend of Huxley's for years. Since some may be ignorant of the marvellous extent to which Huxley was well-informed upon every subject he discussed, we quote a striking instance—one of many—from Mr. Smalley. "When he set forth in his trenchant way some of the absurdities of Auguste Comte, Mr. Frederic Harrison, one of the high priests of positivism in England, replied that Mr. Huxley had evidently never read Comte. Huxley took the trouble to explain that he had early mastered the six volumes of the 'Philosophie Positive,' and had re-read them for the purposes of that discussion."

The combative side of Huxley's character is at least sufficiently well-known to everyone. A great part of his life was spent in fighting; but it was in fighting for science and for freedom of thought. The gentler side of his nature impressed itself on Mr. Smalley. "At his own table he avoided arguments when he could. Others, or all others, did not. Mr. Huxley sat there with a serenity and patience which were admirable, joining in discussions in a way to mitigate their severity; he himself, too, of a nature to avoid all compromise, but keeping under the purely intellectual view, and reviving the social view, when too eager disputants seemed in danger of taking some other."

Huxley was devoted to cats. "Like all men of gentle mind, Mr. Huxley liked this gentle race; liked their coaxing ways, their intelligence, their unlikeness to that human kind with which they have, nevertheless, a sympathy so strong, when the human sympathy and intelligence are equal to theirs. One or other of his cats was always with him. He was never too busy to give them the recognition they sought, and their friendship was one of the things he valued."

It is plain enough, from the work that he accomplished, that Huxley was untiring in his industry. Mr. Smalley testifies:—"He never spared himself. Often and often have I known him leave the circle of family and friends, of which he was the life, very early in the evening and betake himself to his library; a room of which the only luxury was books. If remonstrated with, or appealed to for another half-hour, he would only shake his head. There was something to be done. And it would be midnight or one or two o'clock before it was done, and then he was up at seven in the morning. I sometimes thought he had no higher happiness than work; perhaps nobody has. He would dine on a little soup and a bit of fish; more than that was a clog on his mind. 'The great secret,' he said, 'is to preserve the power of working continuously sixteen hours a day if need be. If you cannot do that you may be caught out any time'."

Sir William Flower upon Huxley.

The Director of the Natural History Museum contributes to the September number of the *North American Review* an interesting series of personal reminiscences of Huxley. He reminds his readers that Huxley was not in early life "what is commonly called a naturalist." "His early tastes were for literature and engineering," and he displayed no boyish love for the formation of collections. Sir W. Flower thinks that most men who have distinguished themselves in zoology or palæontology were specimen-hunters in their boyhood. Darwin, of course, is the first instance that rises in the mind; but every biologist knows personally many others. We are disposed to think, however, that a considerable and increasing number of biologists do not begin as school-boy naturalists. The inquiry would be so interesting that we wish some person of leisure would send a circular to every biologist in Europe and tabulate the answers to the questions:

1. Have you ever made collections?
2. If so, of what?
3. If not, how came you to devote yourself to biological work?

We think that there can be no doubt that every zoologist (and we include palæontologists in the term) ought to have studied species at some period of his career.

Another interesting point referred to by Sir William Flower is Huxley's treatment of "specimens." In this matter there are two kinds of consciences, and it is a grim struggle when it comes to a battle between them. There is the museum conscience, to which the violation of a rare or perfect specimen by scalpel and scissors is the sin not to be forgiven. There is the anatomical conscience, to which shutting up in a glass bottle a rare specimen, instead of dissecting it, seems a miserly stupidity. Of course, the easy solution is when there are more specimens than one. But when there is only one, is it to be dissected or catalogued? There is no absolute answer. The museum man or the anatomist must act according to his lights—and beware of the other. Huxley was frankly anatomical. "He cared for a specimen according to the facilities it afforded for investigation. He cut it up, got all the knowledge he could out of it, and threw it away."

Pasteur.

In another place in this issue we publish notices of Pasteur's chemical work and of the clinical results obtained from his investigations into microbes. It is exceedingly difficult, in the case of a subject in which so many investigators have made almost simultaneous discoveries, to assign to each his due share of praise. We are disposed to think, however, that Dr. Andrewes, in his endeavour to be strictly impartial, has assigned to Pasteur's influence rather less than he might have done with propriety. We do not think it possible to over-estimate the value of Pasteur's application of chemical methods. Before his time such observations as had been made upon the organisms of putrefaction and fermentation were almost entirely morphological. The series of experiments which culminated in the preparation of "Pasteur's Fluid," the solution which contained the minimum of materials necessary to the growth of yeast, was practically the beginning of quantitative work upon micro-organisms. Later on, when Pasteur, and with him most other bacteriologists, were engaged in attempts to attenuate virus by cultivation, the chemical side of the matter seemed of less importance. Now that Pasteur's pupils in the Institute, as well as most other bacteriologists, regard toxins and antitoxins as of more importance from the point of view of medicine than the living organisms themselves, it is the chemical side of bacterial life that is coming into prominence again.

Pasteur's School.

Pasteur was one of the great men who not only conducted investigations themselves, but possessed in the highest degree the power of stimulating others to work. In the issue of the Parisian *Figaro* that appeared immediately after the death of Pasteur, Dr. Maurice de Fleury gave a most interesting account of the "Disciples de Pasteur" in the Rue Dutot. "Although Pasteur has gone," he said, "the Institute will remain as active as ever. This is worth saying to-day, while the news of our great loss is spreading over all Europe. The work of the master is so enduring that the death of the great man is really the death of a saint who regains Heaven after having founded an order. For it is really a kind of religious order in this house full of devotees proved and eminent, monks or missionaries who work in the laboratory unceasingly, or carry their good news into the furthest land of plague or cholera.

"They are full of the communal spirit, each caring more for the glory of the Institute than for their own reputation. They are without jealousies and rivalries. They despise money. M. Duclaux gives a quarter of his salary as sub-director to the young investigators' refectory. Last year M. Roux had a salary of 7,000 francs. Against his will it was raised, and, being unable to refuse it, he put the additional three thousand francs in the common purse." This is that M. Roux whom the emissaries of the anti-vaccination fanatics delight to abuse as a money-seeking charlatan.

London and Chicago: a Contrast.

To those of us who are "aweary, aweary, because a real London University cometh not," Mr. Herricks' account (in *Scribner's Magazine* for October) of the tropical growth of the Chicago University, brings an admiring envy. "Magnificent buildings, an endowment of over six million dollars bestowed in the short period of four years, and a generous annual budget for current expenses may not make a university, but they create the material condition all essential for any ideal enterprise." These generous materials for a university have come from the liberality of Mr. Rockefeller and of the municipality of Chicago itself.

A curious difference between the hard and fast rules of an English University and the flexible ordinances of Chicago is seen in the regulations for attendance. At Chicago each course lasts twelve weeks. A student may reside only one term in the year, and thus spread out the duration of his studies indefinitely. Already, many who are usually deprived of the opportunity for university study by the necessity for continuous residence, have matriculated with the intention of working one term a year, earning their living during the remainder of the year, and spreading out their course over many years. The Scots universities, by limiting their sessions to six winter months, used to attract many students of this kind; and a number of Scotsmen who rose to great distinction were labourers or fishermen for six months, university students for the other six.

An interesting feature of Chicago is the preponderance of post-graduate study. Every possible facility is given for this, and in the present year over three hundred graduates, one-third of the total number of students, were in residence. The attraction to these is the doctor's degree, which, in the fashion of German universities, is to be obtained only after special research work. Thirty thousand dollars a year are offered in fellowships and scholarships to such students: many of the department libraries are reserved for their use, and it seems likely that Chicago is to be the home of a great body of investigators.

It is this last matter that touches the raw of London most surely. The scattered existing institutions provide tolerably for young students and for elementary work; but there is less facility for research in London than in the smallest continental university town. Here and there, at University College, at South Kensington, at the Zoological Gardens, and at some of the medical school laboratories, a few private investigators are given opportunity by the kindness of those in charge. But there is no place where a graduate may go as a right; there is no convenience of libraries or of laboratories. For this reason alone every scientific man in London, in season and out of season, should press for a central, working university.

Catalogue of Medical Literature.

The sixteenth and last volume of that colossal catalogue, the "Index Catalogue of the Surgeon-General's Office of the United States Army" has just been published. This work, the best of its kind extant, is practically a complete index to medical literature, and contains a great number of works more or less connected with the other natural sciences. The library contains, says *Science*, 116,847 books and 191,598 pamphlets. The present volume deals with 12,759 authors' titles, representing 4,857 works and 11,613 pamphlets. We doubt if so large a collection of medical works exists elsewhere, and it speaks well for the United States Government that a comparatively young library, as compared with the libraries of the Old World, should be in such perfect condition. The library has increased at such a pace that no less than five new volumes are needed to record the accessions since the work began, and these will immediately be prepared. This sixteenth is the last volume that will be issued under the personal supervision of Dr. John S. Billings, and we offer our hearty congratulations to him and to his staff on the completion of so gigantic a monument and so valuable a book.

Bibliography of American Algæ.

The number of papers on marine algæ, especially those dealing with the systematic branch of the subject, increases so rapidly that it is extremely difficult for students to avoid missing some important paper, published, as is so often the case, in some rather inaccessible periodical. This difficulty is, perhaps, especially felt when it is desired to study the algæ of some particular part of the world, and the publication of a complete list of the literature dealing with certain areas is much to be desired.

Such a list of the literature of American Algæ has lately been compiled by Miss Josephine E. Tilden, and published as part xxiii. of the *Minnesota Botanical Studies*. It includes the titles of all papers in any way referring to algæ, marine or fresh-water, which occur in America. The geographical limit is wide, and includes, besides North and South America, the West Indies, Galapagos Islands, and even Tristan d'Acunha and Inaccessible Island. We venture to think that this range is too wide, and that such oceanic islands as the two last-mentioned should not be included in a list of papers supposed to be

American. In point of distance they are nearer to the Cape of Good Hope, the marine flora of which includes nearly all the forms found at these islands. In her selection of papers, Miss Tilden has a hard task, and it is difficult to see on what grounds she inserts or rejects a paper. She apparently wishes to include any publication which makes mention of an alga as occurring in America; but to do this it would be necessary to mention almost every monograph of marine algæ and a large number of papers on their morphology. For instance, if Mr. George Murray's paper on *Halicystis* and *Valonia* in the *Phycological Memoirs*, 1893, is cited, because the specimens examined were collected in Bermuda, why are the papers on *Struvea* (*Annals of Botany*, vol. ii., no. vii., Nov., 1888) and *Avrainvillea* (*Journal of Botany*, March and April, 1889), by the same author, omitted? In both of them American and West Indian species are described. This holds good in several other cases. It would surely have been better to include all papers without exception that refer to algæ as found in America and to omit such publications as 562, 946, 1,250, 1,266, 1,267, etc., which refer solely to the cleaning, mounting, and preserving of Diatoms.

Bibliographical work, to be of value, must be done critically and completely. In this case the errors of inclusion are, perhaps, more formidable than those of omission. Miss Tilden hopes to make additions to her list, and she would do an equally good service by first clearing it of much that is irrelevant to the subject.

Dr. John James Wild.

We regret to find that our "Challenger" number was guilty of homicide, which we hasten to assure our readers and the good man it killed was quite unintentional. Dr. John James Wild, who was a member of the civilian scientific staff in the double capacity of secretary to Sir Wyville Thomson and natural history draughtsman to the Expedition, is, we are glad to learn, still of this world. Not merely Plate xvii., but most of the illustrations in our July number are copies of Dr. Wild's original drawings made on board ship, a circumstance which gives them a far greater value.

For many years Dr. Wild has been living in Melbourne, where he has occupied himself in drawing the plates for Sir Frederick M'Coy's "Prodromus to the Zoology and Palæontology of Victoria." This important publication has been greatly delayed on account of the reduction by the Government of the funds voted for scientific purposes, on the plea of retrenchment. The palæontological plates, including many interesting drawings of fossil fishes, have not yet been published, although printed some time ago. It is to be hoped that circumstances will soon change and permit us to see these beautiful examples of scientific lithography, of which Dr. Wild sends us a few specimens.

Victorian Mines.

From time to time we receive the Government Reports of the Secretaries for Mines of various parts of the Australian continent, but as a rule they have little besides technical details of a nature uninteresting to our readers. The last received is that of Victoria for the year 1894, a folio full of plans of mines and pictures of gear. The bulk of the report is concerned with the output of gold, and in this connection the secretary deplores the loss of the Government Analyst, Mr. J. C. Newberry, whose latest investigations were directed to the saving of slime-gold. The chief feature for congratulation is the expanse of the coal industry—no less than 80,000 tons increase over the 1893 output is recorded. A number of new mines have been opened in the Jumbunna district, and these, it is hoped, will shortly double the supply. Sixty tons of tin were raised in Victoria, and thirty-five tons of antimony during 1894, while of gold the total amount of 673,680 ounces appears in the Registrar's returns for the year.

Crabs as Geologists.

From the same Government we have received "Reports on the Victorian Coalfields (No. 3)," by James Stirling, Assistant-Geological Surveyor. From this we cull a few items of more scientific interest.

A valuable ally of the field-geologist is, it appears, to be found in the land-crab. Some time ago Mr. Stirling suggested that the work performed by this diminutive excavator in bringing up pieces of the rock forming the subsoil might help the miner to find coal-seams in South Gippsland, just as the burrowing wombat had disclosed stanniferous lode-stuff in the Australian Alps. The hint was taken. A young miner detected small pieces of coal around the burrow of a crab, sank a shaft on the spot, and cut the coal-seam four feet below the surface. From similar evidence the officers of the geological survey have traced outcrops in places where the rock was masked by alluvium.

Gippsland Coal.

With regard to the origin of coal, Mr. Stirling makes some interesting observations. He is of opinion that the coal-seams of South Gippsland have, in all probability, been formed by the drifting of vegetable matter from a distance, and not as the result of the growth and decay of plants in the localities now occupied by the carbonaceous strata. The manner and formation of the European coal-seams of Upper Carboniferous age has long been a difficult question, and of late years very strong evidence has been brought forward in support of the formation of coal by the gradual deposition of vegetable *débris* drifted from a longer or shorter distance from the forest-covered areas. It is, therefore, of considerable interest to find that the Gippsland coal has apparently had a drifted origin. Among other facts in support of this conclusion Mr. Stirling brings forward the following argument: (1) The absence of true seat-stones containing roots; (2) the occurrence of finely water-worn quartz pebbles and of lenticular deposits of shelly matter in the coal-seams ; (3) the difference in the physical structure of the coal ; and (4) the remarkable variation in the thickness of some of the seams, and the existence of false-bedded strata above and below the coal. He goes on to discuss the flora of the "oolitic beds" of S. Gippsland, but his remarks on this head are not as clear as we could wish.

The Kea of New Zealand.

In the recent number of the *Zoologist* Mr. Taylor White, who has been farming sheep in New Zealand for many years, has some interesting notes upon the Kea parrot, *Nestor notabilis*. Mr. White writes in a somewhat combative spirit, but his report, despite the science correspondent of the *Pall Mall Gazette*, confirms the accepted belief that the Kea has in recent times entirely changed its habits. Mr. Taylor White was in New Zealand before the Kea began to attack sheep. According to him, it did not originally live upon berries and honey, as Mr. Wallace suggested in his volume upon Darwinism. It lived in the mountains above the forest-line, where berries do not grow, and its food was the lichen upon stones. Shepherds began to find that sheep which had missed a shearing and so had long wool, died suddenly, the only sign of death being a small round hole far down the back. The cause of the hole was found to be the Kea, which, according to Mr. Taylor White, was attracted to the sheep by the resemblance of the wool to lichens, and chose the particular spot because it could hold on securely there, in spite of the attempts of the unfortunate animal to dislodge it. According to the same authority, the parrot had no special predilection for the kidney-fat, but simply picked a hole to obtain blood.

Whether Mr. Taylor White be right in supposing the resemblance of long wool to lichens to have been the cause of change, or there be more truth in the earlier suggestions that the Kea learnt the ease of a carnivorous habit from the pickings of slaughterhouses and afterwards went straight to the sheep, is a minor matter which may or may not be settled; but it is interesting to find additional corroboration from one who has seen the change in progress, of a complete change from vegetable to animal food occurring in a short space of years.

Novelties at the Zoo.

Among the novelties recently added to the collection of the Zoological Society is a chimpanzee of greater size, and presumably, therefore, of greater age, than is usual. These animals have to be captured by killing the mother, which naturally leads to the importation into this country, for purposes of sale, of very young specimens. But the new chimpanzee, which is a male, is distinctly above this average, and has, therefore, one would think, a greater chance of accustoming itself to the apparently rather unfavourable environment of the Marsupial house.

The collection of apes has also been increased by the addition of another specimen of the Celebesian monkey (*Cynopithecus niger*), one of the animals peculiar to Celebes, that anomalous island—"a fragment of Miocene Asia" as it has been called. The Marsupial house, in fact, which is by no means exclusively, or even chiefly, devoted to harbouring marsupials, concentrates within it ssomewhat odoriferous precincts the chief objects of interest in the Zoological Society's gardens at present. The most salient among the rest of these is, perhaps, the three-banded armadillo (*Tolypeutes tricinctus*), which has the power of rolling itself into a ball, the snout and tail being received into appropriate notches, and the ears neatly folding up so as to pack away comfortably. This armadillo walks upon its toes at a rapid rate. The species has not been on view for some time.

THE BIOGRAPHY OF A CHIMPANZEE.

WE have seen and read an interesting pamphlet, by Mr. Frank Roper, upon the daily life of a captive chimpanzee exhibited at the Belle Vue Zoological Gardens, near Manchester. It is curious that no one who comes much into relations with chimpanzees can refrain from suggesting that the particular individual of his acquaintance is a species distinct from the ordinary *Troglodytes niger*. Mr. Roper is no exception to this generalisation, which is borne out by the comments respecting "Mafuca" at the Dresden Zoological Gardens and the Bam Chimpanzee of Dr. Giglioli. "Consul" appears to us from the photographs, published in illustration by Mr. Roper, to have been a very ordinary animal, bearing no traces of likeness to the illustrious "Sally," late of the Zoo, to which Mr. Roper has the temerity to liken him. The animal, however, was docile, and learnt a number of tricks which certainly "Sally" did not succeed in acquiring; but then we must bear in mind that the subject of Mr. Roper's biography belonged to the opposite sex. To use a knife and fork would seem to be a difficult feat to an ape with a short and feeble thumb; yet we are assured that the creature ate "like a Christian" with the usual polite appliances of the dinner table, including a serviette with which he carefully wiped his hands after food. The difficulty of reading Mr. Roper's booklet is caused by the fact that we can never be sure when he is speaking in English and when in journalese, the latter language being, of course, not distinguished by the accuracy of the former. The chimpanzee had a habit of studying Nicholson's "Zoology." He "turned over the leaves until he came to the drawing of a monkey, when he immediately jumped on the book and stamped on it, as though he was anxious to stamp the monkey out." But, on the other hand, he looked for a long time, apparently in admiration, at a picture of the Three Graces. Our valued friend "Orpheus at the Zoo" should read what Mr. Roper says about the susceptibility of the animal to music. "Pains were taken," says Mr. Roper, "to ascertain if he took any pleasure in the music of a band," not, we should say, conclusive proof of the absence of a musical taste if he did not. The resources of Belle Vue were taxed to the utmost, with the only result that the ape ran away in disgust. This does not, however, altogether destroy the myth of Orpheus, as Mr. Roper seems to think it does.

The Thumb in Civilisation.

Dr. W. R. Whitehead, of Denver, Col., sends us a reprint from a medical periodical of a paper he wrote entitled, "The Thumb as an Initial Factor in Civilisation." We have considered it attentively, but we have been unable to find in it any new contribution to science. The author describes the peculiarities of the human thumb, especially its possession of a separate flexor muscle, and he attempts to attribute to the human power of opposing the thumb the beginning of all man's civilisation and superiority over the ape. We cannot, however, agree with him in his attempt to make so much of a single peculiarity. "Counting on the fingers with the thumb," he says, "was the initial effort that led to the discovery of the science of the mathematics. Primarily, to draw on the ground with a stick a triangle, to consider its sides and angles, and to discover some of its properties were but additional steps in this direction." One could count on the fingers without an opposable thumb; and an opposable great toe would be as convenient for drawing triangles upon the ground; while, even if the triangles were drawn by it, we do not see how the opposable thumb would lead the ancestral man to consider sides and angles.

But Dr. Whitehead touches a matter of greater interest, and falls into a greater error, when he makes the following statement:—"It appears that the organs of apes which most resemble the same organs of man are not all assembled in any one kind of ape, but seem to be confusedly assigned to very dissimilar apes, and even to half-apes, as if to oppose a barrier to those who shall attempt to trace a too near kinship between these animals and man." It is, as he says, quite true that the bridging brain-convolutions are present in spider-monkeys, and, possibly, in the orang; that lemurs have thumbs more resembling those of man than are to be found in higher apes; that, indeed, analogues to the peculiarities of man are to be found scattered here and there among the primates. But the old idea of arranging modern groups in lineal series has long been abandoned; no comparative anatomist would dream of seeking the ancestors of man among existing monkeys. The existing primates, including man, have diverged in different directions from common ancestors, and the presence of scattered resemblances among existing forms is precisely what theory demands.

The Alkaline Secretions of Moths.

Recently, Mr. Oswald H. Latter showed that a number of moths assist their emergence from the cocoon by softening its anterior end with a strongly alkaline fluid. In a recent communication to the Entomological Society of London, he described a method by which he was able to collect from the mouths of moths on the point of emerging from the cocoons considerable quantities of the fluid. Analysis showed that it contained 1·4 grammes of potassium hydroxide in every 100 c.c. The fluid is contained (in the case of *Dicranura vinula*) in a diverticulum of the mesenteron, which grows out during pupal life immediately behind the stomodæum. The digestive fluids of the larvæ are strongly alkaline. When the caterpillar becomes a chrysalis, the digestive fluids have no longer any work to do; they are stored up, and perhaps concentrated in the diverticulum, and are thus ready to be discharged when the moth is on the point of emergence.

In the same paper, Mr. Latter mentions his discovery of another interesting structure, which he has not yet been able to investigate in detail. At the time of emergence, a short, wide tube opens into the posterior third of the rectum at one end; at the other it opens into the body-cavity. This tube is full of a reddish fluid which is discharged copiously from the rectum immediately after the emergence of the imago. We trust that Mr. Latter will speedily give us further information as to the origin and fate of this remarkable structure. Any openings into the coelome are of morphological interest.

Veiled Medusæ.

In most of the text-books of zoology, as W. K. Brooks points out in his paper on "The Sensory Clubs or Cordyli of *Laodice*" (*Journal of Morphology*, 1895), it is laid down that there is a fundamental distinction between the sense-organs of the veiled Medusæ that come from hydroid stocks and those of the veiled Medusæ which develop directly from the egg. The Hertwigs first made the distinction, and it was adopted by Hæckel. It was supposed that Medusæ with direct development (Trachymedusæ) had auditory clubs with sense-cells of ectodermal origin, while the concretions within these (otoliths) were endodermal. Veiled Medusæ that develop from hydroids were supposed to have marginal sense-organs composed of vesiculated, concretionary, ectodermal cells and sensory cells with sensory hairs supplied from the lesser nerve-ring.

Mr. Brooks has now shown that in many of the "Leptolinæ," in

Laodice and its allies, true endodermal sense-clubs are present, differing only from those of the Trachylinæ in the absence of concretions.

The Senses of Medusæ.

In the same paper Mr. Brooks discusses the physiological nature of the sense-organs of *Laodice* and other Medusæ. He thinks it probable that the sense-vesicles of Medusæ, Mollusca, Crustacea, Brachiopoda, *Doliolum*, and many other invertebrates, may give sensations of sound, but that it by no means follows that this is their only or primary function. In the case of eyes, he thinks it easy to believe that all incipient stages of evolution have been related to light. Indeed, we know that protoplasm itself responds to light, and the various stages of mechanical combinations of sensitive cells, pigment and transparent cells, and focussing cells, are not difficult to imagine. But hearing is different; and he suggests that change of function has played a part in the evolution of auditory organs, since sound has no direct effect upon protoplasm.

Mr. Brooks suggests that possibly the primitive object of these sense-organs with their concretionary masses was to give a sense of gravity. Medusæ are animals nearly of the same specific gravity as the fluid in which they live. An obvious way in which they could appreciate special relations would be if delicate weights were placed round their margins in close relation to the nerve-ring. The slightest tilting would cause a different impression upon the nerve-ring at the different parts of the circumference, as the mobile organs containing the heavier concretions would press differently upon the circumference. "Among the veiled Medusæ the sense-clubs are found in three different stages of perfection:

"1. In the Thaumantidæ and Cannotidæ they are simple clubs, with an enlarged tip, united by a narrow stalk to a sensory eminence on the nerve-ring.

"2. In the Narcomedusæ and in the Aglauridæ among the Trachymedusæ, the enlarged club-shaped tip of the projecting club is loaded with calcareous concretions.

"3. In most of the Trachynemidæ the sensory eminence is raised up around the club in such a way as to enclose it in a sensory vesicle, which, in the Geryonidæ, is embedded in the gelatine of the bell."

Comparison of the figures given by Mr. Brooks with those which the Hertwigs give (in their memoir of the nervous system and sense-organs of the Medusæ) will show that we here have the same organ in three successive stages of perfection. It is clear that each successive stage is adapted for increasing its efficiency as a weight organ, although it is only in the last and most perfected stage that it affords any basis for the analogy with the "auditory organs" of other animals upon which the Hertwigs base their belief that the sense-clubs are ears.

The Plymouth Laboratory.

From the Report of the Director of the Marine Biological Association at Plymouth, we learn that the new system adopted for supplying the tanks in the laboratory with sea-water has shown itself to be a decided improvement upon that originally used. By the new arrangement the water supplied to the laboratory has not been previously used, while the water in the reservoir and the aquarium is constantly replaced by water from the sea. The improvement thus obtained is shown by the fact that foraminifera have been satisfactorily reared, and colonies of hydroids are now found on the sides of the tanks. Soles have also bred this year, and this is the first record of soles having bred naturally in confinement. Shallow tanks have been placed immediately under the windows on the south side, and the direct action of sunlight has kept the water in good condition for the support of delicate forms of animal and vegetable life. The Government grant from the Royal Society will be used towards the expenses of boat hire in connection with an attempt to extend the dredging and trawling work to deeper water between Start Point and the Eddystone. A novel feature in the year's work is the record of a visit made by five University students under Mr. Garstang, to make a general study of living marine animals. When the tables are not all in occupation by naturalists, and so long as it does not interfere with the proper work of the institution, this seems a useful innovation. Professor Weldon's researches on the abnormality of crabs necessitated the fitting up of 500 separate bottles, allowing for a current of sea-water through each bottle; each crab had to be fed daily, and Professor Weldon's results were only arrived at after a maximum of care and labour. The arrangement of the typical specimens in the Museum is making satisfactory progress under Messrs. Garstang, Taylor, and Hodgson. Mr. J. P. Thomasson has renewed his donation of £250 for fishery investigation in the North Sea.

Mr. G. W. Butler reports on the spawning of the common sole; Mr. Cunningham continues his North Sea investigations, and has further evidence on the influence of light on pigments; while Mr. Allen writes some faunistic notes, and on the reproduction of the lobster.

Fresh Herrings.

"The voyage was not considered successful, and the catchers seem less inclined every year to risk life and capital in this enterprise." So says Mr. C. Stacey-Watson, in the *Transactions* of the Norfolk Naturalists' Society, regarding the spring fishery of the Yarmouth and Lowestoft boats; and this seems to be due to the large importations of Scandinavian-caught fish, and to the fact that fishing in the Moray Firth begins earlier than formerly. However this may be, the two sets of fishermen secured no less than 24,441 lasts

6 thousands in the four fishings of Spring, Midsummer, North Sea, and Home. The fishermen seem rather to prefer to fit out their boats and send them to the West of England to the great mackerel fishing. A total of 464 boats were engaged during 1894 in the Herring fishery, with a complement of 2,974 men and boys. This includes the boats from Scotland. The highest catch for the year amounted to 23 lasts 8 thousands, and the biggest delivery in one day was made on October 30, when 132 boats landed at Yarmouth no less than 541 lasts of fish. The average return of the Yarmouth boats was about £750, that of the Scotch £300 to less than £100. This falling off in Scotch hauls is due to the fact that they had the misfortune to fall in with a large school, which, in many cases, struck their nets and filled them so heavily that they carried them to the bottom, twisting and entangling them to such an extent that many of them were so injured as to be of no further use.

A New Case of Symbiosis.

In the most recent issue of *Le Botaniste* (série 4, fasc. 4, 5), Mr. P. A. Dangeard describes a new and remarkable case of symbiosis. Unlike the lichen, where an alga and fungus club together for mutual benefit, we find here an intimate association of two basidiomycetous fungi, *Dacryomyces deliquescens*, and one of the Tremellineæ. The former plays the principal part, entering most largely into the constitution of the thallus. The different shape of the basidia enables us to distinguish the two species, the hymeneal layer containing a mixed assemblage of the ovoid basidia of *Dacryomyces* and the larger cylindrical ones of its associate. Mr. Dangeard found them in September of last year growing on dead wood, but it was only after a detailed study of the specimens that he realised the presence of something other than a normal *Dacryomyces*. As the discoverer observes, it is difficult to imagine what mutual or selfish advantage can ensue from this association of two parasitic fungi.

The Ascent of Water in Plants.

We referred in our last number to some recent work by Messrs. Dixon and Joly on the vexed question of the manner of ascent of the water in the stems of plants. In the latest issue of the *Annals of Botany* (vol. ix., p. 403) the same authors recount some experiments on the subject, in connection with the behaviour of the leaves on a shoot or branch when the lumina of the vessels are choked with foreign substances. Cocoa-butter had already been used by Elfving and gelatine by Errara and Strasburger; besides repeating the older experiments, paraffin wax of low melting-point was also employed, and in another set carbonic acid gas was liberated in the vascular tissue by the reaction of sodium bicarbonate and tartaric acid. All these experiments tend to show that, while the freedom of the lumina is necessary for a rapid and at all adequate transmission of water, yet a slow current may pass through the wood even when the cavities are completely blocked.

In their work with paraffin, interesting casts of the interior of the conducting tissue were obtained by steeping the wood of injected branches in sulphuric acid. "A single night suffices in many cases to remove the wood and leave the paraffin casts of the vessels streaming upwards from below like a sheaf of fine white threads." It was easy to demonstrate in this way the continuity of the elements forming the vessels in the lime, sycamore, and elm.

Postage of Natural History Specimens.

At the close of his article on the International Zoological Congress, Professor Hickson alludes to the resolution that was unanimously adopted concerning the transmission of natural history specimens from one country to another through the post. We have not been behind our scientific contemporaries in occasionally drawing attention to the anomalies and inconveniences of the present restrictions; notwithstanding which we often receive letters asking us to ventilate the matter still further. The question, however, being an international one, it has not seemed to us that isolated and ill-timed action would be of much avail. But the time is now ripe for concerted agitation to begin.

The present facts are these. The Universal Postal Convention has forbidden absolutely the sending through the mails of "animals and insects, living or dead," with the sole exception of live bees. Other natural history specimens, such as fossils and minerals, must be sent by the ordinary letter-post, at the usual rate of 2½d. per half-ounce, a charge which is almost prohibitive in many cases. At the last meeting of the Postal Union it was proposed by the Post Office of the United States that natural history specimens should be sent under the same conditions and at the same rate as samples of merchandise, that rate being the same as for book-post, except that the minimum charge is 1d. In favour of this proposal there were seventeen votes, and against it there were seventeen, but, since a vote of two-thirds was required to carry it, the proposal was defeated. The administrations voting against the amendment were those of Germany, Austria, Hungary, Bolivia, Canada, Spain, Great Britain, Guatemala, British India, Japan, Norway, Portugal, Russia, Sweden, Tunis, Uruguay, and Venezuela.

The next meeting of the Postal Union will be at Washington in 1897, and the Zoological Congress has respectfully requested the Federal Government of Switzerland, which country is now the seat of the bureau of the Union, again to bring forward the above proposal at the forthcoming meeting. It therefore becomes the duty of zoologists and men of science generally, in all countries, to urge the claims of this proposal upon their respective Governments, so that they may instruct their delegates to support it.

Adders Again.

We would direct the attention of those who continue to contribute to the *Field* their experiences of adders swallowing their young to the following paragraph which we cull from a recent publication :—

"It is painful to witness the agony of a mother snake sometimes when, in the flurry and excitement following the appearance of a man amongst the group of reptiles, the offspring of some other snake accidentally take refuge down her throat. She has not the capacity to hold her neighbour's young and her own, of course, and when she has been filled up with strangers and a couple of stray ones of her own appear upon the scene and clamour for admission, her position indeed becomes a trying one. The enemy is at hand, there is no time to disgorge and re-assort the cargo, and the poor old snake is compelled to wriggle away as fast as she is able, leaving her own offspring to perish while she reluctantly saves the lives of others which do not belong to her."

Chinook.

The Smithsonian Institution (Bureau of Ethnology) is doing all in its power to collect and preserve the Indian dialects, now so rapidly passing beyond recovery. The latest publications are "Chinook Texts" (1894), in which various myths of the Clatsop and Chinook tribes are set down with a readable English translation. The collection of this dialect was made in the very nick of time, for Dr. Franz Boas found only two individuals who could speak the dialect. One of these, named Charles Cultee (or more properly QjEltē') proved a veritable storehouse of information, and so grasped Dr. Boas's wishes that he even explained the grammatical construction of the sentences and elucidated the sense of different periods. In the other volume, "The Siouan Tribes of the East" (1894) Mr. James Mooney has given the synonymy of the different tribes dealt with and an historical sketch from the earliest times to the present.

In the Twelfth Report of the Committee on the Fossil Phyllopoda of the Palæozoic Rocks, handed in to the British Association at Ipswich by Professor Rupert Jones, a list has been drawn up of all species referred to in the Reports between 1883–1894. The Report is also interesting from the fact that Professor Lapworth has drawn up a table of the comparative nomenclature of the Lower Palæozoic Rocks from the *Olenellus* zone to the Ludlow series, which will be useful to others than the student of phyllopods, and a table of the geological range of genera and species. Professor Jones gives a fourth table showing the geological order of species.

I.

Louis Pasteur.

BORN AT DÔLE, IN THE JURA, DECEMBER 27, 1822.

DIED AT VILLNEUVE-L'ÉTANG, NEAR ST. CLOUD, SEPTEMBER 28, 1895.

THE facts of Pasteur's life have been so fully detailed in the newspapers that we do not propose to recapitulate them. Those who desire such information may be referred to "Louis Pasteur: His Life and Labours, by his Son-in-law"; translated by Lady Claud Hamilton; New York, 1885; and to an article by Sir James Paget in *Nature*, vol. xliii., pp. 481-485, March 26, 1891. A complete list of Pasteur's writings is given in the *Revue Scientifique*, 4 ser., vol. iv., pp. 427-431, October 5, 1895, which may be purchased for sixpence of Mr. T. Fisher Unwin.

I.—PASTEUR AND THE RUMFORD MEDAL.

IN the year 1856 the Rumford Medal of the Royal Society was awarded to Louis Pasteur. It has often been stated, and is usually repeated in accounts of his life, that the medal was given in recognition of his researches on the polarisation of light; from which it might be supposed that his early studies were in purely physical science, and that he had suddenly and capriciously abandoned that subject for biological investigation. But this would be an entirely erroneous impression. The research contemplated in the award was one which contributed nothing new to the knowledge of polarised light; the medal was awarded to Pasteur, in the words of the President, "for his discovery of the nature of racemic acid and its relation to polarised light."

Another fact commonly overlooked in the popular appreciations of Pasteur's work is that this discovery was intimately related to his subsequent researches, and possessed for him an immense biological interest. During the years 1848 to 1857 he published no less than sixteen papers on this and kindred subjects, and it is interesting to trace in these the dominating idea which led him to the study of ferments and thence to the classic discoveries which have made his name so famous, that in the world at large his earlier labours are almost forgotten.

It is not too much to claim for the discovery relating to racemic acid that, in the domain of crystallography, it was the most important of the present century; while in chemistry it laid the foundation of an entirely new branch of science, now known as stereo-chemistry; one which has been more stimulating to research and more fruitful in result than perhaps any other of modern date.

Those who had the pleasure of hearing Professor Percy Frankland's evening lecture at the British Association meeting at Ipswich will recollect as one of the most vivid reminiscences of the great chemist's life how, when engaged upon his earliest important research, he rushed from his laboratory, and, falling into the arms of a friend, exclaimed enthusiastically, "Je viens de faire une grande découverte!"

The discovery was this. Both tartaric and racemic acids were known to chemists; so far as could be seen they were absolutely identical in all their chemical and physical characters, with one exception; further, from them could be derived a series of tartrates and racemates respectively which appeared to be also identical, with the same exception. The difference lay herein, that while solutions of racemic acid and the racemates were without action on polarised light, solutions of tartaric acid and the tartrates rotated a transmitted beam of plane polarised light to the right. Now Pasteur observed that the crystals of the latter substances (if account be taken of certain minute facets which they present) are dissymmetric; that is to say, any one of these crystals, when held before a mirror, has a shape different from that of its image. It is precisely analogous to the case of a right hand which, when viewed in a mirror, becomes a left hand. Now if there be a relation between the form of the crystal and the properties of the solution, it might be expected that a solution which turned plane polarised light to the left would furnish crystals having the form of the mirrored image. On examining the crystals obtained from the inactive solution of racemic acid, Pasteur found that they consisted of equal quantities of two distinct sorts of crystals bearing precisely this relation to each other: a solution of the one was dextro-rotatory, and the solution of the other was lævo-rotatory. In the solution of racemic acid, which contains equal quantities of both, they neutralise each other's effects, and the solution is without action on polarised light. The two sorts of crystals resemble two similar spiral staircases, one of which twists to the right and the other to the left. Even if they be broken up we can take any one step and say from its shape whether it belongs to the right- or to the left-handed staircase; and in the same way when the crystals are broken up and dissolved, it is possible, from the optical action of the molecules in the solution, to predict the sort of crystal which they will construct.

Biot, hearing of this striking discovery, sent the young chemist some crystals of racemate of sodium and ammonium and begged him to separate them by their forms, in order to ascertain whether their solutions were also optically active. The result may be told in Pasteur's own words: "M. Biot prépara les solutions en proportions bien dosées et au moment de les observer dans l'appareil de polarisation il m'invita de nouveau à me rendre dans son cabinet. Il plaça d'abord dans l'appareil la solution la plus interessante, celle qui devait dévier à gauche. Sans même prendre de mesure, par l'aspect seul des teintes des deux images ordinaire et extraordinaire de l'analyseur, il vit qu'il y avait une forte déviation à gauche. Alors très visiblement ému l'illustre vieillard me prit la main et me dit 'Mon cher enfant, j'ai tant aimé les sciences dans ma vie que cela me fait battre le cœur!'"

Subsequent researches in the hands of Van t'Hoff and others have led to the further discovery that the dissymmetry of the crystal corresponds to a dissymmetry in the chemical structure of the substance, and this has resulted in a vast amount of observation, experiment, and speculation upon the structure of chemical compounds and the possible arrangement of the atoms within the molecule.

But to Pasteur himself the interest of the matter was not mainly chemical or physical. Nothing could better illustrate how a brilliant intellect can achieve splendid results by the deductive method so congenial to the French scientific school. In Pasteur's eyes this dissymmetry was nothing less than a great characteristic feature which distinguishes living from non-living matter; the quality of dissymmetry he believed to be peculiar to substances, such as sugar and albumen, which are formed by the action of life. "L'univers," he said, "est un ensemble dissymétrique. Je suis porté à croire que la vie, telle qu'elle se manifeste à nous, doit être fonction de la dissymétrie de l'univers ou des conséquences qu'elle entraine."

It is easy to understand how this opinion was confirmed by his next discovery, that a living organism (*Penicillium glaucum*) is capable of acting upon a solution of a racemate so as to separate the right-handed from the left-handed tartrate; and this discovery was a step which led him on to the study of ferments and further from the study of crystals.

The view that dissymmetry is peculiar to the products of life is now abandoned, but was held by Pasteur himself, at any rate until a recent date. There can be little doubt that it was the desire to study the nature of life which inspired him in his early researches on dissymmetry in crystalline compounds, and led him to make these brilliant discoveries in crystallography and chemistry which now appear so widely separated from biological science.

H. A. Miers.

II.—The Clinical Results of Pasteur's Work.

In attempting to estimate the benefits conferred upon medicine, surgery, and the allied sciences by the direct and indirect results of Pasteur's work, the first impression is one of surprise that so much should have arisen from the labours of a man who was himself no physician or surgeon, who laid no claim to any clinical knowledge or experience, and was practically a pure scientist. It has been the fashion among some, even in the medical profession, to decry pure science in medicine, and to maintain that empiricism has always proved the surest basis for medical and surgical practice. No more unanswerable argument can be adduced against such than the results of Pasteur's work—which have, partly in his own hands, but much more largely in the hands of those who have followed him and practically applied and developed the principles which he laid down, gone far to revolutionise surgery and obstetrics, to afford a sure and definite basis for preventive medicine, and to point out new lines of treatment which have already done much to reduce the mortality from certain infective diseases and will probably be still further extended in the future. It is the fashion, again, among those who profess an abhorrence of experiment upon living animals, to cry out at the absence of practical result from such proceedings. No more beneficent and far-reaching practical results can be conceived than those which have flowed from Pasteur's researches; and they are due to the application of a rigid experimental method upon living animals.

A distinction must be drawn between the clinical results achieved by Pasteur himself and those which, in the hands of others, have resulted from the application of his discoveries. The latter far outweigh the former, and this is not to be wondered at. Pasteur was primarily a chemist and physicist, and ultimately a biologist, and he was compelled to leave for the most part to others the clinical application of the facts and principles which he had himself established. Nevertheless, he was impelled in some cases to undertake this clinical application with his own hands,—notably in the case of protective inoculations against anthrax and rabies : it is indeed with the extension of the latter mode of treatment to man that his name is most widely known to the public.

It has been claimed for Pasteur that he was the founder of bacteriology. In a sense this may be true, but it is in a general sense only. His discoveries on the subject of fermentation and, above all, the brilliant experiments by which he settled the question of spontaneous generation, first rendered possible the accurate study of micro-organisms. The methods of sterilising cultural media by heat, perfected by Pasteur and Koch, constituted a very great advance in this study. These were matters which Pasteur's training as a chemist and physicist, and his marvellous faculty for original experiment, rendered him particularly fit to investigate. It is not too much to say that the laying of the foundations upon which the superstructure of modern bacteriology has been raised was in a very great measure Pasteur's work. But to the superstructure itself he added little. No unprejudiced mind comparing Pasteur and Koch—as bacteriologists

—can doubt that the development of modern bacteriology is owing in far larger share to the labours of the German scientist.

There is, however, one great branch of bacteriological study with which Pasteur's name will be for ever associated. He, first of all men, conceived and carried out the attenuation of the living virus of a disease and practically applied it for the purpose of protective inoculation. The methods which he employed are a matter of history: they may be superseded by better methods, but nothing can detract from this crowning service of Pasteur to medicine. His earlier efforts in this direction were naturally made upon animals, since in them only could rigid experimentation confirm the truth of his views. The results, in the cases of anthrax, fowl-cholera and swine-erysipelas, were successful: it was found possible by inoculation with a culture of mitigated virulence to produce a mild and non-fatal attack of the disease, which nevertheless protected against the effects of cultures of high virulence. The advantages thus offered to farmers and breeders of animals have been largely made use of in infected districts, but it must be confessed that the expectations which were at first raised have not been completely fulfilled. In the case of anthrax, for instance, it has been found so difficult to produce a "vaccine" of uniform strength that a certain proportion of the inoculated animals die, while others are found insufficiently protected. In spite of this, the method is still employed, especially in infected districts, and with good result. The extension of this method to the treatment of hydrophobia in man was Pasteur's next step, and certainly constitutes the most striking direct clinical application of his discoveries. The absence of any demonstrable microbe in rabies and the impossibility of cultivating the virus outside the animal body were grave difficulties in his way, but these were overcome. Until Pasteur took up the subject, there was no sure pathological or clinical criterion of what was, or was not, rabies. He showed that by inoculation of portions of the spinal cord of an affected animal into the central nervous system in rabbits the disease could be surely reproduced, thus affording a decisive test as to the nature of any given case. This, from every point of view, was a discovery of the highest moment, and it was followed by the further discovery that the spinal cords of affected animals gradually lost their virulence on drying. The application of the principle of protective inoculation was then easy, but became at once of greatly increased value when it was found that protection was afforded by inoculation of the mitigated virus, even after infection from a rabid animal. From these observations has arisen the system of anti-rabic inoculation now practised at the Institut Pasteur and similar institutions elsewhere. Much vilification has been heaped on its author's head by his opponents, and it must be admitted that the system is still on its trial. In attempting to criticise its results the primary difficulty encountered is that we have no accurate statistics of rabies mortality from which we can start. The mortality among persons bitten by rabid animals has been variously estimated at from 5 to 50 per cent.: Horsley's estimate of 15 per cent. for those bitten by rabid dogs is one which is generally accepted, but we have no evidence as to the mortality among those bitten by animals proved to be rabid by exact pathological test. In the statistics furnished by the Institut Pasteur the cases are grouped according as the animal inflicting the bite was proved to be rabid, merely certified as such, or only suspected. An unbiassed survey of the results of the Pasteur treatment shows a very marked decrease in the mortality—viz., to something like 1 per cent. This is an enormous advance on any other method of treatment, but it is in harmony with the experimental evidence on dogs, and there appears no reason to doubt the substantial accuracy of the figures. It is probable enough that further advances will be made, and it may be that this method will be replaced by others: indeed, attempts are already on foot to apply the system of serum therapeutics to rabies. Meanwhile, there can be little doubt that Pasteur's method has been the means of saving many lives from a particularly painful and horrible death.

Such are the direct clinical results of Pasteur's work: into all the indirect results it is not possible to enter here. As we have already said, he laid the foundations on which modern bacteriology has been built up, and it follows that, although the building has been done mainly by others, some share in the credit for the revolution which bacteriology is effecting in every department of medicine and surgery should be assigned to him. The system of antiseptic surgery in particular may be instanced as originating, in the hands of Lister and others, as a fairly direct outcome of his teachings. The results of this system, now almost universally adopted, have been enormously to diminish surgical mortality, and to render safe and possible operations which were previously beyond the dreams of the surgeon. Midwifery, too, has felt Pasteur's influence, in the largely decreased mortality which has followed the introduction of a strictly antiseptic line of treatment. Preventive medicine has gained a sanction which it never had before, and which has placed it on a firmer and surer basis. And all this has been the outcome of the broad and brilliant generalisations which Pasteur laid down, as the result of minute and patient experiment in pure science.

F. W. Andrewes.

II.

Some Casual Thoughts on Museums.

Part II.

Geological Museums.

IN a previous paper (Natural Science, vol. vii., p. 97) I ventured to make some dislocated remarks on museums, especially on local museums, and on that department of the great national museum which answers to local museums elsewhere. I have been asked to devote a little space to geological museums and their arrangement. Here again the concrete seems to me more useful than the abstract, and we have in London a notable instance of how very unmethodical great teaching institutions may become if they grow up by mere hazard. There is in Jermyn Street a first-rate geological museum, the only one in this country. It is essentially a geological collection arranged stratigraphically, and is in many respects a model of what such an institution ought to be; but in others it fails very materially. Its situation is one of the worst in England, for it occupies a site so valuable that there is no proper means of housing its staff, or of enlarging the collection itself, and its very existence is hardly known to nine-tenths of the scientific world. It is the special child, first, of the old School of Mines, and, secondly, of the Geological Survey, and has naturally grown up on the spot occupied formerly by the great teaching centre of geological science. So long as that remained there, many reasons existed for retaining the museum in the same position, but now that the great central Government school for teaching geology has moved elsewhere, there is no longer the same excuse for keeping the museum where it is. Few people know of its existence, and it is really a very considerable light hidden under a very notable bushel. The situation, too, is one where dirt and dust, the great enemies of all collections, accumulate. The building is, in fact, the home of one heroic story: was it not in one of its rooms that a student of geology, being asked to distinguish between *transparent*, *translucent*, and *opaque*, wrote down that he always preferred to define by illustration? "Thus," said he, "the window above me was once transparent, it is now translucent, and it will speedily become opaque." The rooms in which the staff of the museum and of the Geological Survey are housed are a disgrace to a country like ours, and perhaps account for the unhappy and dejected look of so many geological surveyors when not engaged in field-work.

There is literally no reason except a sentimental one why the museum in Jermyn Street should continue to exist where it is. The site, being valuable, would, if sold, easily realise enough to build another wing to the great Museum of Natural History at South Kensington, where the collections could be suitably housed and accommodated, and I know some men, wiser than myself and quite as disinterested, who think with me. The removal of the collections is, however, not all that is required. The museum itself ought to be entirely revolutionised. It contains very heterogeneous and discordant collections. The practical science of mining, which is largely an *art*, together with the various arts supposed to be connected with the mineral products of the earth, are all illustrated in a most confusing way. Because a potter needs clay to model his pots with, we have in the museum, not only different kinds of clay, but illustrations of the various processes of the potter's art, with special and valuable collections of different kinds of pottery, *e.g.*, a small but fine collection of Majolica, a very fine one of Roman pottery from Colchester, the finest collection of Staffordshire ware in the country, and a very large collection of English porcelain. What has all this to do with geology? In the same way, but not to the same extent, the art of the metallurgist, of the polisher and engraver of precious stones, and every conceivable art dealing with things earthy and stony are here illustrated. Why, then, should not all the arts under heaven be taught in this museum, including that of the chiropodist, for are not corns and bunions the remote results of walking in fashionable boots on *stones*? The incongruous exhibits have no doubt come there, some by accident and some by design, but they ought not to remain any longer. There was a time not long ago when in no museum in England was the art of the potter illustrated at all. Hence it was useful to have some bourne where such collections might eventually rest in peace, dust, and neglect, until better times should come. Now, things are very different. Such collections exist, well exhibited and arranged, at the British Museum and at the South Kensington Museum; thither things of the same kind, now buried and lost in Jermyn Street, where they are quite out of place, should be transferred, and with them should go to the scientific department of the latter museum all the specimens exhibiting, not the science of geology, but the applied arts ultimately dependent on the miner, the metal-worker, and others. Let us have these arts adequately illustrated, by all means, but let them be taught in their proper place in the museum of applied science, and not in that where the evolution and history of the earth are illustrated. The works of man and the works of nature belong to different spheres of human study, and it must be equally confusing to the student and to the pleasure-seeker to mix them up and to bring into unfair comparison the fantastic experiments of Thomas Toft and the finished handiwork of the Almighty.

Having got rid of human art and limited ourselves to the true sphere of geological science, we should still need, in a rehabilitated and reconstructed geological museum which is to approach the ideal, another very important change. The museum in Jermyn Street is, confessedly, only a museum of English geology. Its collections are the results of the zeal of the geological surveyors, and it is the rich and manifold harvest they have gathered which is there housed. I am never tired of preaching (and heretic though I be, I shall continue my homily as long as I have breath) that the great bane of English geology, as now learned and taught, is its parochial, and consequently utterly misleading, character.

There was once a parson who had two small livings in the north of England at different periods of his life, and he persuaded himself, and wrote several books to prove, that almost every important event in English history, including the landing of Julius Cæsar and the Battle of Hastings, had taken place in his parishes in Yorkshire. This is precisely the attitude of the men who are responsible for some of the most elaborate and astounding memoirs on geology which have appeared in recent years under high patronage, and deal with some of the most intricate problems of physical science. These authors have never studied physics or mathematics at all, or only in the most perfunctory fashion. They know next to nothing of the mechanical properties of matter, and they have a contempt for the postulates of the more exact sciences. But this is not all. They know hardly anything, either at first- or second-hand, of the foreign representatives of the English beds. Some of them think that all the secrets of the universe are concealed in half-a-dozen chalk-pits in East Anglia, and that it only needs a few weeks' sojourn in these holes to find Aladdin's lamp. Others, who have never seen a glacier and have never tried an experiment on ice, write great volumes, and get them published at the expense of the taxpayer, upon some of the most crooked issues of physics, which can no more be solved by internal cogitation than the famous camel could be produced by the German metaphysician in the same way. This is the actual basis upon which a good deal of recent English geology has been built, and is it wonderful that the teaching is reflected in our museums as well as in our text-books?

The burden of this oft-repeated diatribe is that, if we are to know the history of our great mother, Gaea, which we profess to narrate under the term geology, we must go further afield than surveying half a dozen parishes or half an English county with no better tools and preparation than a land-surveyor's pencil and levelling dial, and no wider experience than can be got out of a single mountain valley or two. We must also know how our explanations will meet the case of similar phenomena elsewhere; we must know what others better trained than ourselves have written on these problems abroad; we must restore geological teaching to the lines, and adopt the training, which great men like Hopkins and Sedgwick and Lyell thought it necessary to have when they discussed, not merely a slice of Old England, but the whole realm of Jupiter, Pluto, and Neptune combined. If this be so, we must, in our museum which is to illustrate geology, have a stratigraphical collection commensurate with, and illustrative of, not merely English strata, but the strata of the whole world. Let us in this way try to dispel the rubbish which has been so persistently taught about homotaxial relations between the strata of areas as far removed from each other as China and Peru, Australia and Britain. Let us in this way also get rid of a nomenclature and arrangement of the beds which were perfectly sound and justified so long as they were limited to English geology, but which are absurd and childish when applied to entirely different stories. The history of Europe and the history of China, treated as human communities, differ *toto cœlo* at every point, and must be illustrated by collections kept entirely distinct and apart. It seems to me that Chinghiz Khan has as many homotaxial relations with Frederick Barbarossa as the Tertiary beds of the Sivaliks have with those of Europe, with which they are so often confused under a common nomenclature. This end can only be secured by having a stratigraphical collection which shall illustrate the stratigraphy of every separate and distinct geological area as a separate and distinct field altogether.

Thirdly—and here I am afraid my heresies will be less tolerated—I hold it to be a mistake to deal with mineralogy and palæontology as if they were subsections of geology. Collecting fossils, as we all know, is what a schoolboy means by geologising; but some older people believe that geology (meaning the history of the various revolutions which the world has seen) is a different thing to collecting fossils and discriminating the various species of minerals. It is true that, in collating the disordered leaves into which Nature's book has been confused, we find that we can distinguish the various pages in a very satisfactory way by their being ear-marked by the presence of certain fossil forms; and these indices of geological horizons we must have in any stratigraphical collection. But for this purpose it is the reverse of useful to have every fossil occurring at every level exhibited: we want the typical forms alone which specially mark the various horizons. It is they that give us the real pagination, and it is merely confusing the student to exhibit everything contained in a bed as its special ear-mark. The great bulk of palæontological remains do not appertain to geology at all, but to the special provinces of zoology and botany. They illustrate the continuity, or the reverse, of *life*, and not the history of the revolutions of the earth's crust, and should be remorselessly removed from the geological collection to the general biological one. In this way an adequate geological museum illustrating the general geology of the earth becomes a much more manageable affair than many suppose.

In the same way we must, no doubt, in order to understand the sequence and history of many rocks (notably the crystalline and metamorphic rocks), know something of mineralogy and of chemistry; but this does not mean that in our geological museum we are to confuse the natural history of specific minerals with the history of successive strata. Petrology is, of course, very much more germane to geology than is mineralogy—a truth which has only recently begun to be realised in our collections, and it seems to me to be as real a mistake to pile up a large series of mineralogical specimens in a purely geological museum as it is to do the same with palæontological specimens. The mineralogical specimens should be kept apart altogether. Having discarded what seem to myself to be discordant elements from a geological museum as now understood, we should then have left a geological museum devoted essentially to illustrating the problems of true geology. It should contain plenty of models or specimens on a large scale, showing joints, faults, flexures, synclinal and anticlinal curves; the junction of different rocks, illustrating conformity and nonconformity, continuous sections from different areas, either built up of the rocks themselves or with the cores of borings, with good and well-named typical fossils from each horizon in adjoining *table-cases*, and there should, where possible, be actual specimens and not drawings or plans. We should, in addition, have abundant models showing the actual work of living glaciers as distinguished from the nightmares which in recent years have pursued so many romantic writers, who despise experiment and an appeal to facts, as every poet should. There should also be models and examples from the laboratory of the actual results of melting rocks under various pressures and conditions, of the effects of shearing, of dynamical and chemical metamorphosis, of the cavities and cracks caused by earthquakes, of the various mechanical processes of Nature such as we actually find her employing, and in addition different series to illustrate the stratification of different parts of the world, arranged in narrow parallel galleries on similar lines to the admirable gallery arranged in the museum in Cromwell Road by Mr. Etheridge, *only that the stratigraphy of each should be kept distinctly separate*, and there should be no attempts made to fill up gaps in one area by inserting evidence from another. Museums should illustrate facts as much as possible and hypotheses as little as may be. We do not want hypothetical sections and wonderful examples of the ingenuity of cloud-building professors as to the origin of certain phenomena. Let these be remitted to the professors' books, the best of which are necessarily ephemeral publications—alas, that it should be so with so much amusing literature! What we want in museums is not poetry, but prose; we want the actual facts of nature represented, and not the workings of some geological dramatist trying his hand at remaking the universe. Those hideous diagrams of *supposed* internal arrangements of volcanoes, of *supposed* denudations on a wide scale, of the *supposed* action of impossible rivers, of glacial nightmares, etc.—let all these be excluded from museums and consigned to geological romances. Let us also exclude those extraordinary diagrams showing the ideally continuous distribution of rocks in which gaps here and gaps there are filled in from other areas. We want the facts, and the facts only, so that the heretic and the orthodox should be on the same level, and so that our museum should not make the architect of the universe responsible for the handiwork of either the most lucid and picturesque of directors of the Geological Survey or the most beaming and popular of heads of Departments of the British Museum for the time being. We want the professor and the museum-keeper to have their little jokes, and we will all laugh at them ; but let it be in their own books and not in our common property, the museums.

If we turn from the great National Museum of Geology as it ought to be to local geological museums as they might be, a few words may also be said. I, of course, exclude museums of the size and importance of the Liverpool Museum, or those at Oxford, Cambridge, or Manchester. A local museum, from the exigencies of opportunity, space, and income, cannot possibly illustrate universal geology, and it is a mistake to welcome into its cabinets all the chips of famous mountains, from Teneriffe to Mount Carmel, which enthusiastic travellers stuff into their pockets, and the dislocated bits of spar, rock-salt, and limestone which have come from sporadic visits to stalactitic caverns, to salt-mines, or to the lovely mountains of Styria where I am writing these lines. All this kind of relic is mere rubbish. It is also a mistake to attempt in a local museum more than a small index collection of English strata illustrated by a map and a few sections. The collection ought really to be limited to illuminating the geology of that particular district, and to be illustrated by careful drawings, not necessarily coloured with the geological tints, which one can learn from any small manual, but with the natural colours of the strata, and showing every important section in the neighbourhood where some geological lesson is illustrated—no imaginative pictures, but actual copies of facts as presented by the rocks. Every fault and dislocation should be carefully modelled and coloured and traced. Specimens of the various rocks—not mere chips, but substantial specimens—should be arranged as much as possible in sequence. Above all, when drift deposits occur, the boulders should be collected carefully and labelled, and, whenever ascertained, a specimen of the mother-rock be put near them, and the lines of migration of the travelled stones be marked on a map. It is a disgrace that, so far as I know, there is no adequate and complete collection of boulders in any museum within our four seas illustrating the geology of the drift, not even in the big museums. No wonder we have fantastic postulates introduced into what should be a sober science, and that gigantic ice-sheets filling up great oceans are invented to explain a few boulders occurring near the sea, which have come from the ballast of some over-weighted or wrecked foreign ship. There ought also to be carefully drawn sections of the curved lines which the laminæ of sand take in the sand-beds of the drift, so that country yokels should have some antidote to the nonsense they may find in geological manuals, where long, continuous, swirling curves, very often reversed, are frequently attributed to the pounding of icebergs or to the internal economy of that mysterious absurdity, a ground moraine. Every well, every mine, and every quarry should, when possible, have the facts it discloses shown graphically either by a model or drawing, preferably a model. In table-cases the typical fossils should be placed with specimens of recent forms, showing what the broken and distorted fossils really mean and what they once were. Some drawings of the animals should also be given, for we have to deal with people who know nothing, or next to nothing; and when a specimen or a series of specimens in a museum ceases to teach something, its further use is not very obvious.

These are only dislocated sentiments, but they condense a theory of geological museums which is not generally adopted, and may suggest a few thoughts to others. I am told that an interesting paper on geological museums was read at the recent meeting of the Museums' Association. This I have not had the advantage of seeing, for I am far away from England; but it is clear that others besides myself look forward to better things in such institutions, and the critic sometimes must precede the reformer. I have more to say, but it will keep for another paper.

HENRY H. HOWORTH.

III.

On the Darwinian Hypothesis of Sexual Selection.

IT seems as if this much-vexed question were as far as ever from being settled. The following pages contain, briefly stated, various facts and considerations that have induced me, in addition to arguments already published, to discard a former belief in "female preferences" as a factor in the evolution of races. I will enumerate, first of all, some miscellaneous objections, passing on later to review the case of one particular species in order to see how far its habits and bodily characters could bear out this hypothesis.

I.—Some General Considerations.

It is difficult, at the outset, to obtain a comprehension of the scope of Sexual, in contradistinction to Natural, selection. To which of the two must we attribute the origin of structures, useful both for combative and life-preserving purposes, or that of many colours artistically beautiful and, at the same time, adaptive? The practical results of both processes seem often to coincide.

Indeed, whether we should appeal to natural or to sexual selection frequently depends on whether a species can be credited with the conscious appreciation of beauty that entitles it to rank among the "higher animals." Under this term Darwin, Weismann, and other supporters of this principle, include animals as low down as the Arthropoda, but the boundary between them and "lower animals" destitute of artistic discrimination cannot but be arbitrary, considering how little we know of their intellectual and emotional capacities. Another thing is no less certain, that sexual dimorphism and complicated ornamental colours continue uninterrupted into lower orders. Thus a different cause must be invoked to explain identity of effect.

Another aspect of the "æsthetic" difficulty is this. Certain secondary sexual characters of "higher animals" are displeasing or inelegant to our eyes. In order to show that their *ugliness* is nevertheless attractive to them, we are asked to call to mind the extraordinary æsthetic notions of many savage tribes of men. Conversely, to prove that *beauty* in widely-separated groups of animals must be a source of gratification to themselves, we need merely consult our own taste, which admires it. Surely an argument on these lines exemplifies an unsatisfactory process of reasoning.

These are, of course, *primâ facie* objections, and it will naturally be urged that sexual selection is not so much a speculation as an induction from the observed fact that the females of many species possess inexplicable sympathies and antipathies for particular males, —in short, that the "members of either sex prefer those individuals of the opposite sex which are to them most attractive." [1]

This *is* an observed fact, but not altogether fortunate as an argument. It proves too much. Supposing the individuals among the "higher animals" really differed and had differed from time immemorial, however slightly, in their choice of partners, all one can say of "likes and dislikes" is that the more they are exercised by one sex the more they appear incapable of modifying the colouring, structure, voice, etc., of the other. For, after all, the tail feathers of two peacocks are pretty much alike even now, after generations of capriciously-minded peahens have exercised their fancies upon them. It would amount to a truism to add that the less these individual tastes are exercised, the less evident becomes the existence of any "selection" whatever.

A special inconvenience arises in the case of polygamous animals. Certain polygamists, such as the pheasants, do not hold nuptial tournaments or resort to battles with other males. But wherever, as in the majority of cases, such contests "for the possession of the female" (Darwin) take place, it is impossible to speak of voluntary selection on the part of the latter. The two things are mutually exclusive.

If, therefore, the exceptional ornaments of the males are the result of female preference, they must have been acquired in their present magnificence before the polygamous, or combative, habits were contracted. Such a supposition is rendered improbable by the very general correlation that exists between polygamous habits and brilliancy of plumage.

If the ornaments have been gained simultaneously with, or subsequent to, the polygamous habits, they demonstrate that processes other than sexual selection are equally capable of forming some of the most highly-finished male ornaments among the "higher animals." This is exactly what I think has taken place.

It is difficult to estimate the objections which the phenomena of analogous variability oppose to sexual selection. I will mention two instances. (1) A curious style of "decoration" that hardly commends itself to our æsthetic taste, namely, to render conspicuous by bright colouring a particular region of the body, has been ascribed, in the

[1] Romanes, "Darwin and after Darwin," i., p. 380; Darwin, "Descent of Man," pp. 414, 522.

case of certain mammals, birds, and insects, to the effects of female preference. (2) The melanic forms of some butterflies, spiders, lizards, birds, and mammals are also considered, by various authors, to have been sexually selected.

It is incredible enough, after all that has been written to prove the "capricious action of sexual selection, fluctuating element of taste, charm of novelty, etc.," that we should still find the females of different species, families, orders, and sub-kingdoms concurring, during untold ages, and with more than human consistency, in their approval of one particular kind of ornamentation. But it becomes still more incredible—if the word could be made to admit of degrees—in the view of the circumstance that, as regards (1), the same parts are also brightly tinted with certain saurians where it is impossible for the females to see them, and respecting (2), there are dark varieties of other animals that no one has hitherto ventured to attribute to sexual selection. Such are, for instance, the recent and non-adaptive forms of colubrine snakes, "higher animals," like *Zamenis viridiflavus, var. carbonarius.* Our own species furnishes a curiously similar instance. The gradual diminution of the xanthous complexion to the advantage of a darker stock appears to be proceeding in various parts of the world quite irrespective of climatical conditions, and yields, therefore, the strongest presumptive evidence in favour of sexual selection. Here, as in the other instances, the ontogeny shows that the males are the first to become modified. Now, in the case of man, there are exceptional facilities for observation and the *à priori* probability that the æsthetic faculties are more highly developed than in other animals. Still, among the many suppositions that have been advanced to account for this displacement of the fair by a darker type, I can find surprisingly little that suggests the "cumulative action of female preferences."

There are difficulties of another order. Compare the classical case of the argus pheasant with that of man. No doubt the earnestness of purpose and *degree* of estimation with which the females of this bird may regard, for the time being, the objects of their affection may be the same as with us: "*le beau pour le crapaud c'est sa crapaude.*" There is, however, a difference in *kind.* For personal beauty with man possesses a purely extrinsic worth—it lies in the eye of the beholder. But if the argus pheasants, waiving private inclinations in favour of sterner motives, have dispassionately judged, as they must have done, with the eye of connoisseurs and by one unvarying[1] standard the artistic merits of their countless generations of suitors, they have set an intrinsic value on the beauty of the latter. Unless this ideal striving coincides with the greatest physical vigour, it can only be due to the survival of the intellectually fittest.

However that may be, it is no hair-splitting distinction, nor is it

[1] Not "approximately," *Proc. Zool. Soc.*, 1881, p. 368.

exactly what we should expect to find, that while man contemplates personal beauty from a subjective point of view, the "higher animals," as typified by the argus pheasant, take an objective one, and whoever believes in sexual selection must ask himself the question: To what could be attributed their initial differentiation in this respect?

I believe no such differentiation has ever taken place, and that, in speculating on the æsthetic faculties of animals, an important element is apt to be disregarded. Man appears to owe what advance he has made in the refinement of these faculties, in the first instance to his social instincts, to the consequent division of labour and the greater *leisure* derived therefrom. Without leisure no artistic product can be consciously evoked or recognised as such; artistic worth does not exist, much less the taste whereby to criticise it. Whatever may be the potential capacity of mind of the "higher animals," I hold that their time is too preoccupied with the actual struggle for existence to permit of the formation of the mental qualities ascribed to the argus pheasant. These are a luxury to which human savages, some of them, have not yet attained.

Somewhat analogous objections apply to the pleasure supposed to be given by the nuptial flights, antics, and dances of many birds. They are of different kinds. The first are such as the aërial evolutions of rooks in spring-time, which no one would connect with female preferences. The leks of the capercailzie illustrate the other extreme, and are quoted by Darwin in support of his theory. As it has also more recently been stated that "it is impossible to conceive what motive can be in the mind of a cock other than that of making himself attractive, when he performs his various antics, displays his ornamental plumes, or sings his melodious songs,"[1] I may translate a passage in a well-known monograph on the capercailzie to the effect that "the hens are by no means always in the neighbourhood of the cock, who, after his balzing, must often go to a considerable distance after them: it is as if a rendezvous had been arranged beforehand."[2]

If, then, the females do not even trouble to look on, *cui bono?* Besides, I think most sportsmen will have found that the hens do not attend regularly at the beginning of the balz-season, hardly ever at the evening performance, and even if they did, any admiration which they might entertain for the postures of their one lord and master, who will not tolerate rivals in his revier, would seem to be gratuitous.

Strange to say, the higher we ascend into the regions of æsthetic perceptibilities the more hazy the outlook. I cannot bring myself to believe that our fair semi-human ancestors habitually forgot them-

[1] Romanes, "Darwin and after Darwin," i. p. 398; but see also *Nineteenth Century*, 1893, p. 889.

[2] Dr. W. Wurm, "Das Auerwild," pp. 54 and 62.

selves so far as to elect husbands—whether for a season or for life is immaterial—on the strength of their terpsichorean proficiency. What a profligate generation! Yet dancing is an ancient practice and one that, while it "corresponds to a universal primitive instinct in man,"[1] has been brought to a high state of perfection by him. We may hence conclude that if the "higher animals" possess an artistic appreciation of dancing, and if female predilections have fostered the development of this pastime by the selection of the best performing males, and if our early progenitors can be fairly described as "higher animals," such preposterous merry-making is as natural with man as it would be discreditable. More's the pity, indeed, that female preferences should produce so little that is lovely in these latter days.

So insensible are the gradations existing between the simplest and the most complex of these phenomena of nuptial flight or dance, that I am driven to the conclusion that gestures and gambollings of all denominations throughout the various orders of saltatory nature—from the "unusual antics and gyrations"[2] of worms up to the contortions performed by the gilded youth in modern ball-rooms—will ultimately be found to be only the outcome of that unfortunate "surplus vitality" which is no nonentity, but a factor to be taken into account. Here lies, indeed, the root of the whole matter. For surplus vitality is another name for the primary physiological processes that supply the material (be it colour, or structures, or exuberant activity, or song) whose subsequent elaboration, as incompatible with the principle of utility, is entrusted to female preferences.

A curious parallel could be drawn between the evolution of the human arts of dancing and music. Neither of them, I think, have the origin ascribed to them in the "Descent of Man" or the "Expression of the Emotions." The infantile and savage delight derived from the mere repetition of musical sounds stands on a level with the unpremeditated caperings indicative of high spirits in the young of many animals, including man. But after some time their dormant complexities are stirred up and rendered subservient to a variety of ends. Thus arise purposive specialisations, such as warlike music, religious dances, etc. Certain forms of both these arts are purely erotic, or "decorative." Yet there is nothing to warrant the belief that either their origin or any successive stage of elaboration is due to predilections on the part of the female sex.

In this connection, one or two points in Darwin's chapters on "Sexual Selection in Relation to Man" may be noticed.

It is generally accepted that among savage tribes the men pay quite as much attention as the women to their tattooings, coiffures,

[1] Mrs. Grove, "On the Ethnographic Aspect of Dancing." The taste for dancing, doubtless, like other characters originally confined to the male, will have been gradually transferred to the other sex. Even now among savage nations it is the males who principally indulge in this sport.

[2] Beddard, "Animal Coloration," p. 268.

plumes, etc.—if not more. It is not merely an exemplification of a law of development that the fair sex should hesitate to abandon a prehistoric caprice of this description which civilised men of the present day have discarded, for this fact also throws a light upon the question of female preferences in past ages. Let us suppose, for a moment, contrary to the Darwinian hypothesis, that the diversified attractions of savage men are not the result of a long-continued process of sexual selection in earlier times. If so, how does it stand with the well-trimmed tufts of hair and the decorative ridges in the face of some of the quadrumana, whose similarity to human modes of embellishment is not fanciful, but real, and expressly insisted on by Darwin (pp. 541 and 549 *seq.*)? If preferential mating has not produced the ornaments of monkeys, birds and other animals will be able to dispense with it still more easily. Granted, on the other hand, that the ornaments of man have been sexually selected like those of all "higher animals," it follows that the women of those early days were able to exercise a free choice, notwithstanding the servile condition in which they are frequently presumed to have existed. Passing over this difficulty, however, it is surprising to find it implicitly and explicitly stated throughout these chapters that the order of selection in the case of man is generally reversed, the males choosing the females.

Now, what does this entail? Nothing less than that the fair sex of our species stands acquitted of any initiative in the appreciation of useless male embellishments. This may be gratifying to the majority of mankind, but the defender of sexual selection is landed in a greater dilemma than ever, for its agency is rendered incompetent, on the expressed opinion of its author, to account for male ornamentation in a species where one might reasonably presuppose the highest development of æsthetic taste on the part of the female sex. By raising a strong presumption against the efficacy of preferential mating in less highly organised groups, this constitutes one of the gravest defects of the theory.

Another difficulty. If promiscuous intercourse and the low estimation in which women are held form two of the four chief causes that prevent or check the action of sexual selection with savages (p. 587), they cannot fail to interfere with its influence in the case of all "higher animals."

Again, respecting the absence of hair on the body of man, Darwin states that "we may reasonably suspect this character to have been gained through sexual selection" (p. 600). Still, if our female semi-human ancestors were the *first* to acquire it (pp. 57 and 601), and afterwards "transmitted it almost equally to their offspring of both sexes while young," there is surely no necessity to invoke sexual selection in order to explain its *subsequent* appearance with the males. And if the peculiarity be due to the action of male preferences of one sort or another, we must extend this explanation to certain of the anthropoid apes, the females of which are also somewhat less hairy than the males. Where, then, should male selection end and female selection begin?

I also venture to doubt whether the jet-blackness of the negro's skin (pp. 195 and 604) that is acquired by the young of both sexes at a comparatively early age can have other than a purely physical origin.

So much for our progenitors. Darwin hardly touches upon the question of sexual selection of the present generation, though he testifies to the gravity of the problem. But it requires no great reflection upon the conditions of modern life to convince oneself that the female members of the human race are not, as a rule, in a position to gratify their fancies in this matter. And if we take the example of an exceptionally situated individual, we find that her choice among a number of suitors is determined, at the last moment, by the most unexpected circumstances, and that she selects, after the decease of her elected partner, another one, different in every single respect. The same applies, *mutatis mutandis*, to the male section of the community.[1]

I am not concerned with the ethical aspects of this fact. For the anthropologist it is sufficient, but essential, to note that even in our own species the possession of "likes and dislikes" implies anything but that of a permanent ideal. If this be so, it becomes difficult to conceive how any definite style of ornamentation[2] could have been perpetuated through æsthetic preferences on the part of either sex.

Having cleared the way by a consideration of some miscellaneous objections, I shall proceed, in the second half of this article, to discuss the problem as exemplified in a single species, *Lacerta muralis*.

G. NORMAN DOUGLASS.

(*To be continued.*)

[1] No doubt our prognathous ancestors were less distracted by social considerations, but there is no reason for crediting them with more constancy of taste as regards personal appearances. It stands to reason, also, that human nature will have been prejudiced at all times against actual disfigurement or semblance of ill-health, but this is irrelevant to the question of choice between physically sound individuals.

[2] I have avoided making any distinction between natural and artificial ornamentation, as none is made in the chapters before me.

IV.

The International Congress of Zoologists.

THE third International Congress of Zoologists, which came to a conclusion on Saturday, September 21, at Leyden, must be considered to have been a very great success.

At the two previous meetings, held in Paris and Moscow, the French language was the only one that was allowed to be used in the general and sectional assemblies, and this restriction undoubtedly gave them a distinctly French and Russian bias. At Leyden it was arranged that the speeches should be delivered either in French, German, or English. The ball was set rolling by Professor Hubrecht, who, in a brilliant speech commencing in French, proceeding in German, and concluding in English, welcomed the members of the Congress and gave a truly international flavour to their deliberations.

A great many of those present felt that it was a pity that England and Germany were not more fully represented, but the meeting at Leyden must be regarded as indicating a change towards real internationalism in zoology, which it is to be hoped will be still further emphasised when the Congress meets in England in 1898.

The reception given to the zoologists by Holland was in every sense a royal one. The beautiful young Queen and her mother, the Queen-Regent, graced one of the most brilliant meetings with their presence; the quiet but interesting old town of Leyden was gaily decorated with bunting during the week, and the railway companies, the clubs, and many private individuals in the city and its neighbourhood were lavish in their hospitality.

With such a reception the Congress was bound to be an extremely pleasant meeting. I feel quite sure that zoologists of all nations who visited Leyden in September will look back upon this Congress for many years to come with gratitude and pleasure. But, apart from its great social success, the Congress this year will be memorable from a purely scientific point of view. At the opening meeting, the address of Professor Weismann on the principles of Natural Selection was regarded, by those who were near enough to the speaker to hear him, as a remarkable and interesting chapter of his philosophical work. Many of the ideas he expounded for the first time on this occasion will doubtless meet with a great deal of criticism when they are published; and, indeed, Professor Eimer, of Tübingen, found occasion at one of the sectional meetings to pass some severe comments upon them ; but the general tone of the meeting showed unmistakably that the philosophy of the distinguished Geheimrath from Freiburg has made a profound impression upon the zoologists of all nations, and is followed by most of them with interest and respect.

The address delivered by Professor Milne Edwards on the resemblances between the fauna of the Mascarene Islands and that of certain islands in the Pacific Ocean, and Mr. John Murray's lecture on the results of deep-sea exploration, were both delivered at general meetings of the Congress, and were listened to with marked interest by large audiences.

In nearly all the sections, interesting and important papers were read by zoologists whose names are familiar to men of science throughout the world, and it was often very difficult to determine to which of four or five celebrated men who were due to speak at the same hour in different rooms it would be most profitable to listen.

The most distinguished audience of the sectional meetings was, however, reserved for the last day, when Dr. Dubois exhibited his fragments of the new "missing link," or *Pithecanthropus erectus*, as it is called. It is not surprising that the young doctor from Java showed some signs of nervousness in reading his paper in the presence of such eminent anthropologists as Virchow, Flower, Rosenberg, Marsh, and others, but he came through the ordeal well, and was highly complimented on his success. The fragments consist of a femur, the vault of a skull, and two molar teeth. The general impression gained from the discussion was that the femur, which showed marked signs of pathological change, might possibly be human, but that the fragment of skull was more ape-like than any human skull hitherto known to science, and consequently belonged to an animal as nearly corresponding with the long looked-for missing link as we may expect to find. One very interesting point which was brought out very clearly by the remarks of Virchow, was that the characters of the skull approached more nearly those of the Gibbons than of any of the other anthropomorphic apes.

But, in addition to the purely scientific work of the Congress, some important conferences took place upon what may be called the organisation of zoological literature.

It has been well known to zoologists for some time past that an important project is in progress for supplying men of science with complete lists of books and papers that are published from a central "bureau" or office. The general plan and the details of the project have been carefully worked out by Dr. H. Haviland Field, a well-known writer on embryological subjects. The proposals have already met with a hearty approval from the editors of the *Zoologischer Anzeiger* and *Zoologischer Jahresbericht*, and from most naturalists on the Continent and in America. In England alone has the scheme met with any serious difficulties, and these difficulties were not, to say the least of it, removed at the meeting of the British Association at Ipswich when the matter was discussed.

It is interesting to note, therefore, that when the scheme was introduced by Professor Bouvier at Leyden it was received with enthusiasm, and the resolutions pledging the meeting to support its general principles were carried unanimously. It is most sincerely to be hoped that the English opposition will now cease, and that the naturalists of our country will join with their colleagues abroad in giving the proposed bureau their hearty support.

Another important resolution concerning the regulations for the transmission by post of living and dead animals was also passed unanimously.[1]

SYDNEY J. HICKSON.

[1] We have given an account of this resolution in our Notes and Comments this month —ED. NAT SC

V.

The Value of Myology as an Aid in the Classification of Animals.[1]

THE opinion of most systematists, and of anatomists too, is, I believe, that the study of muscles is not of much value for classificatory purposes; first, because muscles are liable to a good deal of individual variation; secondly, because they are often difficult to identify by those who are not specially working at them; and thirdly, because of the impression that the arrangement of the muscles depends largely on the habits and mode of life of the animal to which they belong.

With regard to the first objection, that muscles are very variable, Dobson in 1884[2] stated his opinion that the muscles of the lower wild mammals do not show anything like the same proportion of abnormalities that are met with in man. This opinion my own experience bears out, although I am bound to confess that variations do occur fairly often. Still, if several muscles are taken, the risk of any serious inconvenience from this source is small.

The second objection is not a very serious one. Nobody wishes to lay any stress on slight differences of size or attachment, but rather on the presence or absence of muscles, and on the shifting of their attachments from one bone to another.

The third question, namely, the extent to which muscles vary with the mode of life of their possessor, is the one which I wish to consider most fully. I propose to put forward certain facts gathered from a study of the muscles of the great Order, Rodentia, an Order which contains climbing, swimming, digging, running, and, in a sense, flying forms. Thus I hope to substantiate my contention, that the muscles of an animal tell much more about its classificatory position and the habits of its ancestors than about its own present habits.

One of the most interesting points in the myology of rodents has already been discussed by Dobson[3]; it is the relation which the two long flexors of the sole bear one to the other. These two flexors are spoken of in human anatomy as the "flexor longus hallucis," which

[1] Paper read before Section D of the British Association, Ipswich, 1895.

[2] *Journ. Anat.*, xix., p. 16.

[3] *Journ. Anat.*, xvii., p. 142.

rises from the fibula, and the "flexor longus digitorum," which comes from the tibia. As these names are quite misleading when applied to the lower animals, Dobson has very wisely suggested the terms "flexor fibularis" and "flexor tibialis," respectively. In the whole of the sub-order of the Hystricomorpha, or porcupine-like rodents, these two tendons join in the sole; in the squirrel group, or Sciuromorpha, they do not join, but the flexor tibialis is inserted separately into one of the tarsal bones. In a specimen of the flying squirrel (*Pteromys oral*), I found the flexor tibialis dividing, one half joining the flexor fibularis, while the other had the insertion usual in Sciuromorpha. The mouse-like rodents (Myomorpha) are placed by the systematists nearer to the squirrels than to the porcupines; consequently one is not surprised that the long tendons are arranged as in the former animals. I have, however, been somewhat interested to find two exceptions, the bamboo rat (*Rhizomys badius*) and the pocket mouse (*Heteromys longicaudatus*). One of the most curious things is that the jerboas have the tendons united, and in this respect approach the Hystricomorpha. Dobson lays the greatest stress on the value of these tendons as an indication of natural position among the rodents; but I am inclined to think that they should be used carefully and only in conjunction with other muscles. It is largely owing to the arrangement of these tendons that Dobson claims a place for the Dipodidæ among the Hystricomorpha, but I have just been able to show that among the Myomorpha a similar arrangement exists in *Rhizomys* and *Heteromys*. To this question of the position of the Dipodidæ I return later.

Another noteworthy muscle is the "sterno-scapularis." This consists of two parts: one running from the first rib, at its junction with the sternum, to the clavicle, and corresponding entirely to the human subclavius; the other reaching from the clavicle over the supraspinatus muscle to the spine of the scapula. These two parts are often continuous beneath the clavicle, and are supplied by the same nerve. The first part, the "subclavius," is always present; the second part, the "scapulo-clavicularis," is never found in the Sciuromorpha, but was present in every specimen of the Hystricomorpha examined, with the exception of the jerboas, whose position is still unsettled. The hare-like rodents (Lagomorpha), as one would expect, resemble the Hystricomorpha in the presence of the muscle, while the Myomorpha approach the Sciuromorpha in wanting it. Among this latter group, however, are two exceptions in which it is present; namely, the African mole-rats, *Bathyergus* and *Georychus*. The former of these has already been suspected of affinities with the Hystricomorpha on account of the structure of its mandible, and it is interesting to notice how the muscle seconds the testimony of the bone. The action of this muscle must be to lessen the angle between the clavicle and scapula, and so to make the glenoid cavity face more downwards. This action is, doubtless, most useful in digging, and it may be urged that the presence of the muscle in these subterranean forms depends more on their mode of life than on their relationship. Against this view I would urge the case of the mole-rat, *Rhizomys*, which is also subterranean, yet which does not possess the muscle, and also the fact that the muscle is found in all the Hystricomorpha, including animals such as the tree-porcupines, the agoutis, and the cavies. It is interesting to turn aside for a moment to speculate on the methods by which this muscle might appear or disappear. Only two occur to me: first, that it is a delamination from the subjacent supraspinatus; secondly, that it has been formed by the conversion into muscle of the fascia over the supraspinatus, by the encroachment of fibres from the subclavius. In favour of the latter, and against the former, hypothesis are the facts that the muscle is often continuous with the subclavius, and that it is supplied by the same nerve and not by the suprascapular nerve, which supplies the supraspinatus.

Both the muscles already selected as examples tend to show that the myomorphine arrangement is more closely allied to the sciuromorphine than to the hystricomorphine and lagomorphine. It is not difficult to find other examples of this. For instance, the small transverse mandibular muscle, which unites the two halves of the lower jaw close to the symphysis, is present in the Sciuromorpha and Myomorpha, absent in the Hystricomorpha and Lagomorpha.

The scapulo-clavicularis is an instance of a muscle which is not found at all in the Sciuromorpha, is always present in the Hystricomorpha and Lagomorpha, and is very rarely seen in the Myomorpha. I will next give instances of muscles which are present in the more generalised squirrel group, and are gradually lost as we ascend to the more specialised. The above-mentioned transverse mandibular muscle is one instance of this; another is the omo-hyoid, which is always present in the Sciuromorpha and Myomorpha, but is absent in certain families of the Hystricomorpha, such as the Chinchillidæ, Dasyproctidæ, and Caviidæ. In the Hystricidæ it is absent in the ground-porcupines *Hystrix* and *Atherura*, but present in the tree-porcupines *Sphingurus* and *Erethizon*. In the Lagomorpha the muscle is absent in the hare and rabbit.[1] The presence of the omo-hyoid in the tree-porcupines and its absence in the ground-porcupines may certainly be regarded as an instance of change of musculature accompanying change of habits, more especially as there is, so far as I am aware, no arboreal rodent which does not possess an omo-hyoid. My object, however, is not to prove that this never occurs, but rather to show that, in spite of it, many muscles vary very constantly with the relationships of the animals that possess them, and may be advantageously considered in classification.

Another muscle on which I am inclined to lay a good deal of

[1] I have, unfortunately, never had the opportunity of dissecting a *Pica*, the other genus of this suborder, nor can I find any account of its myology.

stress is the "supinator longus," a muscle that tends to disappear on very slight provocation. It is present in all the Sciuromorpha that I have examined, with the exception of the beaver; that is to say, it is present in the squirrel, the flying squirrel (*Pteromys*), the ground squirrel (*Xerus*), the marmot, and the gopher. I am unable to say whether it is found in the families of the Anomalures and Haplodonts as I have never had an opportunity of dissecting examples of these, and can find no records of such dissections; but there is no doubt that the muscle is a very common one among the generalised squirrel sub-order. In the Myomorpha it is not found at all. Among the Hystricomorpha I have never seen it, but I find an account of it in tree-porcupines, dissected by Mivart[1] and Windle.[2] In the Lagomorpha it is also absent. It may be said that this is a muscle which depends very much on the climbing habits of its possessor, and in a certain sense this is true; but the point on which I wish to lay stress is that the marmot, which does not climb and is a near relative of the squirrel, has a well-developed supinator, while the tree-porcupine, *Sphingurus*, has no trace of it—indeed, in Windle's specimen of *Erethizon* it was quite rudimentary. If further evidence be needed that its presence does not necessarily imply climbing, one may point to the fact that it is present in the jerboas, three different species of which I have examined.

The supinator longus is also valuable in the Carnivora, for it is present in the Felidæ, Procyonidæ, and Ursidæ, but absent in the Hyænidæ and Canidæ. It is more important, however, to notice its distribution in the rodents; since some authors, even in books of reference, have stated that it is absent in this Order.

It is not only the presence or absence of certain muscles that varies with the classificatory position of animals; the attachments are also valuable. A good instance of this is the "levator claviculæ" or acromio-trachelien; in the Sciuromorpha and Myomorpha this always rises from the atlas, while in the Hystricomorpha it is most inconstant, in some cases rising from the atlas, and in others from the basioccipital. It will be a good test to pick out those animals in which this change of origin has been effected, and to see whether there is any marked similarity in their mode of life which might account for it. The animals in which I have found the basioccipital origin are the African ground rat (*Aulacodus*) which inhabits cane-brakes, the hutia (*Capromys*) an arboreal form, the coypu (*Myopotamus*) which is aquatic; the ground-porcupines (*Hystrix* and *Atherura*), and the spotted cavy (*Coelogenys*) which are terrestrial forms, as well as three genera of the family of Caviidæ (*Cavia*, *Ceredon*, and *Dolichotis*), all of which are also terrestrial. This list, I think, does not point to the change of attachment being due to any definite change in the animals' mode of life. Hitherto I have only instanced muscles which indicate the sub-order to which the animal belongs; but it would be

[1] *Proc. Zool. Soc.*, 1882, p. 271. [2] *Journ. Anat.*, xxii., p. 126.

quite possible to place a specimen in its proper family by referring to the combinations of muscles which are characteristic of that family. For instance, the absence of a scalenus anticus in a hystricomorphine rodent would at once make me suspect that it was a porcupine; if it wanted a peroneus quarti I should suspect it of being a tree-porcupine; and if in addition it had two heads to the biceps cubiti, a well-developed omo-hyoid, and a levator claviculæ rising from the atlas, I should feel pretty certain that it was one.

The question which I should expect to be asked, and which, indeed, has been asked, is "What light does myology throw on the position of the Dipodidæ?" Dobson[1] says that the only argument for placing them among the Myomorpha is the fact that the tibia and fibula are fused, while in favour of including them in the Hystricomorpha are the united flexors in the sole, the masseter passing through the infraorbital foramen, the external appearance of the ears and muzzle, the armed condition of the penis, and the arrangement of the teeth.

With regard to the fused tendons, I have been able to point out two examples of myomorphine rodents in which these are present. The large size of the infraorbital foramen is a question of degree, since in most myomorphine rodents a small piece of the masseter passes through this opening, and it is only in sciuromorphine and lagomorphine rodents that the infraorbital foramen transmits nothing but the nerve. With regard to the classificatory value of teeth, Mivart, in his work on the Æluroidea,[2] has given grounds for not placing much confidence in them, and, for my own part, I cannot help thinking that, unless used with considerable caution, they are apt to mislead. I can add another claim to those which Dobson has given for regarding the jerboas as hystricomorphine, and that is that they have only one head to the biceps cubiti, while every myomorphine rodent that I have looked at possesses two. On the other hand, in addition to the fusion of the leg-bones, which is never seen in the Hystricomorpha, the two halves of the lower jaw move upon one another and are provided with a transverse mandibular muscle; the digastric is arranged on the sciuromorphine type described by Kunstler,[3] a type which is never found in the Hystricomorpha, but often in the Myomorpha; the scapulo-clavicularis, which I have already laid stress on as being a most constant muscle in the Hystricomorpha, is absent; and the omo-hyoid is present as in all the Myomorpha, while it is often absent in the Hystricomorpha. On the whole, I certainly think that the myology of the jerboas points to their having myomorphine rather than hystricomorphine tendencies, though their many points of difference from both groups might entitle them to subordinal rank, as Dipodomorpha. With regard to the affinities that Dobson believes them to have with the Chinchillidæ, a

[1] *Proc. Zool. Soc.*, 1882, p. 640. [2] *Proc. Zool. Soc.*, 1882.
[3] *Ann. Sci. Nat.*, ser. 7, t. iv., p. 150.

study of their muscles negatives the idea entirely. In addition to the scapulo-clavicularis and the digastric and transverse mandibular points of divergence, the Chinchillidæ have two heads to the biceps cubiti, the jerboas only one; in the Chinchillidæ the biceps is inserted into both bones of the forearm, in the Dipodidæ only into the ulna; in the Chinchillidæ the omo-hyoid is absent, in the jerboas it is present; in the Chinchillidæ the tibialis anticus rises from the tendon of the extensor longus digitorum as well as from the tibia, in the Dipodidæ it rises only from the tibia. I am pleased to notice that Winge, in his monograph on "The Rodents of Lagoa Santa" (*E. Museo Lundii*, iii., 1888) separates the Dipodidæ from the Hystricomorpha, but for other reasons than those I have brought forward.

In concluding this paper I must admit that I have founded my generalisations on the study of one Order of mammals; but this is partly because I have paid more attention to rodents than to other animals, and partly because a general review of myological literature would far exceed the limits of a paper such as this. My observations on other animals, as well as a study of the literature of the subject, make me think that what is true for one of the largest Orders holds good for the rest. Attention may be directed to a most complete paper by Wilson on the myology of *Notoryctes typhlops* as compared with that of other mammals, in which the following passage occurs[1]: "I cannot avoid the conclusion that the structural resemblances in particular to certain members of the order Edentata are not all to be explained as merely the coincidences of somewhat similar functional modifications, but are the enduring evidences of a real if distant morphological kinship." This is practically my own view, and I would urge that certain muscles provide a very good clue to the relationships of animals, the great point being to select the muscles on which reliance is to be placed.

F. G. Parsons.

St. Thomas's Hospital.

[1] *Trans. Roy. Soc. S. Austral.*, 1894.

VI.

The Rôle of Sex.

APPENDIX.

QUETELET, in his "Anthropométrie de l'homme" (1870) has shown that if the height-measurements of a large number of men are compared with one another, the following very interesting facts may be observed. The greater number of men are of average height, many are just above or just below it, and fewer and fewer are found at heights further and further removed from the average. Not only is this true as regards height, but it is also true of every measurable quality, whether of body or mind, that man possesses. This fact can be represented in the form of a diagram (Fig. 1). Along the horizontal line from A to B mark off equal divisions corresponding to the *inches* between the shortest man, A, and the tallest man, B. Let the vertical heights correspond with the *number of individuals* whose heights are found to be the same. At A, which we may suppose is five feet, there will, perhaps, be but a single man, and the curve will be very low in height at that spot. At the next division, corresponding to 5 ft. 1 in., there will, perhaps, be two men, and the curve will rise. When we have finished constructing the curve, it will be observed that its highest point is in the middle, and that its slopes are quite symmetrical. According to Quetelet, the above statement applies to the measurable qualities of every living species, whether of plants or animals. But, as we shall see, it does not apply to groups of inorganic objects.

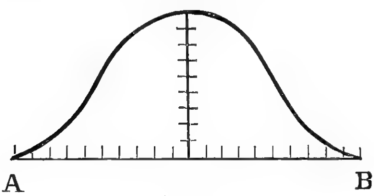


FIG. 1.

So far as I can make out, lakes, mountains, rivers, stones on a beach, crystals growing in a mother liquid, and a hundred other groups of objects, present quite a different curve from Fig. 1. To illustrate this by an example, I give the weights of 327 stones taken haphazard by a spade from the beach. The smaller stones are by far the most numerous, and the highest part of the curve is, therefore, situated at its commencement (Fig. 2). Thus it appears that the symmetrical curve showing a convergence towards a mean is characteristic rather of groups of living than of non-living bodies.

Francis Galton,[1] who has investigated man's mental qualities by the same method that Quetelet used for his physical qualities, would

[1] "Hereditary Genius," pp. 26, 27, and 29.

amend Quetelet's statements in one important particular. While Quetelet thought that we might represent by a simple symmetrical

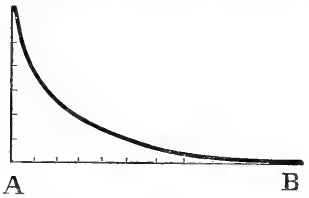


FIG. 2.—Weights of stones from a beach.

0– 5	grammes	=	149
5–10	,,	=	90
10–15	,,	=	28
15–20	,,	=	20
20–25	,,	=	18
25–30	,,	=	9
30–35	,,	=	4
35–40	,,	=	5
40–45	,,	=	3
45–50	,,	=	1

curve the qualities of a group of individuals called by us a "species," Galton insists that free interbreeding between members of that group is a necessary condition, without which the curve will not preserve the same proportions. Now, free interbreeding does not occur between different races, and as Galton remarks on p. 29, "it clearly would not be proper to combine the heights of men belonging to two dissimilar races in the expectation that the compound result would be governed by the same constants." Venn[1] illustrates this by an attempt to mix the heights of the taller English with those of the shorter French race. He says, "If we mix up the French and English heights what will follow? Beginning from the English mean of 5 ft. 9 in. the heights will at first almost entirely follow the law determined by the English conditions, for at this point the English data are very numerous, and the French by comparison very few. But as we begin to approach the French mean the numbers will cease to show the continual diminution which they should according to the English scale of arrangement, for here the French data are in turn very numerous, and the English by comparison few." The result of such a combination of heterogeneous elements is illustrated by Fig. 3 (of course in an exaggerated form.)

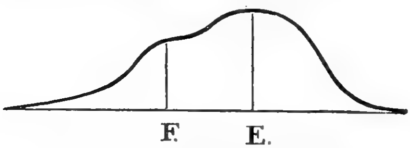


FIG. 3.—French and English.

FIG. 4.—Pugs and St. Bernards.

More striking still would be the compound curve which would result were the heights of the Bushmen and the Patagonians mixed together, or even a more extreme example still, the heights of pugs and St. Bernard dogs. Here we are dealing with two races or breeds of the same species, with two groups of individuals which at one time interbred, but which are now separated from each other, and as a result of selection have become vastly different. In these cases the two curves are not superimposed at all, but lie far apart, for the largest pug is smaller than the smallest St. Bernard. (Fig. 4.)

The simplicity and symmetry of the curve of any measurable

[1] "Logic of Chance," 1876, p. 40.

quality taken from a group of individuals will, therefore, be a test of interbreeding, and we shall be able to say, after the inspection of such a curve, whether or not the individuals measured belong to one or more interbreeding groups; this method of inquiry has already been put in practice and is yielding very valuable results. (See NATURAL SCIENCE, vol. vi., pp. 217–221.) Now interbreeding is essentially a result attainable by sexual intercourse alone, for the products of asexual reproduction are offspring which start on deviating lines, and never mix their qualities with their mates, so long as asexual multiplication continues. Only in those groups of individuals which interbreed by sexual union do we find that the mass of the progeny tends towards the mean or average, and as Galton in his later work, "Natural Inheritance," has insisted, the progeny of a sexual union approaches even nearer to the mean type or mid-species than does the mid-parent itself.

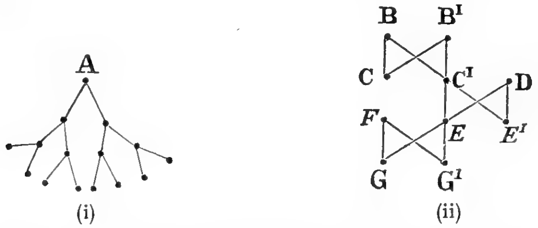


FIG. 5.—Diagrams to illustrate (i) asexual and (ii) sexual reproduction: (i) An individual, A, divides into two, these into four, and these into eight individuals. No interaction between individuals occurs. (ii) Two individuals, B and B^1, unite and produce C and C^1. C^1 unites with another individual, D, to produce E and E^1, E unites with F to produce G and G^1. Constant interaction occurs.

We find, then, that as an actual fact sexual union between members of a group of individuals leads to a convergence towards a mean or average type, and that under constant surrounding conditions this type is preserved. It is curious that those writers who have discussed the utility of sex should have overlooked the results of Quetelet's and Galton's work, for here we find an answer to many of their inquiries. It is true that Quetelet and Galton did not interest themselves in the question from the same point of view that we have taken up: they were more concerned in determining the actual mean, and the law of deviation from that mean. Nevertheless, the facts they gleaned were ready at hand, and obviously bear on this and many other biological problems.

The *convergence to the mean* is, then, a result of sexual reproduction; it may be termed the Rôle of Sex, and one, indeed, of no second order. The tendency constantly to vary is a property inherent in protoplasm, yet often for long periods of time the environment may be the same. In order that a species may continue to live in such a constant environment, the effects of variation must be checked. Sexual multiplication, a conservative function, antagonises the progressive tendency of variation.

J. BERRY HAYCRAFT.

SOME NEW BOOKS.

Birds of Heligoland.

Heligoland as an Ornithological Observatory. By Heinrich Gätke. Translated by Rudolph Rosenstock, M.A. Crown 8vo. Pp. x., 599. Edinburgh: David Douglas, 1895. Price £1 1s.

A most fascinating addition to recent ornithological literature is to be found in the English version of Mr. Gätke's "Birds of Heligoland." The original text, "Die Vogelwarte Helgoland," was published at Brunswick some four years ago, under the sponsorship of Professor Rudolf Blasius; so rapidly was its popularity evinced that, for the last year or two, it has been out of print, and even difficult to procure. Englishmen are notoriously reluctant to take the trouble to read German texts. It was, therefore, a happy thought of Mr. J. A. Harvie Brown to secure the publication of an English edition in this country. Mr. Harvie Brown is not only one of our leading authorities on avian migration, but he has a delicate taste in making books, and is careful to blend artistic illustrations with a severely accurate *resumé* of facts. In the present instance, he enjoyed the coöperation of another accomplished student of migration, Mr. Eagle Clarke, of Edinburgh. At the suggestion of the latter gentleman, the difficult task of translating "Die Vogelwarte Helgoland" was assigned to Mr. Rudolph Rosenstock. Comparisons are apt to be invidious, but we are bound to confess that Mr. Rosenstock has carried out his share of the work with singular fidelity. The labour of revising upwards of 600 pages must have been enormous, and the results reflect the greatest possible credit upon all concerned. The English edition is bound in the usual sage-green cloth affected by that spirited publisher, Mr. Douglas; and it makes an exceedingly handsome volume. Mr. Gätke is essentially a cosmopolitan naturalist. He has specially studied the birds which visit Heligoland, because he had convenient or even unequalled opportunities for doing so. Had his lot in life been cast among the Andes, he would have studied the "Ornis" of the Andes with equal alacrity. The reader who desires to do justice to Gätke's genius must guard against the mistake that Mr. Gätke is merely a local faunist. Mr. Gätke is primarily occupied with *first* principles. Accordingly, he places in the van of his work a series of admirable essays upon topics of such general importance as the velocity of avian flight, the direction of flight, the meteorological conditions which govern avian migration, and allied questions, such as are of universal interest. Gätke may or may not be right in his conclusions, but they deserve the closest examination at the hands of professed experts. The second division of the book consists of a single essay on changes in the colour of feathers. This is extremely suggestive, and might very well have received a more exhaustive treatment. It is only when we reach the third section of the book that we find ourselves really at home with the genial author

For we see Mr. Gätke at his very best upon the island which he has found so fruitful an observatory, and his companionship is felt to be a delightful privilege. Gätke is a painter by profession, and he has a keen perception of the beautiful. He never allows his imagination to run loose. He is too careful a *savant* to do that. But he takes us into his confidences, tells us of the lickings he got as a boy in the Mark of Brandenburg, the escapades of birds'-nesting days, the ambition to paint which drew him to Heligoland, and the many charming *rencontres* with rare birds that have fallen to his lot. Truly marvellous his experience of rare birds has been, unequalled by any of his European contemporaries. Much of his luck in meeting strange birds was due to his intimate knowledge of the literature of the subject; to his great experience in handling skins obtained elsewhere; and last, but not least, to his natural aptitude of eye and ear. But Gätke's enthusiasm was infectious. His zeal provoked zeal. His friendly intercourse with the natives of the island offered many opportunities for his tutoring them to distinguish between one species and another. He taught them what rarities to expect, encouraged them in the midst of failure, rewarded them generously when a rare specimen was brought to him. During the long years of Gätke's watch for migrating hosts of birds, many changes have taken place in their movements. When he was a young man, the shorelark (*Otocorys alpestris*) was hardly known to the island. Nowadays he assures us that hundreds of thousands of shorelarks pass along Heligoland every autumn. He gives us a dainty vignette from nature in his account of the migration of the Golden-crested Wren (*Regulus cristatus*), the "Lütj Müüsk" or Little Wren of the Heligoland folk: "Imagine a mild and clear evening in spring; the sun has set long since and the voices of all the feathered wanderers are hushed in sleep—the last soft 'pitz' of the Redbreast has long since died away, and for some considerable space no sound has disturbed the scented stillness of the air. Suddenly through the silence, like half in a dream, the clear fine note of our little wren is heard, and soon afterwards the bird is seen rising from the neighbouring bushes, through the still luminous evening sky; at measured intervals its call-note—'*hüt—hüt—hüt*'—is heard as it flies off, in slightly ascending spirals, over the neighbouring gardens; then from every bush—here, there, near and far—the cry is answered '*hüt,—hüt, hüt,—hüt, hüt—hüt,*' in loud, clear tones, and from all sides its travelling companions, wakened for the journey, rise upwards, following in the wake of the earliest starter; the latter, however, when the answering voices have announced that all the sleepers are aroused, ceases circling about, and rises with breast erect and brief and rapid strokes of the wings, almost vertically upwards; soon all assemble in a somewhat loose swarm, the call-notes are silenced when the last straggler has joined the departing flock, and the tiny wanderers vanish from sight" (p. 318). It is no exaggeration to say that there are scores of passages equal in beauty to that just cited. Nor should it be forgotten that in some respects Gätke stands *alone*. No other European naturalist shares his knowledge of the habits of the yellow-browed warbler (*Phylloscopus superciliosus*), Richard's Pipit (*Anthus richardi*), or sundry other species of birds. But the volume must be read from end to end to be fully appreciated. Gleams of humour light up its pages when least expected, as when the veteran smacks his lips at the prospect of fat thrushes caught in the throstle-garden, or gives us a sly recipe for making a pie of kittiwakes. Alas! there is also a pathos in the work, for it is the *magnum opus* of an aged worker. We sadly fear that we may hope for no more brilliant essays from the gifted pen to which already we owe so much. When Gätke penned the preface to the German edition of this work on his seventy-seventh birthday, he proffered the labours of his life as "eine wilkommene Gabe" to his fellow naturalists. It is dangerous to prophesy, but we are firmly convinced that Gätke's unique work will be enormously useful in promoting the study of the why and wherefore of avian migration. Meantime, we thank him with all our heart for the delightful insight that he has given us into "Die Vogelwarte Helgoand."

H. A. Macpherson.

Swayne's Somaliland.

Seventeen Trips through Somaliland. A record of exploration and big game shooting, 1885 to 1893, being the narrative of several journeys in the Hinterland of the Somali Coast Protectorate, dating from the beginning of its administration by Great Britain until the present time, with descriptive notes on the wild fauna of the country. By Captain H. G. C. Swayne, R.E., C.M.Z.S., F.R.G.S. 8vo. Pp. xx., 386, with two maps and 56 illustrations. London: Rowland Ward & Co., 1895. Price 18s. nett.

Since the memorable expedition when the two James and Lort-Phillips broke down the barrier of superstition which had so long kept Europeans out of the Eastern Horn of Africa, our knowledge of the country has made rapid progress. Unfortunately, however, most of the work done there has been carried out by shooting parties who have had no time to spare for careful scientific observation, and James's "Unknown Horn of Africa" still gives the best general list of the fauna of the country. We may, therefore, welcome all the more cordially the book of a man who has been engaged in the country for the last eight years, especially as he has been employed in definite work there on behalf of the Indian Government. His maps and reports, which have previously been printed (we wish we could say published) by the Indian War Office, have shown that Captain Swayne is a skilled cartographer and an accurate observer. We therefore turn to this book expecting it to prove a most important addition to the literature of Somaliland. We are not disappointed.

Captain Swayne writes with an intimate acquaintance with the country; his first visit to it was a short shooting trip in January, 1885, followed during the next three years by six journeys in the British Protectorate on Government service. In 1887 he made his first important expedition after big game. His two most daring and important journeys were carried out in 1892 and 1893. In the former year he marched, *viâ* Hargeisa and Milmil, to Gildessa, in order to explore the Abyssinian frontier; he met the Abyssinians, by whom his caravan was surrounded and imprisoned, and it was only by great firmness and tact that Captain Swayne succeeded in avoiding a conflict. He had to leave Gildessa secretly by night, and safely recrossed the Haud to the coast at Zaila. He brought back with him, however, most important news as to the political conditions of the Abyssinian borderland. In the following year he returned to Harar, where he was well received by Ras Makunan, the Abyssinian in command. Later in the same year he crossed the Haud again, but, keeping more to the east, reached the upper part of the Webi Shabéleh (or Shabeyli), which had previously been reached by James's expedition. There he met the Adone, a race of negroes, apparently Bantu. On the way back from this expedition, Captain Swayne, with half the caravan, turned aside into the Golis Range for three weeks' shooting, securing a kudu each week. Almost

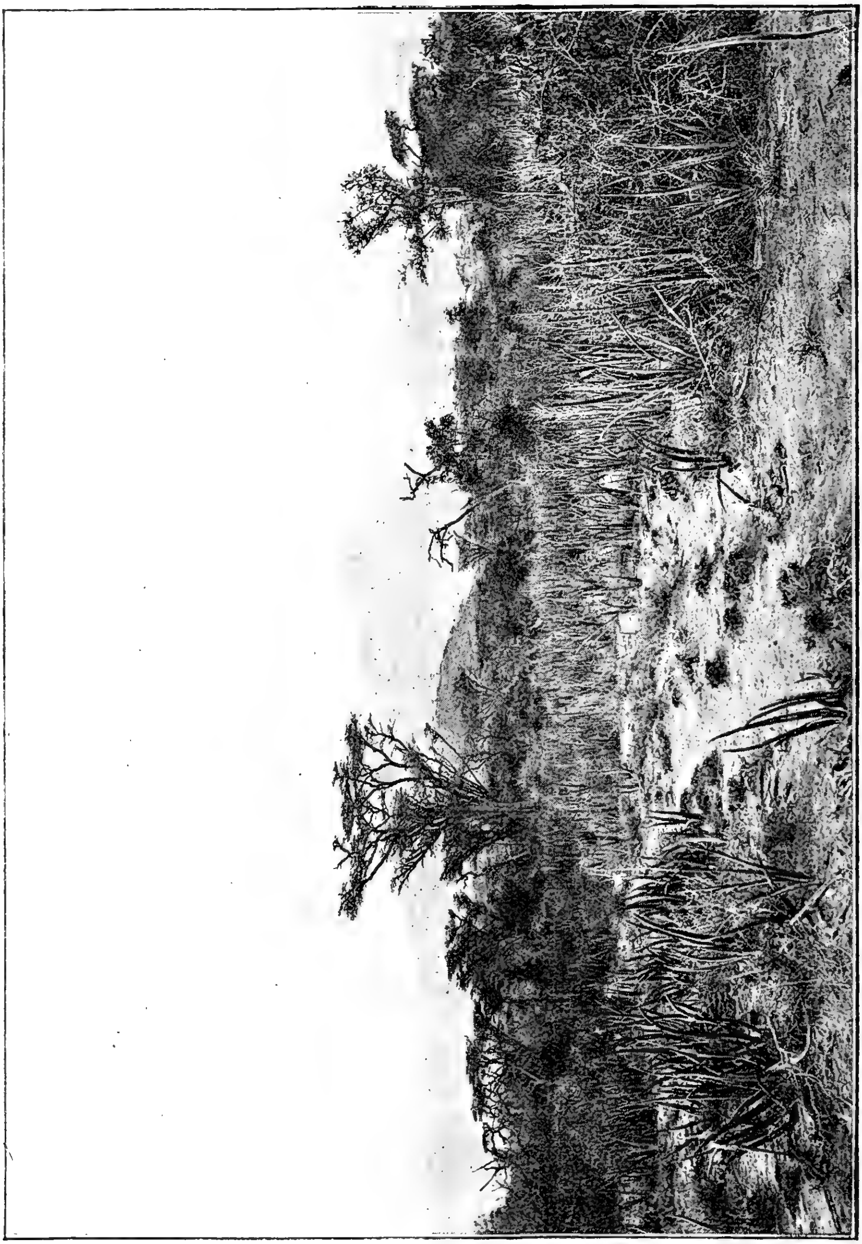


Fig. 1.—Henweina Valley, Gan Libah Mountain in the distance. From a photograph by Captain Swayne. The vegetation consists of *Acacia* and *Sanseveira*.

immediately after his return to the coast he again set out on his last expedition, which was a second visit to the Webi Shabéleh, intending to cross this and explore the Galla regions to the south. But the late Prince Ruspoli had just fought his way through that country, and had, as Captain Swayne expresses it, "been singularly unfortunate in the impression left behind." Captain Swayne had, therefore, either to fight his way into the district, or not go in at all, and he chose the latter alternative. Under the circumstances, there can be no doubt that his forbearance has helped to remove the bitter feeling of the Galla of that district against Europeans, and will thus facilitate the future exploration of the country.

After the conclusion of the narrative portion of the volume, Captain Swayne adds a chapter on the fauna of Somaliland, and three appendices, giving instructions on the equipment of expeditions, notes on the physical geography and on the trade of the country. The account of the fauna is an expansion of the author's paper on the Antelopes of Somaliland, published in the *Proceedings* of the Zoological Society, and forms one of the most valuable chapters in the book, containing interesting notes on the habits of the animals. Unlike the accounts of many sportsmen, it is well up-to-date in nomenclature; sometimes it is almost too much so, for the adoption of *Madoqua* without references or explanation may be puzzling to those who know only *Neotragus*, and not having seen Thomas's paper, are not acquainted with the reason for the change. In addition to remarks on the habits of the animals, the author gives some account of the methods in which they are hunted by the natives; among these, the description of the system by which the Midgan capture the ostrich is the most interesting. The value of this chapter is increased by the numerous illustrations; but these are of the conventional type, and of less originality than the sketches of animals at home, which are scattered through the book. These are of unequal value, but the majority are excellent. The figures of animals which illustrate books of travel are usually based on overstuffed museum specimens. Some of Captain Swayne's sketches are rather scratchy and less finished than if they had been executed by a professional artist at home. But they are of far greater value, for they give a good idea of the animals in action. Owing to the courtesy of the publishers, two of them are reproduced here (Figg. 2 and 3); one shows a herd of water-buck (*Kobus ellipsiprymnus*), and the other some *Gazella soemmeringi* at play. Both of these truthfully portray the appearance and gait of the living animals, and show that Captain Swayne has the eye of a true artist.

The full-page photographic reproductions are also very useful, for they give a better idea of the character of the sandy scrub-covered plains of East Africa than any illustrations previously published in England. The only things we know which can compare with them are those issued by Paulitschke. One of them (Fig. 1) has also been kindly lent by the publishers, and shows the sandy, turfless ground, the umbrella-shaped acacias, and the sharp, bayonet-shaped *Sanseveira* (which is unfortunately described as an aloe throughout the book), characteristic of this type of country. The illustrations are so admirable that they often help one to detect errors in the text, for the sections dealing with animals which are not included in the category of sporting game, and with the plants, are not equal to the rest of the book. Thus the rock-rabbits, to which the author refers, are shown by the illustration on p. 256 to be *Hyrax*. He also identifies some trees in the Webi Shabéleh as *Casuarina*, although the occurrence of that genus there is most improbable. He gives an illustration of a rhinoceros at the pool at Kuredelli (p. 190), and in the background are some trees, which may be those in question; if so, they are probably *Tamarix*. The white bulbs at the base of the thorns of the "galol" (*Acacia* sp.) are apparently regarded as an essential part of the tree, though they are an abnormal growth due to the attacks of ants. The section on the ethnology might also be improved. The use of the term negrito is rather loose, and we regret the absence of more

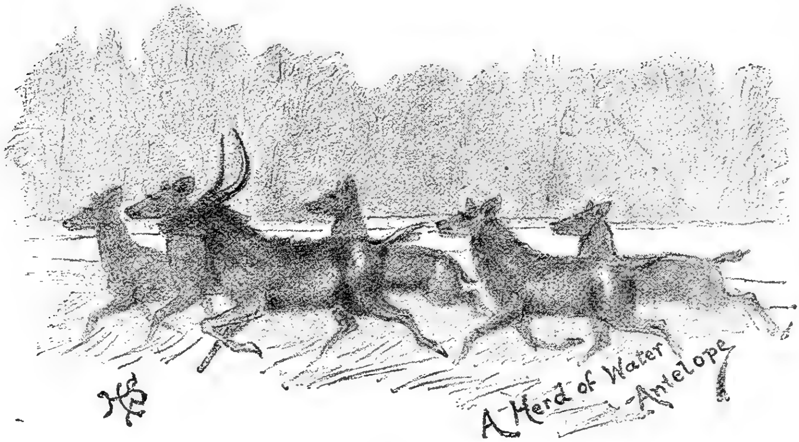


FIG. 2.

definite information about the Tomal and Midgan, two of the most interesting tribes in Somaliland. The author has probably seen more than anyone else of the Midgans, but his account does not solve the problems in connection with their affinities and origin. The author is enthusiastic over the Somali, but he is quite conscious of their failings; he obviously has the power of getting rapidly into sympathy

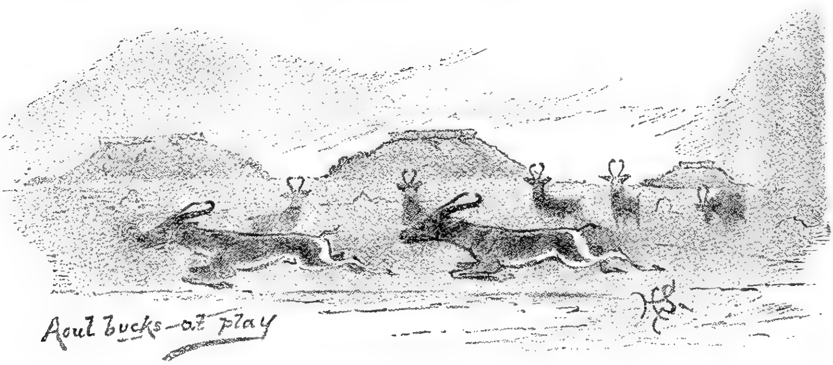


FIG. 3.

with his men, and thus has been enabled to utilise to the fullest their intelligence, pluck, and devotion. But he admits that bad Somali are mutinous, surly, and lazy, and may be cowards to boot; and he justly accuses the Somali as a race with being careless, vain, avaricious, and passionate. He attributes their ostentatious devotion to their prayers simply to a desire to show off. Captain Swayne's account of the Somali is, of course, less complete than that of Paulitschke, but it is the best we know in English. It gives a good account of their habits and character, but, unfortunately, says less about their physical features. The conclusions which he has arrived at independently in regard to the affinities of the tribe are better than some which he has accepted, apparently somewhat reluctantly, in deference to opinions of men whom he regarded as high authorities.

A few defects and deficiencies in special parts of the book cannot, however, seriously detract from its value and importance; and the author must be congratulated on an important addition to the literature of East Africa. Captain Swayne's work is more business-like and instructive than James's racy narrative; it is more reliable and juster in its judgments than Burton's "First Footprints in East Africa"; and it is more generally intelligible and interesting than the detailed, scientific monographs of Paulitschke. It may be confidently recommended as the best existing account of our new protectorate of Somaliland, of its game, and of its people.

J. W. Gregory.

Some Recent Carcinology.

Report upon the Crustacea of the Order Stomatopoda collected by the Steamer "Albatross," between 1885 and 1891, and on other specimens in the U.S. National Museum. By Robert Payne Bigelow, Ph.D., Bruce Fellow in the Johns Hopkins University. From the *Proc. U.S. Nat. Mus.*, vol. xvii., pp. 489-550, pls. xx.-xxii. Washington, 1894.

Descriptions of New Genera and Species of Crabs of the Family Lithodidæ, with Notes on the Young of *Lithodes camtschaticus* and *Lithodes brevipes*. By James E. Benedict, Assistant-Curator, Department of Marine Invertebrates. *Proc. U.S. Nat. Mus.*, vol. xvii., pp. 479-488. Washington, 1894.

Morphologisch-biologische Studien über den Bewegungsapparat der Arthropoden. Von Dr. Theodor List, Mit Tafel xiv.-xviii. und 3 Figuren im Texte. 1. Theil: *Astacus fluviatilis*. Preisgekrönte Beantwortung einer für das Jahr 1894, von der mathemat.-naturw. Abtheilung der Grossh. techn. Hochschule in Darmstadt gestellter Aufgabe. *Morphol. Jahrbuch.*, xx. Bd., 3 Heft. Leipzig, 1895. 2. Theil. Die Decapoden. Mit Tafel 4-6 und 9 Figuren im Text., *Mittheilungen aus der Zoologischen Station zu Neapel.* Band. xii., 1. Heft. Pp. 74-168. 1895.

Dr. Bigelow here furnishes valuable analytical keys to the genera and species of the Squillidæ in general. He supplies figures and detailed descriptions of the fourteen new species which he had already established in 1893. *Odontodactylus*, which in that year he separated from *Gonodactylus* as a subgenus, is here raised to the rank of a genus. He accepts in all nine genera of Squillidæ, whereas H. J. Hansen, in his Stomatopoda of the Plankton Expedition, 1895, reduces the number to seven. But Dr. Bigelow retains the *Leptosquilla* of Miers and the *Pterygosquilla* of Hilgendorf with a hesitation which almost amounts to dismissing them. Hansen includes them both under *Squilla*. The *Protosquilla* of Brooks, admitted as valid by Bigelow, is re-united to *Gonodactylus* by Hansen, who, on his own account, assigns *Pseudosquilla stylifera* (Milne Edwards) to a new genus, *Hemisquilla*.

Under the name of "the Odonterichthus larva," Dr. Bigelow exhibits two forms as probably the young of *Odontodactylus*. The larvæ of Stomatopoda, he says, are sometimes to be found in immense schools. When working at Bimini Islands, Bahamas, in the summer of 1892, he found a few of these larvæ of various kinds and stages almost every time that the towing-net was used; but after dark on three successive evenings in July the towing-nets were crowded with an immense number of very small specimens of Gonerichthi, the young forms, as it is reasonably supposed, of the genus *Gonodactylus.* Of larval Squillidæ there is a most important discussion in Hansen's work above mentioned. For the adult forms, the student will find Dr. Bigelow's paper of very great service.

Mr. Benedict's paper on the Lithodidæ describes eleven new species, and establishes four new genera.

Several of the new forms seem to be interesting, and the descriptions are no doubt adequate, but there are no illustrations. From a naturalist's point of view, it is almost a calamity to have a new genus instituted without any figures of the typical species. No skill has ever made technical description agreeable reading, so that a new form can only hope for welcome when, by the help of accurate drawings, its distinguishing features can be perceived, if not at a glance, at least without excessive tedium.

Attention should be called to Dr. List's remarkable and amply-illustrated essay on the locomotor apparatus of the crayfish. The ordinary observer will, perhaps, be surprised to find himself confronted in its pages with geometrical diagrams and the formulæ of algebra and trigonometry; but there is much also which the unmathematical reader can follow. For example, the author points out that the last pair of walking feet in the crayfish push, while the three preceding pairs pull, and that the position of the last pair facing the others might lead us to expect a difference in its way of working. But so little, he adds, has this characteristic been taken notice of in the figuring of crayfishes that, even in Huxley's classic monograph, the frontispiece represents the animal in a position which, if it ever occurs at all, is, at any rate, a very constrained one.

Since the above was written, Dr. List has published a valuable Second Part dealing with the motor organs in a considerable number of Macrura and Brachyura. To those who will follow his observations on the living animal, even a common prawn may become an uncommonly interesting object. The circumstance that such an animal has its body-segments (or somites) and its limbs and limb-segments varying in length and strength, in shape and ornament, in mobility and mode of attachment, may easily pass unadmired. But when the nice adaptation of these characteristics to the creature's economy is observed in activity, when, for example, the delicate fore feet can be seen actually taking a mote out of *Leander's* eye, only a churlish insensibility could refuse to be gratified. A human traveller might be tempted to feel disgust at the cumbersome luggage and unportable furniture of his own civilised state, when he finds how compactly and readily a shrimp carries about its person the practical equivalent of brushes and combs, knives and forks, sieves, thread, cement, tongs and shovels, boat-hooks, paddles, and rudder. Dr. List very properly alludes to the admirable observations already made by Dr. C. W. S. Aurivillius on the relations between the seemingly trivial details of structure and the really important necessities of life in various Crustacea. The subject is a wide one, with many interesting opportunities still unexhausted.

In regard to the commonly accepted view that the trunk-limbs of the decapods "consist in the Natantia of seven free joints," Dr. List considers that it no longer has full validity, his investigations having proved that in a series of forms "one joint may be subdivided into a series of 'free' jointlets, which are completely comparable to the other joints." But it may be urged that, in deciding the normal number of segments in the malacostracan limb, one has rather to consider the origin of the "jointlets" than their acquired character. In passing, it may be noticed that Dr. H. J. Hansen advocates the view that the limb is typically not seven-jointed but eight-jointed. There is apparently no evidence to show what number of segments it started with, but in the present stage of its evolution it would seem to be a matter of convenience to describe it as seven-jointed, although, as I have said elsewhere, it must "be noticed that there are Crustacea in which one or other of the joints, most often the fifth, is itself multiarticulate, thus adding to the normal number, which, on the other hand, is still more frequently diminished by coalescence, absorption, or complete failure of development affecting various parts of the limb."

Were there space it would be pleasant to quote the whole of Dr. List's description of the way in which *Callianassa subterranea* (Montagu) constructs its tunnel in fine sand beneath the water. The relations of form in this eccentric-looking crustacean are, as he says, very unintelligible until eye-witness of its mode of working has shown how its resources, fit though few, result in a truly wonderful piece of architecture. THOMAS R. R. STEBBING.

"I DO PERCEIVE HERE A DIVIDED DUTY."

BRACHIOPODS (RECENT). By A. E. Shipley. BRACHIOPODS (FOSSIL). By F. R. C. Reed. Being pp. 461–512 of vol. iii. of the "CAMBRIDGE NATURAL HISTORY." London: Macmillan, 1895. Price of the volume 17s. nett.

To the section of this volume that deals with Mollusca, and was reviewed in the September number of NATURAL SCIENCE, the chapters now to be considered are in marked contrast. Mr. Cooke's contribution attracts the naturalist by its account of the habits and economy of living animals; the part for which Messrs. Shipley and Reed are responsible will be more welcome to the student of anatomy and palæontology. Of a truth "brachiopods *au naturel*," even when idealised by Bret Harte, hardly lend themselves to a light anecdotal touch, nor do they serve as popular illustrations of the wonders of nature. The Cambridge naturalists have therefore sought—and what is more, have found—their success in a clear and up-to-date exposition of the Morphology, Embryology, Ontogeny, and Phylogeny of the group. Hard words, my masters! but they break no bones, and in the hands of Messrs. Shipley and Reed are not so terrible as the amateur might think. The subject is still further elucidated by figures as superior to the ordinary clichés as were those of the Mollusca; among them the sagittal section of *Cistella* (p. 470) and the view of *Spirifer* (p. 501) are specially to be commended. It does not detract from the value of the former figure that Mr. Shipley cannot make up his mind whether *Cistella* is a subgenus of *Argiope* (p. 472, top line), or *Argiope* a subgenus of *Cistella* (fig. 314, legend, and p. 479), or whether *Cistella* and *Argiope* are two independent genera (pp. 470, 479, 487). A "mere systematist" would tell Mr. Shipley that the name *Argiope* belongs to a spider, and that the brachiopod species mentioned under that name have been referred to *Cistella*, with the exception of *Argiope decollata*, which is a *Megathyris*. Similarly, Mr. Reed! *Magellania* is not a subgenus of *Waldheimia*; what you meant to say was *Magellania* (olim *Waldheimia*) *flavescens*. These things are trifles, but the editors of the "Cambridge Natural History" should remember that they cause the wicked to blaspheme.

I have had occasion, in the course of other duties, to read these chapters with great care, and, though there are a few slips, I am glad of this opportunity to praise the accuracy of detail and the use made of recent writings. None the less do I consider that the work is to be condemned, and that an admirable opportunity has been passed by. If the whole subject of the Brachiopoda cannot be dealt with by any single one of the Cambridge morphologists, by all means let us have two of them. But that is no reason why we should have two accounts of shell-structure, two of ontogeny, two of classification; still less why the two accounts should be at variance with one another. One can only suppose that here is some deep-laid plot to reduce to an absurdity the severance of Recent from Fossil forms. For in this case it is not merely wrong; it is ridiculous. Mr. Shipley tells us that in the Ecardines "the shell is chitinous, but slightly strengthened by a deposit of calcareous salts": Mr. Reed tells us that the Trimerellidæ, which he places in the Ecardines, "have heavy, thick calcareous shells." Mr. Shipley puts his "*Argiope*" and "*Cistella*" into the Terebratulidæ: Mr. Reed constructs a separate family for them. Mr. Reed gives an account of the phylogeny, which is based primarily on features of embryonic development in living Brachiopoda: these features are not even alluded to in Mr. Shipley's account of the embryology. The difference between Cambrian and Recent forms is perhaps less in the Brachiopoda than in any other group of the Metazoa; yet, were it not for the recurrence of a few names, the general reader might well imagine that two quite distinct groups were here being described.

Now consider what might have been done. These two learned and lucid writers might have joined forces; they might have given us an account of the anatomy that should not be self-contradictory; they might have discussed the ontogeny of both fossil and living brachiopods, showing how the former explain the latter; they might have told us the fascinating story of the evolution of the Brachiopoda, from the Cambrian down to the present—the story that Darwin longed in vain to hear, that Davidson himself could not tell, since the key to its hieroglyphics was reserved for Beecher to find. And when they had done this, they might have given us a classification (not two classifications) which should be a summary of the whole history and relationships of all Brachiopoda, living and extinct. That is what we might have had. That is what Hall and Clarke have given us. But the tale as told by Messrs. Shipley and Reed is "full of sound and fury, signifying nothing."

F. A. Bather.

A New Work on Geographical Distribution.

Cambridge Natural Science Manuals. A Text-Book of Zoogeography. By Frank E. Beddard, M.A., F.R.S. Crown 8vo. Pp. vi., 246, with 5 maps. Cambridge, 1895. Price 6s.

Students must often have wished for a book on the geographical distribution of animals giving the leading principles and the main illustrative facts of that most fascinating branch of natural science without the wealth of detail to be found in Dr. Wallace's classical volumes. This want Mr. Beddard comes forward to supply. Admittedly founded largely on Dr. Wallace's writings and on the excellent smaller books on the same subject by Professors Heilprin and Trouessart, the present work contains a fair proportion of matter not found in these, especially with regard to the distribution of various invertebrates. The plan of the work can be thoroughly commended. The opening chapter deals with the general facts of distribution, giving instances of wide, discontinuous, and restricted ranges, and sketching the distribution of certain selected groups of vertebrates and invertebrates. In compiling his facts as to reptiles, Mr. Beddard makes use of Mr. Boulenger's recent British Museum catalogues. Summaries of the distribution of earthworms and land planarians are specially welcome; and the main results of Mr. Pocock's paper in NATURAL SCIENCE (May, 1894) on the distribution of scorpions are set forth, though it is unfortunate that Mr. Beddard's remarks on the Buthidæ seem to suggest that the archaic character of a pentagonal sternum is usual in that family instead of exceptional. In his chapter on Zoological Geography, Mr. Beddard adopts the well-known six regions of Sclater. It is surprising to find here that the only alternative suggested to the retention of the Palæarctic and Nearctic Regions is the adoption of Heilprin's Holarctic Realm comprising the two. In the concluding chapter, however, a reference to Hart Merriam's proposed Boreal and Sonoran Regions (*see* NAT. SCI., July, 1894) is to be found. Mr. Beddard furnishes under each region and sub-region a concise list of the peculiar and most characteristic vertebrates. He also gives some useful illustrations of graphic methods for indicating the main facts of distribution without maps, by means of lines arranged to form spaces roughly approximating to the relative positions of the various regions.

The third chapter is devoted to the causes influencing distribution; and here the author discusses what physical features serve as barriers to the extension of various animals and what means special groups have of migrating from country to country. The earthworms are again used in illustration, and Mr. Beddard's remarks on their transmission by human agency are of special interest. In the coast regions and near the towns of tropical countries, European species abound, while in the interior the true indigenous worm-fauna is to be found. In this chapter there is also an impartial summary of the evidence for and against the permanence of oceanic and continental areas. Considerable space is devoted to a discussion of the supposed former northward extension of the Antarctic Continent, and the evidence in favour of such a view to be derived from the presence of identical genera of earthworms (Acanthodrilidæ) in New Zealand and Patagonia is stated with much force. From his review of the facts for and against "Lemuria," it appears that Mr. Beddard does not share Dr. Wallace's absolute disbelief in that much-disputed hypothetical tract. The fourth chapter deals with the fauna of islands, and necessarily recalls "Island Life." The animals of the British Isles, Madagascar, the Galapagos, and New Zealand—all dealt with by Dr. Wallace—are briefly sketched, but new examples of oceanic islands are given by Mr. Beddard in Fernando Noronha and Kerguelen. The sketch of the former—an archipelago not quite 200 miles off Brazil—is summarised from a report by Mr. Ridley, and its fauna shows West Indian affinities, though the winged forms have a South American facies. With regard to the animals of Kerguelen, Mr. Beddard points out their poverty in numbers but their wealth in peculiar forms. Some general remarks on the characteristics of island animals conclude the chapter, from which the author surmises that there is a tendency in such forms to darken in colour.

The section on the British fauna is unsatisfactory. The reader would conclude from Mr. Beddard's remarks (p. 185) that the extinct "Large Copper" butterfly (*Polyommatus dispar*) was confined to Britain, whereas its variety *rutilus* has a wide continental range. We read also (p. 186) that "a black slug spotted with yellow, *Geomalacus maculosus*, was discovered on the shores of Lake Caragh, in Kerry, in the year 1842, and has not been met with elsewhere since that year." More than twenty years ago Heynemann recorded this species from Portugal, and recently its known range in the south-west of Ireland has been considerably extended. This error is specially unfortunate, as the occurrence of the slug in both Portugal and south-west Ireland is far more suggestive and interesting than if it were found in the latter country alone. It is hard to understand how Mr. Beddard can have been betrayed into these statements, as the facts about both butterfly and slug are correctly given (pp. 347, 357) in the last edition of "Island Life," although Dr. Wallace, by some oversight, includes *G. maculosus* in his list (p. 356) of peculiar British species.

Possibly the book has been somewhat hastily compiled; the name of the Liberian hippopotamus (p. 100) is given as *Chœropotamus* (a genus of Eocene ungulates) instead of *Chœropsis*, and we are told (p. 89) that "a great many of the [Palæarctic] mammalia are either specifically identical with North American forms or are very near indeed to them. The Aurochs and the Wapiti are hardly, if at all, specifically different from Luhdorf's Deer and the American bison." Surely the student will gather from this that the Aurochs is a deer and that the Palæarctic bison is known as the Wapiti!

Mr. Beddard's concluding chapter is devoted to theoretical considerations. He warns the reader that the place where a group of animals is at present most abundant need not be the place of its origin. But he then puts forward a view, which will probably be the greatest surprise to naturalists to be found in the book, that the marsupials originated in Australia. Mr. Beddard seems led to this opinion by the consideration that, though some placental mammals have made their way into the Australian Region, the marsupials have not been exterminated by them. "The Marsupials," he writes, "have had the start in a country eminently suited to them, and have only been beaten in the struggle for existence in regions subsequently settled in by them and therefore perhaps less fit for their peculiar organisation." The older view, that the marsupials have found in Australia a "protected area" seems, however, to have far more to commend it to our acceptance. The extreme paucity of the Australian placental mammals as compared with the marsupials, and the divergence of the latter into groups of structure and habits corresponding with the various placental orders, point to the marsupials having had in Australia a tract preserved for their almost exclusive use. And the spread of the rabbit in Australia (which Mr. Beddard strangely brings forward in support of his view) surely shows what would happen to the marsupials were a large influx of placentals to take place. Perhaps, however, Mr. Beddard holds this opinion loosely, for in the section on the Polar Origin of Life, immediately following, he instances the marsupials as an ancient and primitive group, "once existing in great variety in Europe and North America . . . . the survivors having now been pushed into the furthest corner of the world—the Australian Continent."

A question of much interest touched at several points in Mr. Beddard's book is the possibility of a form of life originating independently in more than one place. As to this, he is disposed to adopt a "middle position." There can be no reasonable doubt that an identical variety may be developed independently in two places under similar conditions. And as, on any theory of evolution, the variety must provide the starting point for all the higher classificatory groups, this admission may lead us a long way.

G. H. CARPENTER.

DAIRY BACTERIOLOGY.

DAIRY BACTERIOLOGY. A Short Manual for the Use of Students in Dairy Schools, Cheesemakers, and Farmers. By Dr. Ed. von Freudenreich. Translated by J. R. Ainsworth Davis. Pp. 115. London: Methuen & Co., 1895. Price 2s. 6d.

PASTEURISATION OF MILK AND CREAM FOR DIRECT CONSUMPTION. University of Wisconsin Agricultural Experiment Station, Bulletin no. 44. 8vo. Pp. 48. Madison, Wisconsin, 1895.

THERE is no room for dispute as to the advantage of a knowledge of at least the elements of bacteriology in the case of those who manage dairies. For long it has been a reproach to England that her dairy produce is inferior to that of Scotland, and, still more to that of Denmark and Sweden, of Switzerland and of France. This defect is partly due to the dense stupidity of the average English farmer, a stupidity that would have caused his ruin in any other occupation, and partly to the neglect of the pursuit of agriculture by successive Governments. Every county in England has now the opportunity of giving necessary instruction in dairywork, which, indeed, was one of the trades by special clause permitted to be taught under the Technical Instruction Acts. Many of the counties are taking advantage of their new opportunities, by instituting peripatetic dairy-schools; others are combining to aid or to establish agricultural colleges of more pretentious character. Dr. Freudenreich's book offers itself adroitly to the new dairymaid.

The first thirty-five pages give a brief but adequate account of bacteria, the manner of things they are, their habitat, life-history, and the methods of investigating them. The rest of the book is purely pertinent to the dairy. Milk from a healthy cow when it leaves the udder should be free from bacteria; but as it forms a cultivation medium almost ideal, it swarms with them in a few hours. The forms most commonly found and the differences between pathogenic and harmless bacteria are discussed sufficiently to impress upon readers the necessity for the most careful attention to the bacteriology of milk. Unfortunately, as the writer explains, there are no methods of complete sterilisation that do not destroy, to some extent, the delicate flavour of milk. On the other hand, the process of Pasteurisation is both practicable and of considerable advantage. As the writer shows, it destroys a certain number of germs and retards the development of all for a considerable time. But the one thing made plain, and for which alone the book should be in the hands of all connected with dairies, is that the germs of pathogenic bacteria can and should be prevented from ever gaining access to milk. This is possible only by the isolation of all cases of infectious diseases, and by the complete destruction of all contaminated things. This, no doubt, is a matter more for local and central sanitary authorities than for dairymen, but these must learn the dangers, and the resulting necessity for active co-operation with sanitary authorities. We have full confidence in recommending the book to all persons interested.

The valuable pamphlet from Wisconsin is a complete practical treatise on the nature, advantages, and methods of the process of Pasteurisation. In the process of sterilisation, milk must be subjected to the temperature of boiling water for a prolonged period or succession of periods. Such is the resisting action of spores and the ease of contamination in the various processes, that even sterilised milk is rarely absolutely free from spores by the time it reaches the consumer. Moreover, the cost of the process is considerable; the constitution of the milk is altered, and the flavour is that of cooked milk. The process invented many years ago by Pasteur consists in the exposure of the milk for a short time to a temperature of about 140° Fahr. By this means, although spores are not destroyed, all the bacteria in the milk are destroyed, and consequently it keeps for a longer time than untreated milk. As the lactic acid bacteria do not form spores in milk, they are completely destroyed, and when the Pasteurised milk does begin to go wrong, it does not become disagreeable to the taste and useless for cooking purposes. Moreover, by Pasteur's process the fresh flavour is not destroyed, and the constitution of the milk is altered only slightly.

The "Bulletin" is, no doubt, too advanced for dairymaids, but we hope that it will reach the hands of all dairy teachers and technical instructors. And in especial we hope that it will reach the hands of the technical instruction committees and university authorities, who are subsidising and directing the agricultural departments of colleges and universities in England. For such persons are taking up the work of *teaching* agriculture vigorously enough, if not always wisely; but proper experimental work, such as this of the University of Wisconsin, is still sadly to seek in England.

Biology under the Essex County Council.

Biology Notes, no. 6, March, 1895, County of Essex Technical Instruction. County Technical Laboratories, Chelmsford.

This excellent little periodical is an indication that biology is being taught practically and intelligently under the provisions made by the Technical Instruction Committee of the Essex County Council. The number now before us contains some useful notes upon the practical aids to technical instruction wanted in the county. The writer urges the formation of a natural history museum in every town. We are by no means certain that this suggestion is practicable. A local museum soon degenerates into a mere collection of useless rubbish, unless a large annual income can be secured to provide for the maintenance of the collection by a skilled curator. It would be more practicable to have a central museum in the county, and to make arrangements for the issue to local schools and classes of typical loan collections illustrating the chief local minerals and fossils, the structure of plants and animals and so forth.

For another suggestion made by the same writer we have nothing but the highest praise. There should be attached to every elementary school in the county a small experimental garden. A plot of a few yards square is all the space required, and the necessary seeds, cuttings, and manures, with appropriate directions, could be issued at periodical intervals from the central laboratories at Chelmsford.

Among the features of special interest in the March number are well-arranged notes for "Practical Lessons in Botany." These should be of great use to the local teachers who are conducting classes under the auspices of the Council.

The Index to Flowering Plants.

On the 10th of October the fourth and last fasciculus of Mr. Daydon Jackson's colossal task, the "Index Kewensis Plantarum Phanerogamarum," was published. This includes *Psidium Gardnerianum* to

Zyzygium, and the "Addenda et emendanda graviora hactenus notata." There are also two title-pages, one for vol. i. and one for vol. ii., each bearing the date of 1895. Now, as fasciculi 1 and 2 came out in 1893, and fasciculus 3 in 1894, we cannot believe that a bibliographer of such reputation as Mr. Jackson could permit such a falsification by his publishers. We hope that in rebinding the book these new title-pages will be left at the end, and the proper title-pages kept in their proper positions. The preface also strikes us as not entirely consonant with the facts; it reiterates the statement that the work has been "carried out at the Herbarium of the Royal Gardens, Kew, with the aid of the staff of that establishment." We should be tired of hearing this, even if it were the whole truth.

We heartily congratulate Mr. Jackson and his staff on the accomplishment of their work, a work not only a monument of labour, but one so valuable as to be beyond price.

WITH the beginning of 1896 the bibliographic section of the *Zoologischer Anzeiger* will join forces with the Central Bureau, whose organisation we owe to Dr. H. H. Field, and will appear with the following title-page:—

BIBLIOGRAPHIA ZOOLOGICA

publiée par le Bureau International de Bibliographie, sous la rédaction de	herausgegeben vom International Bibliographischer Bureau, unter Redaktion von	published by the International Bibliographic Bureau, under the Editorship of

J. VICTOR CARUS,
Professor in Leipzig.
LEIPZIG
Wilh. Engelmann.

The annual subscription is fixed at fifteen shillings. Similar arrangements are nearly completed for a "Bibliographia Anatomica." These fortnightly publications are not intended to supplant existing Records, "The Zoological" or others, merely to furnish them with raw material ready sorted.

THAT excellent journal called *Insect Life*, published by the Agricultural Department of the United States, has been discontinued. The *American Naturalist* in an outspoken note on the matter, comments severely on this false economy on the part of an administration which has up to the present time taken the lead in economic entomology. The investigation into the lives of noxious insects is one of the most important that a Government can undertake, as it concerns the immediate welfare of thousands, and its neglect may lead to serious disaster.

WE have received the first two parts of *The West Indian Home Builder*, "a monthly magazine, devoted to the interests of West Indian Homes, and to developing West Indian Resources. The official organ of the Minor Industries Profit-Sharing Company, Limited. Subscription, 5s. per annum." 8vo. Barbados, W.I.

MESSRS. CASSELL send us the first part, price 6d., of a new monthly issue of Sir Robert Ball's "Story of the Heavens." With this part is presented a clear chart of the northern constellations. The edition, which will be completed in eighteen parts, is said to be revised.

OBITUARY.

CHARLES VALENTINE RILEY.

Born September 18, 1843. Died September 14, 1895.

THE man of science and the practical cultivator may well unite in mourning the death, through a lamentable cycling accident, of this prince of economic entomologists. Though his life-work was almost entirely done in America, Riley was English by birth—a native of London. Educated at Chelsea, Dieppe, and Bonn, he emigrated to the United States in 1860 and settled on a farm in Illinois. The practical experience thus gained was of the highest importance when he came later on to apply scientific principles to agricultural questions. In his early days in America he worked as a journalist and took part in the War of Secession. In 1868, he was appointed State Entomologist of Missouri, and the nine annual reports issued while he held this post mark an epoch in the economic study of insects. Like his subsequent writings, these reports are characterised by scientific accuracy coupled with clear and popular exposition; and while of special value to the farmer, fruit-grower, and forester, they abound with observations of interest to the pure naturalist. In 1877, Riley was appointed Chief of the U.S. Entomological Commission, and a year later Entomologist to the Department of Agriculture at Washington. This post he resigned somewhat quickly, but was re-appointed to it in 1881. He then organised the Division of Entomology, from which has issued an invaluable series of publications on the application of entomology to practical ends. Riley will be specially remembered for his researches on Phylloxera, and his successful use of the natural enemies of insect-destroyers of crops for waging against them an exterminating warfare. The introduction of the ladybird *Vedalia* from Australia to California to prey upon the previously-introduced coccid *Icerya* was one of the most notable examples of this. Besides his economic work, Riley acted as curator of insects in the U.S. National Museum, and edited the *American Entomologist*. In June of last year he resigned his posts through failing health and an impression that he could work more effectively if free from the trammels of office. Regret will be universal that the labours of his well-earned leisure have been brought to so untimely an end.

G. H. C.

JOHN ELLOR TAYLOR.

Born September 23, 1835. Died September 30, 1895.

DR. TAYLOR was born at Levenshulme, near Manchester, and was the son of a foreman in a cotton factory. He began life in the engineers' shop of the London and North Western Railway at

Crewe, and in his spare time studied Latin and Greek and the rudiments of science. Removing to Manchester, he contributed to some local paper, and his articles afterwards formed his first book. He adopted the profession of journalist, and was appointed editor of the *People's Journal*, Norwich, about 1860, and made the paper a great success. In 1872, he was appointed Curator of the Ipswich Museum on the death of Mr. George Knights. The museum, once an educational institute of considerable importance, had become somewhat effete, but under Taylor's rule it rapidly gained ground, and became one of the leading museums in the kingdom. Taylor's science lectures attracted numbers of hearers, and he did much to popularise his favourite subject of geology. His skill with the blackboard was remarkable, and he was also successful in modelling and colouring fish. But perhaps Dr. Taylor will be best known by his *Science Gossip*, a popular natural history journal which had an immediate and wide circulation. This was started in 1866, and is now continued under the editorship of Mr. J. T. Carrington. He was the author also of numerous popular handbooks, the best known of which are "British Fossils," "Half-Hours in the Green Lanes," and "Half-Hours at the Seaside." His last public appearance was at the Ipswich meeting of the British Association last September.

We are indebted to a sympathetic article by F. W. W. in the *East Anglian Daily Times* for the greater part of our information.

Moritz Willkomm, whose death has recently been announced, was born in 1821 at Herwigsdorf, in Saxony. At the age of 20 he went to the University of Leipzig to study medicine and natural science. In 1844 he began his travels in the Spanish peninsula, the flora of which he thoroughly investigated; it was this that formed the subject of his thesis when he was admitted into the Philosophical Faculty of Leipzig University in 1852. In the following years he published "Icones et Descriptiones Plantarum novarum criticarum et variarum Europæ Austro-occidentalis præcipue Hispaniæ" (1852–6). Having taught for some time at Leipzig, and afterwards at Tharandt, he was, in 1868, called to the University of Dorpat, and in 1873 to the Chair of Botany in the German University at Prague, in which city he also became Director of the Botanical Gardens. Among his other works may be mentioned "Illustrationes Floræ Hispaniæ insularumque Balearicum" (1881–92) and the most useful "Prodromus Floræ Hispaniæ" (1861–80) with its supplement in 1893. In the last-mentioned undertaking he was associated with I. Lange. Willkomm also published valuable works dealing with German and Austrian forestry, as well as a hand-book to the plants of Germany, Austria, and Switzerland.

Professor Heinrich Adolf Bardeleben, the eminent surgeon, died at Berlin on September 25, aged seventy-six. He was born at Frankfort-on-the-Oder in 1819, and was educated for medicine at

Berlin, Heidelberg, and Paris. He became Prosector (1843) and afterwards Professor at Giessen, and in 1849 became Professor at Greifswald. In 1868, he went to Berlin University as Professor of Surgery. He saw service in the field in 1866 and 1870, and was created surgeon-general at the close of the Franco-Prussian War. Bardeleben's best-known work was "Lehrbuch der Chirurgie und Operationslehre," 1852, of which the eighth edition appeared in 1879–82.

PAUL HOWARD MACGILLIVRAY, well-known for his researches on Australian Polyzoa, died at Bendigo, Victoria, on July 8 last. He was a son of John Macgillivray, the son of the more famous William. His contributions to the history of the Polyzoa began in 1859, and, altogether he produced some two dozen papers on the subject in the *Trans. R. Society Victoria* and other publications. He was an active member of the Field Naturalists' Club of Victoria, and looked after the interests of the Bendigo Science Society, the Bendigo School of Mines, and other institutions. The *Victorian Naturalist* states that his fellow-townsmen propose to erect a memorial to mark their sense of his usefulness to the town and to science.

DR. E. VON REBEUR-PASCHWITZ, who died October 1, 1895, at the early age of 34, modified the horizontal pendulum of Zöllner, and converted it into an instrument admirably adapted for recording the movements of the ground, and especially those which are due to strong and distant earthquakes. His work in this department of seismology is of great and permanent value. Few men have laboured so earnestly and with such success, even when they have not been hampered, as he was, by continual illness, weakness, and suffering.

THE deaths are also announced of:—THOMAS JAMES SLATTER, the well-known collector of Gloucestershire fossils, on August 1, at Evesham, aged sixty-one; ANGELO MANZONI, the well-known geologist and palæontologist, at Ravenna, on July 14; Dr. ERNST DE SURY, Professor of Medical Jurisprudence at Basle, on August 20; Dr. RIRA, botanist and African explorer, at Rome, on July 24; Dr. F. MIESCHER, Professor of Zoology at Basle University, at Davos, on August 26, at the age of fifty-one; Dr. H. SENONER, the geologist, of Vienna, on August 30 last. Dr. DEMETRIUS BRANDZA, Professor of Botany and Director of the Botanical Institute at Bucharest, who died on August 15, at the age of forty-eight, was the author of "Histoire botanique et thérapeutique des Gentianacées employées en Médecine" and a Prodromus of the Flora of Roumania (1879–83).

THE *Kew Bulletin* for September records the death, at Madras, on August 17, of Mr. ANDREW JAMIESON, Curator of the gardens and parks at Ootacamund, Milgiris. Formerly a member of the gardening staff at Kew, Mr. Jamieson was appointed to Ootacamund in 1868.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments have recently been made:—Mr. F. B. Stead, of King's College, Cambridge, as naturalist to carry on the fishery investigations at the Marine Biological Association at Plymouth; Mr. T. V. Hodgson, as director's assistant at the same place; Bernard H. Woodward, as Curator of the Museum, Perth, Western Australia; Mr. C. French, jun., to the Entomological Branch of the Department of Agriculture in Victoria; Dr. R. Metzner, to the chair of Physiology at Barcelona; Dr. Hans Lenk, as Professor of Geology to Erlangen University; Dr. E. Ihne, to the Technical High School of Darmstadt; Dr. Haecker, as Assistant Professor in Zoology to the University of Freiburg-in-Breisgau; Dr. Strahl, as Professor and Director of the Anatomical Institute in Giessen; Dr. Hermann Credner, as full Professor of Historical Geology and Palæontology to Leipzig University; Dr. Dalla-Torre, as Assistant-Professor of Zoology to the University of Innsbruck; Dr. Max Verworn, as Professor of Physiology at Jena; Dr. Otto Jaekel as Prof.-Extraordinarius of Geology, in Berlin. Dr. Albert Fleischmann is undertaking the duties of Professor Selenka at Erlangen during the professor's temporary absence; Dr. Selenka is nominated honorary Professor at Munich. Dr. Duclaux has been elected President of the Pasteur Institute.

The following news comes from America:—Professor E. J. Chapman has resigned the chair of Geology and Mineralogy in Toronto University. Professor F. L. Washburn has gone to the Oregon State University. Professor F. W. Rane has resigned the chair of Agriculture at the University of West Virginia to take that of the New Hampshire College of Agriculture. Professor G. E. Morrow has accepted the Presidency of the Oklahama Agricultural College at Stillwater. Professor E. W. Doran has accepted the Presidency of Ozark College at Greenfield, Missouri. Professor H. J. Waters has been elected Director of the Missouri Experiment Station. Professor F. B. Mumford has been appointed Professor of Agriculture in the Missouri State University; Dr. Walter B. Rankin and Dr. C. F. W. McClure, Professors of Biology in Princeton College; H. B. Kümmel, Assistant-Geologist in the Geological Survey of New Jersey (Trenton); Dr. G. P. Grimsley, of Columbus, Ohio, as Professor of Geology and Natural History in Washburn College, Topeka, Kansas; Dr. W. S. Strong, of the University of Colorado, as Professor of Geology and Physics in Bates College; W. D. Matthew, of Columbia College, as Assistant in Vertebrate Palæontology in the American Museum of Natural History.

We note the following botanical appointments:—Mr. T. H. Stephen, formerly of Kew, and lately Curator of the Lal Bagh Botanic Gardens, Bangalore, Mysore, to be Superintendent of the Public Gardens at Nagpur, Central Provinces, in succession to the late Mr. J. R. Ward, who died last January; F. Reinitzer, of Prague, to be Prof.-Extraordinarius at Graz. In America, the *Botanical Gazette* records the appointments of Dr. R. H. True to be instructor in pharmacognostical botany at the Wisconsin University; Dr. W. A. Setchell to a professorship in botany in the California University; and Dr. J. E. Humphrey to be lecturer in botany at the Johns Hopkins University.

SOME friends of Mr. Joseph Thomson being desirous of erecting a memorial monument over his grave at Thornhill, a subscription has been opened for that purpose. Those who wish to join in this tribute to the memory of the African traveller may send their subscriptions to J. G. Bartholomew, hon. sec., Royal Scottish Geographical Society, Queen Street, Edinburgh.

THE late Professor Babington has left his botanical collections, and Miss Saul her collection of shells, to the University of Cambridge.

THE report of the committee to consider the question of the desirability of the compulsory retirement of professors serving under the Crown has been published. The committee is of the opinion that when a professor reaches sixty-five years the head of the college should report to the Government concerning the efficiency of the teaching. If this be satisfactory, the superannuation of the professor should not take place till he has reached seventy, but at that age retirement should be compulsory. Heads of colleges, should the college be likely to suffer from a retirement at seventy, should be allowed to remain until seventy-five.

DURING the meeting of the International Zoological Congress, the University of Utrecht conferred its degree upon Professor Weismann, Sir William Flower, and Professor Milne Edwards.

THE University of New York has received from Miss Helen Gould sufficient funds to endow two scholarships of 5,000 dols. each. The Massachusetts Institute of Technology receives 10,000 dols. under the will of the late Benjamin P. Cheney.

THE programme of the Union University, Schenectady, New York, includes courses on mineralogy and lithology, general, economic, historical, field, and areal geology, independent research and palæontology. Especial efforts are being made to promote the field-work of the classes by excursions in the district this autumn and next spring. The library is rapidly growing, and the specimens in the museum have been identified, labelled, and arranged. We are glad to hear that "a collection of recent shells has been selected which is used for preliminary training in palæontology." The study of zoology as a whole is one to be encouraged, rather than the absurd restrictions to "fossil" or "recent" so common even in the present day.

FROM the Annual Report of the Gordon Technical College at Geelong, we gather that the field-work is in a flourishing condition, while the work of the museum has progressed steadily, despite the shortness of funds consequent on general depression. Everything in the museum has now been placed under glass, and the building was opened to the public in January last. Messrs. H. E. Hill and J. Hammerton are the Honorary Curators. The Field Naturalists' Club has handed its collection of minerals over to the Gordon College, and there is now only one museum in Geelong. A new quarterly publication was started in August last called *The Wombat*, and in it are papers by D. Le Souëf on "Victorian Macropodidæ," and by Sidney Johnson on "Some Native (Victorian) Woods." This publication, which is at present disfigured by advertisements in every page, will, it is hoped, gradually assume sufficient importance to confine these matters to special pages.

SYDNEY University has been obliged to decline the bequest of Sir William Macleay, for the purpose of founding a chair of bacteriology, owing to the conditions attached. The money will therefore go, says *Science*, to the Linnean Society of New South Wales, to support a bacteriologist who will carry on experiments and take pupils.

THE synopsis of evening demonstrations and lectures to be delivered this session at the Birkbeck Institution by Mr. G. F. Harris, has been issued. The subjects are elementary, advanced, honours, and applied geology, mineralogy, and elementary and advanced physiography.

Toynbee Hall, Whitechapel, has made an advance in its good work of education. The various committees, including that for the University Extension Lectures, have combined to form a single Education Committee. Among the lectures for the winter session the following are likely to interest our readers:—"Life and its Functions," by P. Chalmers Mitchell, Fridays, at 8 p.m.; Practical Biology, in connection with the above, by Miss K. Hall, Wednesdays, at 8 p.m.; Practical Physiology, by S. Rowland, Mondays, at 8 p.m.; Stratigraphical Geology, by Miss Raisin, Tuesdays, at 7.45 p.m.; Botany, by G. May, Thursdays, at 7.30 p.m.; "The Physiology of Every-day Life," by D. Walsh, Sundays, at 11.30 a.m. In addition, Professor Michael Foster will inaugurate a series of popular lectures on biological subjects; among the lecturers will be Professors Victor Horsley and Gotch. The meetings of the Natural History Society are held on the first Monday of every month, at 8 p.m. The good work which this Society does was well exemplified at the Conversazione on September 28 by an interesting series of exhibits from the Lake district, the Channel Islands, North Wales, Epping Forest, and even places so distant as the Forum at Rome. It is a pity to have to read at the end of all this that "the Education Committee, composed chiefly of students, experiences great difficulty every year in raising sufficient funds to meet expenses, in spite of the fact that all the teaching, except the Extension Lectures, is freely given by the class-takers."

According to the *Daily Chronicle* a new school of science, art, and technology, which has been erected by the Dover Corporation at a cost of £10,000, was opened on September 19. It adjoins the municipal buildings, with which it has connection, and is a notable addition to the architecture of the town. The school is lighted throughout by electricity.

At the beginning of October the Mayor of Brighton laid the foundation stone of a technical institute in Brighton. The sum of £26,000 is to be spent upon it, and it will accommodate the 1,100 scholars which the Corporation is said to be now training in various schools in the town.

The *Brighton Herald* informs us that it has been resolved by the Library, Museum, and Fine Arts Committee of Brighton to expend £115 instead of £100, on the new Illustrated Catalogues of the Museum of Birds. Mr. Lomax had written that not only had the letterpress been revised and enriched with notes made by Mr. Booth himself, but full descriptions were given of the additional cases which the collection had received, and an account of Mr. Booth's work in building up the "Booth Bird Museum" was prefixed. A portrait of Mr. Booth has been added and about fifteen illustrations.

Plans and contract drawings have been submitted for the extension of the Library, Museum, and Art Gallery. These plans the Committee has approved, and it has instructed the surveyor to prepare detailed specifications and quantities, upon which tenders may be invited for the performance of the work by special contract. The scheme, estimated to cost £22,800, has already been approved, and the drawings are now exhibited in the Council Chamber.

The Committee of the Sunday Society has fixed the date of the fourth "Museum Sunday" for Sunday, November 3.

We learn from the *Tasmanian Mail* of August 17 that several important additions have just been made to the Tasmanian Museum, which are calculated to materially add to the popularity of that attractive institution. In the Australian room a fine collection of the auriferous and argentiferous rocks of Queensland has been displayed. The contributing fields and districts embrace Charters Towers, Gympie, Gladstone, Glastonbury, Rockhampton, Warwick, Stanthorpe, and Moreton. Altogether there are more than 2,000 specimens, and to local students of mineralogy they will prove very valuable. A noticeable improvement in the arrangement of this room is the fixing of the shelves in the centre cases in a sloping instead of a horizontal position. The contents of the shelves (the larger fossils) can be thus seen to much greater advantage. Downstairs in the general room a very valuable collection of native implements and dresses from the Fly River, New Guinea, presented by the Rev. James Chalmers, of the London Missionary Society, has been placed in a position worthy its importance. Highly-finished specimens of drums, pipes, wooden shields, head ornaments, fishing baskets, adzes, bone daggers, armlets, etc., are included and, together with specimens previously obtained from the south-east end of New Guinea, these form the best collection of New Guinea ethnological specimens in the colonies, saving only that in the Sydney Museum. The stone axes are particularly fine and well finished, weighing from 10 lb. to 12 lb.

A Reuter's telegram states that the Cape Government has appointed a Geological Commission, consisting of the Hon. Mr. Merriman, Dr. Muir, Dr. Gill, Mr. Stewart, and Mr. Currey. The work of the Commission will extend over a considerable period, and the results are expected to be of the utmost service to Cape Colony.

The annual report of the Director-General of the Geological Survey has just reached us. We rejoice to hear officially that the topography of the old series of ordnance one-inch maps in the South of England is imperfect and inadequate, and it has been decided to engrave the results of the Drift Survey on the New Series of maps. We hope Surrey is considered by the Ordnance Survey to be in this district. Sheet 11 of the General Geological Map (four miles to the inch) will shortly be issued, and sheet 9 has been completed and is in the hands of the engraver. The account of the middle and upper oolitic rocks by Mr. H. B. Woodward is in type and is promised for this year.

The record of field work done during the year is a very full one, but interesting discoveries are few. Among them we notice the remarkable crush-breccias of the Isle of Man, which have now been worked out by Mr. Lamplugh. Mr. Strahan has found a bed of white oolitic rock forty feet thick in the middle of the main limestone in the South Wales Coalfield. In the note on work done in Permian districts there is a pleasing reference to the assistance rendered to the Survey by an outsider, Mr. J. D. Kendall. A long array of results in the geology of Scotland is set down, but as they are mostly minutiæ, we must refer our readers to the report. A brief summary of progress in Ireland is given, but this does not amount to much, as the director is hampered by a reduced vote, and field-work has had to be abandoned. One point, however, of great importance is set forth, and is that Sir A. Geikie is satisfied that Mr. Kilroe has proved that the Croagh Patrick Quartzite and its southern equivalent does not belong to Dalradian, but is of Llandovery age. It is thus necessary to colour a large area as Silurian instead of Metamorphic.

We have already noticed that the Museum of Practical Geology is now open every week-day instead of being closed on Fridays as heretofore.

We learn from the *American Geologist* that Mr. Max Krahmann, editor of the *Zeitschrift für praktische Geologie*, announces that hereafter that journal will be published in Berlin (Charlottenburg, Schillerstrasse 22), and that in connection with it he will establish a "Bureau for Practical Geology," where maps, books, and advice concerning economic geology can be obtained.

The Perthshire Society of Natural Science has lately been devoting itself to the natural history of the banks of the Tay, and the full account of these researches is embodied in a series of papers published in the *Transactions* (vol. ii., part 2). The present series of papers deals with Physiography, by Dr. H. R. Mill and James Coates; Stratigraphical and Physical Geology, by James Coates; Superficial

Deposits, by the Rev. F. Smith; Flowering Plants, by the late Buchanan White; Mollusca, by H. Coates; Birds, by Colonel Drummond Hay; Mammalia, by Buchanan White; and Chemistry of the Tay Water, by Dr. Andrew Thomson. This series of local papers is of considerable value and interest, and we shall be glad to see a second series dealing with the groups not yet investigated

The Perthshire Society's Museum, which is in Tay Street, Perth, contains representative collections of the local fauna, flora, and petrology of Perthshire, as well as an index collection of general natural science. The latter is kept entirely distinct from the former. The new museum building will be opened by Sir William Flower on Friday, November 29, when, if we may judge of the energy of those engaged, everything will be completely arranged.

THE *Transactions* and Annual Report of the Manchester Microscopical Society for 1894 presents us with a portrait of Professor Weiss, the president, whose address on "The Chromosomes of the Nucleus" is printed in full. The Society numbers 217. It suffered a serious loss in the death of Professor Milnes Marshall, its president for seven years. To commemorate his name a subscription list was opened, and £33 pounds collected, of which £20 was sent to the Owens College Committee, and the remainder spent on books for the Society's library. There is a balance in hand of £15 in the treasurer's report. Besides Dr. Weiss's address, there is a paper by Dr. Moss on "The Value of the Radula as an aid to Classification," in which the author shows that the radula alone cannot be of sufficient value for the purpose. There is, also, among other papers, an interesting account of a visit to Cumbrae and those grand old field-naturalists, Mr. and Mrs. David Robertson.

LAST month we briefly noted that Mr. Mansel-Pleydell had been the recipient of a piece of silver plate in consideration of his services to Dorsetshire natural history. We find that the occasion was the more interesting as it marked the twentieth anniversary of the foundation of the Dorset Natural History and Antiquarian Club, which was due in great part to Mr. Mansel-Pleydell's exertions. The plate took the form of a flower vase in delicate allusion to Mr. Mansel-Pleydell's last work, "The Flora of Dorset."

THE accounts of the Norfolk and Norwich Naturalists' Society are before us. They show, in common with those of other similar societies, how much good work can be done with a little money. The new number of the *Transactions* (vol. vi., part 1) is full of interesting papers, notably one on Neolithic Man in Thetford district by W. G. Clarke. Mr. Southwell has some notes on additions to the Norwich Museum in 1894, the principal of which were a variety of *Caprimulgus europæus*, a Scandinavian form of the Dipper (*Cinclus melanogaster*), a Richard's Pipit (*Anthus ricardi*) among local birds; a Rose Perch (*Scorpæna dactyloptera*)from Yarmouth, an addition to the fishes of the East Coast, and two large Breams (*Abramis brama*) from the river Wensum. Mr. F. Danby Palmer has collected some valuable notes on old-time Yarmouth naturalists.

A SUBSCRIPTION list has been opened in Bristol for the purchase of Mr. Nockler's collection of Jenner relics in connection with the introduction of vaccination.

A BRONZE bust of Robert Brown, the botanist, has been presented by Miss Paton to the Montrose Town Council. It has been placed in a niche in the house where Brown was born in 1773.

IN the *Proceedings* of the Birmingham Natural History Society (vol. ix. (2), 1895), Mr. W. Jerome Harrison has published a Bibliography of Midland Glacialogy, including over 150 papers, ranging from 1811–1894, which should be instrumental in stemming the flood of glacial literature.

CORRESPONDENCE.

The Mounting of Wet Preparations for Museums.

In his interesting paper, "Morphology at the National Museum," recently published in your pages, Mr. Ridewood alludes to a difficulty experienced in labelling dissections intended to be preserved in spirit.

Such a difficulty I also encountered when recently mounting some preparations for the Index Collection of Invertebrates, now in course of formation at Leicester, and, not feeling satisfied with the methods in vogue, either at the National Museum or at Oxford, I finally adopted the expedient of substituting thin silver wire, coated with vermilion, for the usual paper pointers.

The oil colour should be used (mixed with a little medium to facilitate drying) and applied to the wire while the latter is rigidly extended. In attaching a pointer to its label, one of the extremities is bent at right angles and passed through a perforation in a thin strip of paper which is fastened to the back of the label with coaguline. The bent head of the pointer is thus firmly held between the two pieces of paper, leaving the rest of the wire projecting behind. When labelling, the pointer may either be thrust into the tissue, or, where this cannot be done, the judicious use of a few drops of photoxylin will suffice to hold the label in any desired position.

This method is specially useful when dealing with specimens which project considerably beyond the glass plate to which they are affixed, since the labels can be brought to a level with the surface of the preparation. When the object is a flat one (*e.g.*, the nerve-chain of *Astacus*), I prefer to attach the labels to the glass plate with coaguline. In this case, one extremity of the pointer rests on the tissue, the other is held between the label and the glass.

The advantages of such a pointer seem to me to be twofold; first, its rigidity, and consequent power of supporting the label in any position, and, secondly, its uniform thickness, having in this respect an advantage over paper. I may mention that, when the wire has been properly coated, I have not detected any perceptible change in colour after an immersion of some months. However, should contact with the metal tend in time to produce deterioration in this respect, it would not be difficult, I imagine, to substitute a rigid, non-metallic substance for the wire here recommended.

I note that Mr. Ridewood urges the transparency of paper when immersed in spirit as a reason for attaching the labels to the outside of the preparation jar. I do not myself think that this transparency interferes to any serious extent with the legibility of the print, added to which greater uniformity in appearance is secured, to say nothing of the facilities offered for indicating the various parts of the dissection by *direct contact* with the extremity of the pointer; to my mind a point of no little importance.

Leicester Museum. F. R. Rowley.

NOTICE.

To Contributors.—*All communications to be addressed to the* Editor *of* Natural Science, *at* 22, St. Andrew Street, Holborn Circus, London, E.C. *Correspondence and notes intended for any particular month should be sent in not later than the* 10*th of the preceding month.*

To the Trade.—Natural Science *is published on the* 25*th of each month; all advertisements should be in the Publishers' hands not later than the* 20*th.*

The "Challenger" Number.—*In reply to enquiries, we remind our readers that, although the* First *edition of this ran out of print immediately, there are still some copies of the* Second *edition to be obtained at the usual price*—One Shilling. *No more will now be printed, so orders should be sent at once.*

NATURAL SCIENCE:

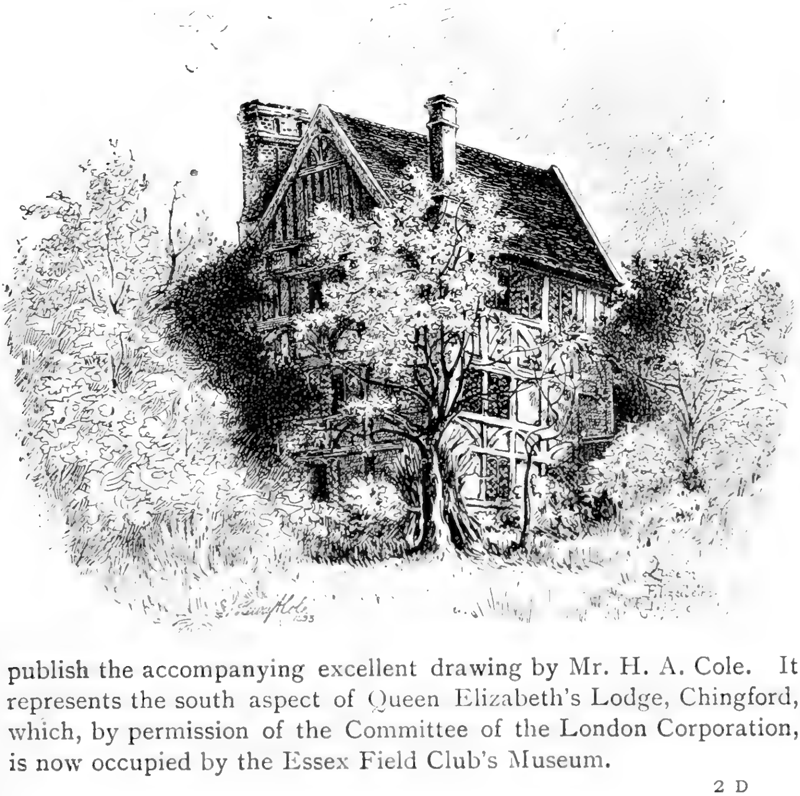
A Monthly Review of Scientific Progress.

No 46. Vol. VII. DECEMBER, 1895.

NOTES AND COMMENTS.

The Museum in Epping Forest.

IN our "News" pages we give an account of the opening of the Epping Forest Local Museum. Through the kindness of Mr. William Cole, Honorary Secretary of the Essex Field Club, we are enabled to



publish the accompanying excellent drawing by Mr. H. A. Cole. It represents the south aspect of Queen Elizabeth's Lodge, Chingford, which, by permission of the Committee of the London Corporation, is now occupied by the Essex Field Club's Museum.

TRUSTEES FOR LOCAL MUSEUMS.

AT the opening of the Epping Forest Local Museum, Sir William Flower raised the important question of the permanence of such institutions. Remembering how many local museums depend for their success on the efforts and enthusiasm of one or two individuals, whose death or removal is synonymous with the decay of the collection, Sir William asked what guarantee the Essex Field Club could afford that valuable donations to its new museum would always be preserved with the same care that would undoubtedly be bestowed upon them by the first Honorary Curator, Mr. Cole. Unless some guarantee of this kind were forthcoming, he thought that many would-be donors, especially those having archæological specimens, would hesitate before handing over their treasures to the care of the Club. He did not venture upon any suggestion, and his responsible position as an officer of the British Museum would, perhaps, hardly permit him to refer to any scheme of affiliation of the various local museums with those directly supported by the State. We think, however, it is high time that some such scheme were seriously considered. A bequest made many years ago to the Bristol Museum was accepted by the Trustees of the British Museum as a reversion, in case at any time the former institution should collapse or fall into destructive neglect; and when the Bristol Corporation lately undertook the control of this museum, it was necessary first to convince the Trustees of the British Museum of the perfection of their arrangements, before the transfer of the property could be effected. It is too much to expect that the already overburdened body of eminent men just mentioned should undertake similar responsibilities throughout the kingdom; but we see no reason why a State Commission should not be appointed to work in conjunction with the Science and Art Department, the Trustees of the British Museum, and those of the National Gallery, to maintain a general oversight over all local collections and bequests entrusted to their care. The Commission might be constituted much on the same lines as that dealing with the preservation of ancient monuments. As in the case of the latter, the recognition of the Trusteeship of the State Commission should be an entirely voluntary matter; but donors would soon begin to favour those museums where such a guarantee for the safe custody of their specimens existed.

We could mention many lamentable instances in which a controlling organisation of the kind suggested might operate with advantage to the devotees of natural science. It would be difficult, however, to find a more striking illustration than that afforded by the Moore Collection of Fossils at Bath. No geologist can visit the Bath Literary and Philosophical Institution without feeling deep and just indignation. The specimens are nominally under the care of an accomplished honorary curator of wide experience, universally respected by his fellow geologists; practically, his advice is set aside by a preponderance of conflicting interests, and the result is a disgrace to any body of educated men at the end of the nineteenth century. Beautiful slabs of rock with delicate projecting skeletons of reptiles are left to the tender mercies of the audiences who crowd into the *quondam* museum, attending lectures and entertainments. Ugly pieces of wood are nailed across the frames, and occasional pieces of coarse netting testify to at least some qualms of conscience on the part of the Bath Committee. If these precious specimens are to be kept apart from the remainder of the collection and to decorate a lecture hall, they ought to be covered by secure glass cases, which would preserve them from accident and mischievous fingers. Better still if the subscribers who purchased the Moore Collection for the native town of the geologist who amassed it, had the opportunity of making some competent State Commission its permanent trustee, and rescuing it from the vagaries of a mixed local committee.

Local Museums and Educational Bodies.

But if men of eminence cannot easily be found to serve as trustees for local museums, or if the local authorities are unwilling to place themselves beneath the official thumb, yet there is another way out of the difficulty, and one which has occasionally been advocated in our own pages. We are reminded of it, not only by the speech of Sir William Flower, but by some notes on the subject which appeared in the *Leeds Mercury* for October 20, and which endorse the suggestions that we have previously put forward. The kernel of the scheme is closer co-operation between the local museums and the local educational bodies. Many of our great public schools have started museums for natural history, or other purposes, and the services which such museums render to education will hardly be denied by anyone who has read the accounts which have from time to time been published in this Journal. But if museums and other collections are of use to the schools, similarly the schools may be made of use to the museums. Certainly such institutions as Eton and Winchester, or as the numerous Grammar schools scattered about our country, are not by any means so liable to extinction, or even to change, as are the committees or individuals that often have the control of local museums. Consequently, in the words of the *Leeds Mercury*:

"In towns where there exist a local museum and a local Grammar school, it is proposed that the latter should 'take over' the former, have the contents thoroughly overhauled, weeded-out, properly classified, and accurately and succinctly labelled, and 'housed' in a special building in close proximity to the school. By this means such museums would be made to serve a good educational purpose, and—as in the United States in particular—there should be no difficulty in arrangements being made for the preservation of their 'popular' element by the museum being thrown open to the public on certain days of the week. It is suggested, also, that whatever endowment funds these institutions may be possessed of should be appropriated at the same time, and their management placed in the hands of Governors, who would be, as a matter of course, gentlemen of education, who would take care that the museum was not made the dumping-heap for all sorts of bequests, the indiscriminate acceptance of which makes scientific classification impossible. Certainly, there is a great field for improvement, and the direction of reform suggested has some good, practical features about it."

Dr. Hertwig on the Cell.

When the original edition of Oscar Hertwig's treatise on the cell appeared, we reviewed it at considerable length (Natural Science, ii., p. 225). It is unnecessary to devote part of our columns on new books to praise the excellent translation of the work, edited by Dr. H. J. Campbell, and recently issued by Messrs. Swan Sonnenschein (London, 1895, price 12s.). At the present time, when the cell-theory is a topic of the day, this careful and accurate translation of a work by, perhaps, the leading exponent of the theory is unusually welcome. As Hertwig points out, a whole series of conceptions clusters round the term "cell," and although in many respects "the cell-theory is the centre around which the biological research of the present time revolves," it cannot be said that our present conception is final or perfect. Roughly speaking, the chief stages in the series of conceptions are these. Originally, the term cell was applied to the small room-like spaces, provided with firm walls and filled with fluid, to be seen in plants. The wall was the most striking occurrence, and the name arose from this. The continuance of the name, now that the idea is incongruous with it, has led, we think, to an appearance of conflict when no real conflict exists. But we cannot agree with Mr. Bourne's approval of the word "cyte" as a substitute; for the idea "box" retains precisely the error of the word "cell." It is not an enclosed space, but a localised piece of matter that we wish to name. The second term in the series of concepts is due chiefly to Max Schultze; the cell-wall was regarded as an "accident" of the cell. The cell was a small mass of protoplasm endowed with the attributes of life. While this idea ruled, the question arose as to whether or no every cell had a nucleus; improvements in the method of observation, and extension of actual observations, led to the conviction that the nucleus was an essential factor of the cell. This gives us the last definition of the concept; the cell is a little mass of protoplasm, which contains in its interior a specially-formed portion, the nucleus. The problem over which Mr. Sedgwick and others do rage exceedingly, seems to us to be not much more, in essence, than this: round each nucleus there is a mass of protoplasm, in most cases plainly dominated by the nucleus; are the mass of protoplasm and the included nucleus necessarily bound together as an individual, or may the nucleus move through the protoplasm and acquire a new "sphere of influence"?

The Cell in Botany.

The gradual change in the idea "cell" is most plainly written in Botanical History. Botanists retained the conception of the cell-wall, combining with it Max Schultze's protoplasmic idea. In the older text-books the plant unit is a "cell," *i.e.*, a cellulose chamber enclosing protoplasm and cell-sap. An aggregation of such, like bricks in a wall, formed a tissue. The brick-wall metaphor was an unfortunate one. It gave quite a wrong impression of the origin of tissues, for the bricks are separate structures brought together to form the whole, whereas the cells of a tissue have had a common origin. Improvement in microscopic method has shown that, so far from being independent units, cells are in many cases brought into intimate connection with their neighbours by strands of the living protoplasm passing through the separating wall. Further advance will probably demonstrate such a connection between the cells in all actively living tissues.

The present position may be briefly stated as follows. The unit is a mass of protoplasm in which is embedded a nucleus. Such a unit, or "energid," as it has been termed, is the starting point of every plant; in the lowest forms, development goes no further—as, for instance, in the smaller motile form of the tiny green alga which examination syllabi call *Protococcus*. The first step towards a higher development is the protection of the individual by a cell-wall, *i.e.*, by the secretion round itself of a cellulose membrane formed by and from itself. The resting stage of "Protococcus," or the fertilised egg-cell, the oöspore of higher plants, is an example of such a unicellular individual or phase.

Further development may proceed in two ways. The protoplasmic unit (energid) may grow and divide repeatedly without the separation of the resulting daughter units by partition walls. There is thus produced within a common membrane, which undergoes meanwhile a corresponding increase in size, a large number of nuclei embedded in a general mass of protoplasm. This mode has been adopted in whole groups of Algæ and Fungi; examples are the fresh-water *Vaucheria* and a well-known mould, *Mucor*. Such unseptate individuals, which may reach a considerable size and show a surprising amount of morphological differentiation, as in *Caulerpa*, where a horizontal stem bears roots below and leaves above, are termed "Cœnocytes." The structure in these cases may be strengthened by bars of cellulose stretched across from wall to wall.

Plants like the filamentous green fresh-water alga *Cladophora* illustrate incomplete septation. Each segment of the filament includes within its wall, not one, but a number of "energids." In most cases where the individual attains any size and must provide its own support, as in land-plants, the completely septate form has been adopted. Here the protoplasmic units are each separated (though probably *not* isolated) by a cell-wall. Thus in the great majority of plants the cell is a very real and useful conception, and regarded merely as a chambering of the protoplasm necessitated by increase in size, differentiation, and need for support, will lead to no misunderstandings.

It is interesting to note that the cœnocytic condition occurs in certain stages in the life-cycle of completely septate plants. The endosperm, or tissue produced in the embryo-sac, which in the gymnosperms is the sexual individual bearing the female organs, is in its first stages non-septate, and though generally becoming completely septate, may remain incompletely so. A similar free cell-formation characterises the early development of the oöspores of the cycads.

The Reign of the Nucleus.

As in general botany and zoology, so also in special cellular histology, modern attention is being more and more concentrated upon the nucleus. It is unnecessary to do more than glance through the illustrations of scientific journals to see that new discoveries and new theories alike refer to the nucleus. In the case of cell-division, the opinion is growing that the changes begin in the nucleus, and that the apparent changes in the protoplasm are due to forces radiated out from changes in the nucleus. The centrosphere, the spindle, and so forth, more and more are being regarded as the visible results of such action of the nucleus upon the protoplasm as a magnet has upon sprinkled iron filings; although, it must be admitted, there are still many observers who interpret the "centrosome" as a special organ of the "cell," and among these, judging from the "Atlas" to which we allude later, Professor E. B. Wilson must be included. In the matter of fertilisation, almost everyone now agrees that what was regarded as a cellular matter is really a nuclear matter. It is the nucleus of the spermatozoon that unites with the nucleus of the egg: and apparently the protoplasm of the body of either the male or female cell is indifferent to the result. As we know, in theoretical questions very great importance formerly given to cells is now transferred to nuclei. Weismann originally spoke of germ-cells: now he speaks of germ-plasma, meaning by that nuclear matter. The continuity of the germ-plasm now for him means, not the existence of a chain of cell-division, of which the successive generations are pendants, but the continuity of nuclear material. Instead of the early separation from the fertilised egg of germinal cells, he speaks of germ-tracks, along which the undisintegrated germ-plasm is handed. In Hertwig's criticism of Weismann, where the question of "heirs-equal" or "heirs-unequal" (Natural Science, vol. v., pp. 132, 184) division occurs, the argument turns upon the nucleus, although the cell, rather than the nucleus, is spoken of.

Adam Sedgwick on the Inadequacy of the Cell-Theory.

So long ago as 1883, when the cell-theory was supreme, Mr. Adam Sedgwick criticised it, and at repeated intervals he has returned to the attack. He took the view that embryonic development was not the formation of cells from a single cell accompanied by co-ordination and modification of these separate units into a harmonious whole. He held that the whole was always co-ordinate and continuous, and that the process of development was "a multiplication of nuclei and a specialisation of tracts and vacuoles in a continuous mass of vacuolated protoplasm." In 1888, in his monograph on the development of *Peripatus*, he insisted that the development did not proceed by the formation of cells. Nuclei multiplied: special tracts were plotted off, and as development proceeded separate cells were marked off. In the *Quarterly Journal of Microscopical Science* (Nov., 1894), he draws conclusions of the same nature from his observation of elasmobranch embryos. The so-called mesenchyme tissue in them is always drawn and usually thought of as a system of branched cells lying between the inner and outer layers, and connected with these only at the points where the mesenchyme is supposed to take origin from the outer layer. Mr. Sedgwick assures us that this is not the case: that the whole young elasmobranch is a continuous mass of pale tissue; on the surfaces the nuclei are arranged in layers, and give an appearance to those on the look-out for epithelia of being distinct epithelia: that the mesenchyme is a net-work of the same fundamental protoplasm, continuous in itself and with the ectoderm and endoderm, and having nuclei at the nodes. Similarly, he asserts that nerves neither grow out as cell-processes from the neural crest to the periphery nor inwards from the periphery. The rival theories are both wrong. It is more correct to say that nerves are simply parts of the continuous ground-substance, which become specialised by the intrusion of nuclei. As it happens, save in the case of the third nerve, the specialisation and entrance of nuclei appear from the centre towards the periphery, from the neural crest outwards. The nerves themselves are developments of the mesoblastic reticulum.

The Nucleus and "its Sphere of Influence."

Mr. Sedgwick, no doubt purposely, couches his attack in strong words, but as our arguments in the preceding paragraphs show, we are not certain that he is a solitary prophet speaking to an unheeding generation. We agree with him thoroughly that many mistakes have been made by the persistence of the original idea that cells have walls, and that embryologists frequently represent areas around nuclei by lines, where these are not clearly marked off, and that they speak and think of the proliferation of cells, when they mean only the proliferation of nuclei. But while the habit has lingered on in drawing, and in many cases in language, in theory and in real interpretation of the facts, it is nuclei and not cells that seem to most of chief importance. The idea of the continuity of the protoplasm is thoroughly well-established, for plants and for animals, young and old. On the other hand, the idea of units multiplying by division, which used to be attached to the cell, daily receives greater justification as applied to the nucleus. Each nucleus has a sphere of influence, most obvious in the activities of division, but frequently expressed by the formation of cell-walls at the limits of the sphere, or after the shrinking caused by reagents, in lines which may not correspond to definite structures. No doubt, when Mr. Sedgwick's more detailed conceptions are published, it will be plainer whether or no he is inclined to abandon this theory of units, even in its transference to the nucleus. But it seems evident to us that recent work generally, and especially experimental work, supports him in attaching little importance to the frequent division of protoplasm into areas round nuclei, but increasing importance to the presence in so-called multi-cellular organisms of localised foci which multiply by division.

Mr. G. C. Bourne on the Cell-Theory.

Those who have been considering Mr. Sedgwick's arguments will naturally turn to Mr. G. C. Bourne's "Criticism on the Cell-Theory" in the *Quarterly Journal of Microscopical Science* (August, 1895). We cannot agree, however, that Mr. Bourne's learned and ingenious essay is much more than dialectic. We differ at the outset from his view that Mr. Sedgwick is vague or that "the phenomena to which he draws our attention have received their due meed of recognition from the time that the cellular structure of tissues was first studied." As we have already shown, we think that Mr. Sedgwick has exaggerated the results of the devotion given by zoologists to the cell-theory. On the other hand, it is quite true that in drawings of embryonic and adult tissues, zoologists habitually in the last ten years have represented by sharp lines the boundaries between cells, and so have given to the separation of the protoplasm of cells an importance that is a matter of theory rather than of observation. Recognition of the existence of multinucleate Protozoa, and of organisms like myxomycetes and *Botrydium*, and of the continuity of the protoplasm through cell-walls, is not Mr. Sedgwick's point. The side of embryonic development that has been most prominent in zoological writing and teaching has been the multiplication and marshalling of cells: the side of histology that has been most prominent is the presence of cellular units in tissues. It has been recognised on all hands that the cells in embryonic and adult tissues are distinct from each other in varying degrees; but the fundamental idea has been that cells consisting of protoplasm and nucleus are the unit masses. Against this Mr. Sedgwick urges the totally distinct conception that while nuclei are discrete unit masses multiplying by division, the protoplasm in which these lie is typically a continuous mass increasing by continuous growth. Mr. Bourne lays great stress on recent and beautiful work upon cell-lineage in development. But in most of these cases what has been proved is *nuclear* lineage. Hertwig, experimenting with the frog, showed that nuclei could assume different positions in the general mass of protoplasm under different conditions of development, and we doubt if even the apparent migrations of cells in the development of *Nereis* necessarily imply more than migration of nuclei. In drawing an argument for the cell-theory from the definite places assigned "cells" in development, Bourne seems to us to have overlooked the experiments of Wilson, Driesch, and Hertwig, who have shown that the nuclei may be moved about in the protoplasmic mass almost as freely as "a heap of billiard balls may roll over each other."

E. B. Wilson's Atlas of Fertilisation and Karyokinesis.

As we have been discussiug the cell, we may refer here to a beautiful Atlas of Fertilisation and Karyokinesis of the Ovum, recently published (price $4 = sixteen shillings), by Macmillan & Co.'s American house, for the Columbia University Press. It consists of ten plates, each containing four photo-micrographs of stages in the cell-division and fertilisation of the sea-urchin, *Toxopneustes variegatus*. The letterpress, in addition to descriptions of the plates, contains a full account of the maturation and fertilisation of eggs, illustrated by drawings partly from preparations of *Toxopneustes* and partly from other material. The photographic technique was conducted by Mr. Edward Leaming at the Columbia University College of Physicians and Surgeons, while Professor Wilson prepared the sections and preparations, and focussed the apparatus upon the requisite objects. Every biologist owes the greatest gratitude to the authors and publishers of this beautiful volume: and only those who have laboured themselves to make good photographic plates from specimens exhibiting karyokinesis can appreciate the wonderful delicacy of the results. The eggs were "fixed" with a mixture of concentrated aqueous solution of corrosive sublimate (80 per cent.) and glacial acetic acid (20 per cent.); and they were stained on the slide with Heidenhain's iron-hæmatoxylin.

It is unnecessary to refer at length to details which every histologist will wish to see himself, and which are too technical for those who are not specialists in histology. Among points of more general interest, we may mention that Professor Wilson accepts the view that a definite number of chromosomes are present in the nucleus of each species. When an egg is preparing to throw off polar bodies, a large part of the chromatin disappears into the "linin" or nucleo-plasm, while the remainder appears in half the number of chromosomes normal in the cells of the tissue. Each of these chromosomes is arranged as a tetrad, and when the first polar body is given off each tetrad divides into an extruded and a retained dyad. For the second polar body, each of the retained dyads divides, and three chromosomes are extruded, three retained, each being a quarter of the original tetrad. It is clear that the distinction between reducing divisions and ordinary divisions suggested by Professor Weismann cannot be applied to the formation of the polar bodies as interpreted by Professor Wilson. Another interesting general point, very plainly illustrated in these photo-micrographs, refers to the early stages in polyspermy. In *Toxopneustes* two spermatozoa may enter the egg simultaneously. An aster is formed around each, and they move equally towards the nucleus of the egg-cell. When they reach it, each aster divides, and there is formed a "quadrille" figure, consisting of the egg-nucleus found with the two sperm-nuclei, and surrounded by four asters at equal distances. The joint nucleus then divides, so that four daughter-nuclei are formed. Professor Wilson thinks, and his figures bear him out, that when Fol originally described the "quadrille" figure, he was dealing with an abnormal occurrence of this kind.

Fossil Cells.

It is plain that, though the hard cell-walls of extinct plants may leave evidence behind them, as indeed they do in abundance, it is very unlikely that there should be fossil evidence of animal cells. However, in some cases, it happens that such evidence does exist, and as it may not be known to many of our readers, we give it. The earliest known remains of the skeleton of chordate animals, which may have been either fishes or something lower, are fragments of dermal armour from the Silurian Formation. Their microscopical structure is often beautifully preserved, and can be examined almost as readily as the tissue of an existing animal. The simplest of these fossils are thus proved to be mere granules of "shagreen," each formed round a little papilla and nourished by radiating, branching capillary tubules. The soft papilla is never fossilised, always replaced by rocky matrix; but, judging by analogy with modern sharks, it must have been furnished with the little formative cells termed "odontoblasts." Sometimes these tubercles are fused together into continuous plates; and among Devonian fossils instances are already common in which a great basal layer of hard tissue is developed, leaving the original tubercles as a simple pustulate ornament on the exterior. The secondary basal layer is often provided with little spaces, which must have been occupied by cells similar to those of modern bone; but in very many—perhaps in the majority of cases—the tissue consists of parallel or concentric layers conforming with the outer surface, and not traversed by any passages analogous to the haversian canals of true bone. Such skeletal tissue is named "isopedin." Typical bone, however, is also found in some dermal armour even of Devonian age.

Another form of dermal skeleton of the Upper Silurian and

Devonian periods, but apparently never represented later, is that of the singular group of Pteraspidians (*see* NATURAL SCIENCE, October, 1892). The greater part of the thickness of the plates of these organisms is formed by delicate structureless lamellæ or laminæ, concentric with the exposed faces, exhibiting no minute cavities for protoplasm-cells, but surrounding and enclosing great vascular spaces. The outer layer alone consists of ridges, through which delicate capillary canals radiate from a central soft tissue of which no trace is fossilised.

RECONSTRUCTIONS FROM SERIES OF SECTIONS.

AN elaborate and technical paper by Mr. H. B. Pollard (published in the eighth volume of Spengel's *Zoologische Jahrbücher*) contains the results of work based upon a method little practised or, indeed, known in England, though long since described in NATURAL SCIENCE.[1] Mr. Pollard has been investigating the anatomy and development of the head in siluroids and other fishes, for some years, and he has now perfected, at the Owens College, the method of Born which he learned in Germany. When a complex structure like the head of a young fish has to be investigated by means of series of sections, it is, as everyone knows who has worked with continuous series, very difficult to construct from the consecutive drawings a solid image in the mind. Mr. Pollard built up models in the following way: The heads of the young fish were decalcified, and double-stained with alum carmine and bleu de lyon. They were then cut in a series, each section being of known thickness. Next, drawings of the sections were made with a camera, and the drawings were transferred to plates of wax. The thickness of each plate was carefully made the same multiple of the thickness of the section that the camera drawing was of the area of the section. The plates of wax were then cut out following the drawing, so that a series of wax representations of the series of sections was obtained. These were too large and too brittle to be handled conveniently, and the special improvement of Mr. Pollard upon Born's method was that he electroplated his wax slices. The plated slices were then fixed together in their order, and the resulting model was, within slight limits of error, a faithful copy of the original head. In his paper Mr. Pollard gives a number of drawings from the models.

THE HEART IN BIRDS AND REPTILES.

IN a recent number of the *Proceedings of the Zoological Society* (part iii., 1895), Messrs. F. E. Beddard and Chalmers Mitchell describe the heart of the alligator, giving a number of useful figures. They refer at some length to the interesting morphological question of the homology of the valve in the right ventricle of the bird's heart.

[1] Vol. iii., p. 340, in "Natural Science at the Chicago Exhibition."

Since Professor Lankester's memoir on the subject, it has been accepted generally that the entire avian valve corresponds to one-half only of the complete valve of the crocodile and of the mammal. The valve is attached by a muscular bridge to the wall of the heart, and this point of attachment divides it into a long fleshy flap on the right side, and a membranous, shorter flap on the septal side. Messrs. Beddard and Chalmers Mitchell regard the septal flap as a valve corresponding to the septal valve of the alligator: its anatomical relations are identical with those of the alligator's septal valve, and in several birds they have found a considerable portion of muscle present in it.

The Anatomy of Chauna.

To the same number of the *Proceedings* Mr. Chalmers Mitchell contributes a detailed paper on the anatomy of the Crested Screamer. It is, no doubt, becoming more and more certain that the value of investigations in vertebrate anatomy is comparatively small until a large number of individuals in each species has been examined; but in the meantime a detailed examination of a comparatively rare and isolated form like a screamer has a considerable value. Of the three species of screamers known, Garrod has written an account of the anatomy of *Palamedea;* Beddard and Mitchell of that of *Chauna derbiana*, and Mr. Mitchell now compares *C. chavaria* with the others. To anatomists in general, the most interesting part of his paper will be the comparison he makes between the alimentary canals in the ostrich, in the crested screamer, and in the Anatidæ. In all three, the dispositions of the intestine are comparatively simple, and are not much modified from a primitive straight gut, but of the three the screamer is least modified. Dr. Gadow has already made a memorable contribution to knowledge of the alimentary canal in his series of papers upon the taxonomic value of the intestinal convolutions, but it is evident that the subject is yet far from exhaustion.

An Autograph Portrait of Huxley.

Mr. Thomas Whitelegge, of the Australian Museum, Sydney, has been so kind as to write to us as follows: "I read with great interest the account in your August number of the late Professor T. H. Huxley; the portrait was especially interesting. I send you a copy of a sketch drawn by himself when in Sydney in 1848, which I think you will admit is a capital likeness if compared with the one you publish. . . . The original sketch is on the fly-leaf of a book, 'The Pilgrims of the Rhine' (Lytton), and is now in the possession of Mrs. Deane, of 'Waimea,' Woollahra, Sydney." From a note on this drawing contributed by Mr. Charles Hedley to the Australasian edition of the *Review of Reviews*, we extract the following remarks: "Before he became a celebrity, the late Professor Huxley visited Australia in the capacity of surgeon to H.M.S. 'Rattlesnake.' Not only did this cruise exercise its influence upon his intellectual life, but as he met his future wife in the person of a Sydney lady it was also eventful in his domestic history. . . . Upon her birthday Huxley presented the little daughter of a friend with a volume of Lytton's poems, and sketched upon the title-page a drawing of himself.

Dressed in the shoes, knee-breeches, and frock coat of the period, he seems to be bowing his departure. In his extended right hand a watch is held, to show that time will not permit him to linger another minute. By those who knew him in later years the face is said to be a capital likeness."

We may take this opportunity of quoting the following lines which form the epitaph on Huxley's tombstone:

> "And if there be no meeting past the grave,
> If all is darkness, silence, yet 'tis rest.
> Be not afraid, ye waiting hearts that weep
> For God 'still giveth His beloved sleep.'
> And if an endless sleep He wills, so best"

These touching words were written by Mrs. Huxley, and, according to the *British Medical Journal,* were used at Huxley's own request.

The *Athenæum* informs us that a difference has arisen among the members of the Huxley Memorial Committee as to whether the memorial should take the form of a statue or of a scholarship. Our esteemed contemporary votes in favour of the statue, remarking that there are scholarships enough already. We do not wish to disagree with so respected a journal, but in favour of the scholarship we, in our turn, might say, "There are statues enough already."

STIPULES.

AN addition to the literature of stipules—the well-known basal appendages of the leaf-stalk—will be found in the last number of the Linnean Society's *Journal* (vol. xxx., pp. 463–532), where Sir John Lubbock describes the form and discusses the function of these structures in a large number of plants. Young leaves, still enclosed in the bud, are extremely susceptible to cold and drought, and also afford tempting food to insects and other animals. It is, therefore, not surprising to find that the most general purpose served by the stipules is bud-protection. In many cases they fall after the unfolding of the leaf—as in the lime—where the pinky-white scales litter the ground beneath the tree. Often they are persistent, and supply one of the most constant characteristics of a whole family, as in the Rubiaceæ, in the British representatives of which it is difficult to distinguish stipules and leaves. Sir John has a few interesting cases in this connection. In a species of pepper (*Piper longum*) the pair of stipules of the youngest unfolded leaf covers the terminal bud with a sort of nightcap, the stalk of the same leaf appearing continuous with the main axis. A similar arrangement occurs in the magnolias. In *Alstonia scholaris*, belonging to the Apocynaceæ, the leaves form a whorl at the tip of each season's growth, while a triangular outgrowth or ligule from the base of the upper surface of each converges towards one centre, thus covering all but the extreme apex of the terminal bud. This ligule is doubtless a stipular structure. In *Buddleia* (Loganiaceæ), on the contrary, the deeply-channelled petioles with their dilated base protect the axillary buds so well that stipules are dispensed with in the early stages of the leaves, and develop only as these gradually attain their full size. An exstipulate rose is an anomaly: such, however, is *Rosa simplicifolia*, where the petiole has only a thin margin continuous with the blade and dilated at the base to protect the bud in its axil. It is stated, on the authority of Dr. Masters, that the vascular bundle intended for the stipules still exists, "indicating that they existed formerly."

In *Nymphæa tuberosa*, an ally of our water-lily, the stipules are 2–3½ centimetres long, and with the decaying remains of old leaves form a covering to the dense, compact, submerged, winter bud, protecting the tender young leaves "from fishes and other aquatic animals that feed on vegetation."

Stipules of two or more kinds are sometimes found in the same plant. In *Catha edulis* (Celastrineæ), besides the true, narrow-pointed, ciliate, erect stipules, there is a second set consisting of "coarse fringes or cilia, not unlike the 'Tamenta of ferns," in front of the petioles and true stipules. When the latter fall, the plant appears to possess only these fringes. In a member of an allied family—*Paliurus australis* (Rhamnaceæ)—they are again dimorphic, but here spiny in both cases, serving two purposes. On the strong, upright, young stems they are largest and longest, being slightly decurved, and nearly equal in size. On the slenderer lateral shoots they are very unequal and dissimilar. Those on the upper side of the branches are longer, long-pointed, and straight, and arranged in two ranks, one to the right, the other to the left of the shoot. On the lower face, they are short and decurved, or hooked. It is suggested that, while the straight ones serve to protect the plant from browsing animals, the hooked ones will, in addition, help it to climb or scramble among the bushes or shrubs. The enlargement of some of the stipules in certain acacias to form great horn-like structures, which are generally hollow with a small opening, and, in America at least, usually tenanted by colonies of stinging ants, is an interesting and often-cited case in myrmecophily. Similarly, the greatly enlarged leaf-sheath turned up at the edges, in some species of *Smilax*, forms a pocket, in which, as Burck has already pointed out, ants come to live. Burck, however, believes this development to be quite independent of the necessity for bud-protection, and merely the result of the benefit accruing to the plant from the presence of the ants. The base of the petiole in *Korthalsia*, a rattan palm, is developed into a large hollow ocrea (or sheath) which ants use as a home. In this case, at any rate, it is impossible to conceive of any benefit resulting to the plant.

Apart from certain cases of biological importance akin to those cited above, Sir John's paper is useful in pointing out the existence of stipules in exceptional cases, or in genera and species in which they have hitherto been undescribed.

African Orchids.

If the plants brought home by Mr. Scott Elliot from his recent trip to Central Africa and Mt. Ruwenzori prove as interesting throughout as the orchids and asclepiads have done, he is much to be congratulated on the results of his expedition. The October number of the *Journal of Botany* contains the conclusion of an account of the orchids by Mr. Rendle and the first part of a description of the asclepiads by Mr. R. Schlechter. Among other novelties in the latter family we notice a new genus, while of the orchids a large percentage have been hitherto unknown to botanists. Most of these belong to typical tropical African genera like *Lissochilus*, *Eulophia*, *Angræcum*, *Polystachya*, *Habenaria* and the like, but in one case Mr. Elliot's plant gives a widely extended area to its genus. *Epipactis* (helleborine) is a name well known to British botanists, and by the discovery of a new species (*E. africana*) at 8,000 to 10,000 feet on Mt. Ruwenzori, the genus hitherto known only from the north of the continent has its range extended into the heart of tropical Africa. The new species closely resembles our native *Epipactis latifolia* in its stem and leaves, but has larger flowers.

North American Deltoid Moths.

Dr. J. B. Smith has just issued (*U. S. Nat. Museum Bulletin*, 48) another of his valuable memoirs on the moth-fauna of Boreal North America, containing the group of noctuids generally known as Deltoidea—the snout-moths and their allies. The work comprises a discussion of the limits of the section, with special reference to structural characters, followed by tables, and descriptions of the genera and species, including a full synonymy. There are nine photographic plates to illustrate the species described; in the majority of figures the characters are clearly brought out by the process employed. We also notice with pleasure the five plates which show the structural characters of the various genera. Among the deltoid moths, the males are often provided with complex and mysterious sense-organs on the feelers and legs. That attention is drawn to such structures, as is done by Dr. Smith's figures, is a welcome contrast to the neglect of everything but the wing-patterns, which too often characterises the work of systematic writers on the Lepidoptera.

Dispersal of Marine Animals by Seaweeds.

Mr. Rupert Vallentin (*Annals and Magazine of Natural History*, Nov., 1895), gives the results of many interesting observations he has made upon the dispersal of marine animals. His attention was attracted to the subject by finding, three miles south of Falmouth Harbour, a mass of *Fucus serratus* floating in the ebbing tide. To its base was attached a large stone, and numerous hydroids and bryozoans were carried as passengers. Many of the common seaweeds float for considerable periods, *Fucus nodosus*, for instance, for eleven and a half weeks, and, therefore, with favourable winds and surface currents, seaweeds and the animals upon them could travel enormous distances. He has found *Cardium edule* and the common mussel attached to floating weeds, as well as masses of the ova of *Aplysia*, while many annelids and hydroids are quite common. It is clear, then, that, in addition to dispersal by free-swimming larvæ, a number of littoral and bottom-forms may spread by this passive agency; as the large weeds of the Laminarian zone are frequently uprooted during storms. We have always thought that the delicate, short-lived pelagic stages of many annelids and molluscs were given too great an importance from the point of view of dispersal, and Mr. Vallentin's observations help to explain many difficult cases.

I.

Ocean Deposits, Ancient and Modern.

II.—The Mollusca.

OF the various forms of animal life abounding off our shores, the most wide-spread, as also the most important, are the Mollusca; and their general distribution having been well determined, it is possible to compare their extension in our day with their extension in the older stratified deposits. Returning, therefore, to the type more specially selected for comparative purposes in this discussion, viz., the Upper Cretaceous period, several questions at once present themselves for solution, and may now be taken in order.

1. Was the molluscan fauna of that period, in its main features, similar to that existing at the present day?

Although, owing to the lapse of time since the Chalk was deposited, specific resemblance may be impossible, yet should generic identity and more especially a marked similarity in the grouping of the forms be admitted, then such facts must become of the greatest interest. To determine what the prevalent fauna of the period was, it is necessary to seek areas which are generally allowed to have been free from the influences which led to the formation of the true Chalk deposits. Such areas are situated in southern and south-western Germany, comprising the Cretaceous deposits of Bohemia, Saxony, the Hartz, and Westphalia. Here existed a molluscan fauna resembling in all its main features that fauna of the present day which occurs in decidedly subtropical regions.

Although most of our leading text-books represent the appearance of many Gastropoda—especially of such carnivorous forms as *Voluta* and *Fasciolaria*, in the Maestricht Chalk and Faxe Limestones—as novel and startling, and peculiarly foreshadowing the advent of the Tertiary period, yet these genera seem to have existed throughout all Upper Cretaceous time, on the borders of the South German continental area. *Voluta*, *Conus*, *Strombus*, *Turritella*, *Trochus*, and *Fusus*, as also *Cerithium*, *Natica*, and *Buccinum*, are by no means uncommon in the strata of Bohemia and Saxony, and had a very wide extension during the period which corresponds to that of our Upper Chalk. Nor are these the only localities where such an assemblage has been met with. In New Jersey, Clark and Williams have shown the presence of no less than 282 species of Mollusca, of which 45 per cent. are Gastropoda. Also in the Blackdown Hills, at the base of our own Upper Cretaceous series, univalves play a most important part, but with marked changes of genera, forcing upon us the conclusion that even before the Cretaceous period minor faunal provinces were clearly marked out. Of the forms here present, *Turbo* is prominent, *Solarium*, *Natica*, and *Littorina* are important, while *Voluta*, *Conus*, *Strombus*, *Mitra*, and *Phorus* are entirely absent. We are thus led to the suggestion that the conditions in our own region were probably of a more temperate character than were those which prevailed further to the south on the Austro-Saxon frontier. The answer to our first question appears to be that the principal genera of univalve Mollusca in Cretaceous times were identical with those of the present day. The variations observed in their distribution are probably due to the difference of temperature and surrounding conditions, while their specific richness indicates that theirs was no new appearance, but a direct continuity, obeying laws which research and comparison may lead us to determine more fully in the future.

Exclusive of molluscan genera now extinct, such as *Inoceramus* and *Gervillia*, I have been able to obtain the record from Germany and England of thirty-three genera of Gastropoda embracing no less than 171 species; and of bivalves (Pelecypoda) forty-eight genera with close upon 300 species.

For the extension of the Mollusca in the German Cretaceous, one may refer to Geinitz, "Quadersandsteingebirge in Deutschland" (1849–50), and F. A. Roemer, "Die Versteinerungen des Norddeutschen Kreidegebirges" (1840), in both of which are to be found useful tables indicating clearly the genera, the number of species, and their general distribution in the Upper Cretaceous strata of Germany.

2. In natural sequence to the above we are now led to inquire whether at the present day any particular distribution is to be observed in the Gastropoda on the one hand, and the Pelecypoda (Lamellibranchia) on the other, more especially in connection with their bathymetric extension.

The records of the "Challenger" Expedition reveal the fact that the Gastropoda rapidly diminish both in number and specific richness as greater depths are approached, only comparatively few of their genera having been met with beyond a limit of 500 fathoms. Thus, of the genera known as occurring in the Upper Cretaceous, twelve only have been found at depths exceeding 300 fathoms. Five only appear to be of a decidedly ubiquitous character, viz., *Trochus*, *Actæon*, *Pleurotoma*, the Scaphopod *Dentalium*, and more rarely *Natica*. At a depth of over a thousand fathoms *Fusus*, *Scalaria*, *Eulima*, *Murex*, and *Aporrhais* have each been once met with, these same genera, together with *Solarium* and *Turbo*, being more abundant between 300 and 1,000 fathoms.

An examination of the records of the Lamellibranchiate genera known from the Upper Cretaceous, and still existing, shows that but few extend beyond the 1,000-fathom line, yet at these considerable depths *Arca* has been found 7 times, *Lima* 4, *Lyonsia* 3, *Leda* 2, *Nucula* 2, *Pecten* 2, *Pectunculus* 1, *Venus* 1, *Teredo* 1, and *Modiola* 1. At a range not exceeding 600, but deeper than 300 fathoms, *Anomia*, *Lucina*, *Tellina*, and *Cardium* have also been obtained. The fine-shelled forms, such as *Neæra* and *Callocardia*, are decidedly deep-sea in their characters; but should they have existed during Cretaceous time, it is more than probable that, owing to the delicacy of their tests, they would not have been preserved.

3. What is the character of the distribution of the Mollusca in Cretaceous times, and is there any general resemblance to the sequences above noted?

We have in Germany two regions serving as a basis for comparison with modern conditions: the shore-line of the South German Continent on the one hand, and on the other the Rügen Chalk, which must have occupied a fairly central position in the Chalk Ocean. Taking for the purpose of analysis those strata of the first area which correspond in age to our Upper Chalk, we find the Gastropoda represented by ninety-six species, the principal genera having the following specific development: 13 species of *Fusus*, 12 of *Trochus*, 11 of *Rostellaria*, 8 of *Turritella*, 7 of *Cerithium*, 6 of *Voluta*, 6 of *Dentalium*, 4 of *Acmæa*, and 4 of *Strombus*. Similarly, the Pelecypoda are represented by 186 species, distributed as follows among the predominant genera: *Pecten* 30, *Arca* 16, *Lima* and *Venus* each 13, *Inoceramus* 12, *Nucula* 10, *Avicula* and *Cardium* each 8, *Mytilus* 7, *Corbula* and *Pholadomya* each 6, *Cardita* and *Pectunculus* each 5 species.

In favour of the idea that the Chalk of Rügen was deposited in far deeper seas than the above, there is the following evidence: in it are found only 2 genera of Gastropoda, viz., *Trochus* 1 species, and *Nerita* 1 species; 2 species of Dimyaria, both *Arca*; 19 species of Monomyaria distributed between the ubiquitous genera *Inoceramus*, *Pecten*, and *Lima*; also 1 species of *Gervillia*, which, commencing in the lowest beds of the Upper Cretaceous and continuing to the highest, has not only a wide range in time, but also an extended one in area, occurring, as it does, in Bohemia, Saxony, Schleswig, the Hartz, and Aix-la-Chapelle. It is surely significant that every one of the comparable genera found at Rügen is of a type known to exist in modern seas at a depth of over 1,000 fathoms, and that all the littoral forms so abundant on the shore-line of the South German continent should have absolutely and entirely disappeared.

Again, from a geographical point of view, some marked distinctions are to be observed. Leaving the Aix-la-Chapelle deposits out of account, we find that of twenty-four Gastropod genera a gradual variation takes place; 18 occur in Bohemia, 13 in Westphalia, 10 in Schleswig, and 6 in the Hartz. On the other hand, the Dimyaria take almost an exactly opposite course, there being 21 in the Hartz, 20 in Schleswig, 16 in Bohemia, and 10 in Westphalia. Combining, therefore, this evidence with the changes in the lithological character of the Upper Cretaceous rocks, viz., the more sandy condition of the strata in Bohemia and Saxony, and their more calcareous character in Schleswig and Rügen; and taking into account the far greater richness of the echinoderm fauna in the northern provinces of Germany, it should be conceded that the Mollusca displayed a definite arrangement and grouping in Cretaceous times, the Gastropoda being richer in species nearer shore, the Dimyaria becoming more abundant in depths beyond the littoral boundaries, while in the deep sea Monomyaria were decisively predominant.

We are consequently led to the conclusion that in Upper Cretaceous times the continental shore-lines and oceanic areas had a molluscan fauna subject to laws of distribution like those of the present day; and that the Gastropoda, Scaphopoda, and Pelecypoda occurring in the white chalk of northern Germany belong to genera which at the present day range in depth up to or over a thousand fathoms.

The preceding discussion has chiefly dealt with beds occurring in Germany, all deposited at the same period, but under dissimilar conditions. Let us now turn to England and trace the change in the molluscan fauna, not in space, but in time, and mark the variation displayed during the changing conditions at the close of the Cretaceous period.

Evidence is by no means wanting of the existence of a very rich molluscan fauna at the beginning of the Upper Cretaceous period, and this has already been referred to in the mention of the Blackdown deposits. For the sake of comparison with the German data, a list, based on a personal study of our national collections, may be given. Gastropoda, 25 species: the principal genera are *Turbo* 4, *Natica*, *Littorina*, *Aporrhais*, and *Fusus* 3 each, *Turritella* and *Rostellaria* 2 each, other genera being *Murex* and *Dentalium*. Pelecypoda, 64 species: the principal genera are *Trigonia* 12, *Cytherea* 7, *Nucula*, *Astarte*, and *Exogyra* 4 each, *Cyprina*, *Cardium*, *Cucullæa*, and *Mytilus* 3 each. For the same period in Germany the principal types were: Gastropoda; *Trochus* 10, *Rostellaria* 6, *Turritella* and *Pleurotomaria* 3 each, but the tropical forms, *Voluta*, *Conus*, and *Strombus*, were already sparsely represented: Pelecypoda; *Pecten* 18, *Lima*, *Arca*, and *Mytilus* 8 each, *Inoceramus* 5, *Gastrochæna*, *Cardium*, *Cyprina*, *Nucula*, and *Avicula* 3 each. It appears to follow from these data that the minor life-provinces of the Mollusca were already well marked out; the result of subsequent changes was on the one hand, to accentuate the tropical character and increase the specific richness of the German fauna, and on the other to reduce the molluscan variety in the English area.

In the higher strata of the Upper Greensand of England the change becomes well marked. *Pleurotomaria* now takes the lead among the Gastropoda with three species, *Aporrhais* having two only, and the remainder but one each, a remarkable reduction when compared with Blackdown conditions. The area from which these data have been taken is in no sense restricted in its character, embracing, as it does, the Upper Greensand of Warminster, Devizes, Cambridge, and the Isle of Wight. This conclusion is confirmed by various memoirs of the Geological Survey, and Westlake's analysis of Barrois' results, which take into account the Norwich district and the whole of the London Basin. Among Pelecypoda, the foreshadowing of the predominance of Monomyaria is already marked. In the Isle of Wight, *Ostrea* is represented by 10, *Pecten* by 3 species, whereas *Trigonia* has only 5; *Lima*, *Plicatula*, and *Spondylus*, with 3 species each, have as principal Dimyarian competitors *Panopæa* and *Cucullæa*, also with 3 species each. At Devizes the same facts hold good, *Pecten*, *Lima*, and *Inoceramus* having each three species, *Modiola* alone among Dimyaria being represented by an equal number. On reaching the Chalk Marl the distribution becomes exceedingly simple in its character, and in only one county, viz., Sussex, more especially at Hamsey, near Lewes, has any important combination of genera been met with. This combination, however, is one of the highest interest, and is, in fact, startling in its nature, for at this spot, and nowhere else, we find suddenly revealed groupings of *Trochus*, our only *Voluta*, *Buccinum*, *Cerithium*, *Turritella*, *Turbo*, *Solarium*, *Aporrhais*, *Pholadomya*, and *Dentalium*, the last three also having been met with together at Dover or Folkestone. It is most remarkable that so many tropical or subtropical forms should be found at this one spot. Lewes is one of the richest neighbourhoods for Cretaceous fossils, and I have suggested that this and other features may have been due to the presence of a great current at this locality. It is also evident from the nature of the fauna that this current must have been a warm one, possibly flowing from the east, and deflected northwards by land areas in the region of our western counties. With this sole exception the rule I have formulated seems to be constant; the Monomyarian fauna is decidedly predominant, *Lima* and *Ostrea* having 6 species each, *Pecten* 5, and *Janira* 3. Further details can be gathered from the Survey memoirs, Barrois' work, and the collection in the Natural History Museum.

From the *Belemnitella plena* zone (at the base of the Middle Chalk) upwards, the Gastropoda and Dimyaria lose their importance. *Inoceramus*, *Lima*, *Pecten*, *Spondylus*, *Plicatula*, and *Avicula* are, as is well known, the only genera common in the zones of the Middle Chalk, and by no means rare in those of the Upper Chalk. Other finds should be considered casual, in no way invalidating the conclusion as to the deep-sea nature of the deposit. A large specimen of *Pleurotomaria* seen by me at Lewes, which had been obtained from the *Marsupites* zone, and the *Pinna* from the Upper Chalk at Bromley, created in my own mind for some time a real difficulty, which was, however, removed after reading the "Challenger" Report on the Lamellibranchiata (vol. xiii., p. 5), in which Mr. E. A. Smith, referring to deep-sea forms, says: "We might multiply examples of the different ranges in depth at which various species have been obtained by the 'Challenger' and other expeditions, but those which have been cited are sufficient to show that the same species is equally well adapted for living in deep or shallow water, and, as far as our observations have reached, the shells appear to be very little affected by the difference of the depth or the nature of the bottom." This opinion was all the more gratifying as it fully confirmed the conclusions I had based on my own studies of the Cretaceous faunal distribution.

Attention must now be drawn to two exceptions to the rule here laid down, which demand more extended consideration. Lithological evidence points to the close of the Middle Chalk period as having been a time of change, probably in the direction of reëlevation. The palæontological facts seem peculiarly striking in this respect. *Holaster*, of which *H. subglobosus* was the highest of the Grey Chalk Marl species, now reappears in the Chalk Rock as *Holaster planus*. Ammonites and scaphites, which were last met with in abundance in the Grey Chalk, return in the Chalk Rock of Oxfordshire as the species *Pachydiscus prosperianus* and *Scaphites geinitzi*. The arenaceous Foraminifera, the abundant quartz grains from the residues, the crystals of tourmaline, were all left behind in the Grey Chalk, but again we find them appearing in the Chalk Rock. Is there no lesson, no significance in this? To me it seems clearly to indicate that the distribution of the animal forms is in the main independent of the character of the sea-bottom, and is far more influenced by temperature as a direct result of depth, and by the strength of the prevailing currents. Here, then, we see the principle of colonies supported by historical data. Time has produced some alteration in the species, but genera reappear which apparently had disappeared from the stage of Cretaceous history, these belonging to the most varied groups, and identical with those that existed throughout the whole of the Lower Chalk period. If this be so with the Cephalopoda, should we not expect that, in some measure at least, the other Mollusca would also be affected? Here, too, the results are of a character to convince the most sceptical. *Turbo gemmatus*, and forms of *Trochus* and *Solarium*, again resume their place among the important fossils of this series. The trochoid forms are the last to disappear during depression, and they are also the first to reappear during elevation, and should my theory be accepted as having a firm and logical basis, it would no longer be necessary to go to lithological characters to learn whether elevation or depression had taken place, since the fossils themselves would clearly establish the physical changes of the period.

At the close of the Upper Cretaceous period, a remarkable group—rare, it is true, but preserved in our great national collection—claims our attention. In the upper portion of the *Belemnitella mucronata* zone at Norwich the following forms have been met with: *Emarginulina*, *Corbula*, *Chama*, *Nucula*, and *Dentalium*. The appearance of these seems to have been the first sign of that change which was about to close the Cretaceous period, and the first indication of that reëlevation which was to alter the whole character of palæontological history. This single gastropod, the scaphopod, and these few dimyarian bivalves seem already to suggest the great alteration in physical conditions which was about to supervene. To these must also be added the large *Terebratula obesa*, which occurs both in the Warminster Upper Greensand and the Upper Chalk of Norwich.

A comparison of the general relations of the molluscan sequence in the past with that existing at the present day seems to establish a certain resemblance and parallelism which should receive the fullest attention from the student of Cretaceous history, and the following facts seem worthy of consideration. The character of the genera from the South German strata, as also of those from the Blackdown Hills, is that of a fauna now living at a depth of less than 30 fathoms. The depression producing the Upper Greensand formation caused the disappearance of many gastropod and dimyarian genera, the survivors being similar to those now existing beyond the 30-fathom line. The predominance in the Lower Chalk of such Monomyaria as *Pecten* and *Lima* is evidence of a depth exceeding 300 fathoms; and this is confirmed by other evidence (see *Proc. Geol. Assoc.*, May, 1894). From the Middle Chalk period onward are to be found only these ubiquitous types, and those of extinct monomyarian genera; but the presence of *Trochus*, *Turbo*, and *Solarium* in the Chalk Rock is paralleled at the present day by the same association found at Culebra Island at a depth of 390 fathoms. Referring to the fact, already noted, that the Mollusca of the Upper Chalk are of the same types as those which at the present day extend their range to the greater oceanic depths, and that the faunal characters are so closely paralleled by those of the oceans of the present day, I would submit that the Chalk Sea was a true oceanic depression, and would use this as an argument against the permanence of oceanic basins (see my "Genesis of the Chalk," p. 227).

Although after careful study it seems evident that those genera which are present in both the Chalk and the now existing oceans have the same character of distribution, it must be admitted that many types of the present day having a wide bathymetrical range had no representatives in Cretaceous times. *Pleurotoma* is a form of the widest distribution in depths exceeding 1,000 fathoms, yet no traces of it are to be found in the chalks and marls of the Upper Cretaceous period Among the deep-sea Pelecypoda, *Neæra*, *Callocardia*, and *Cryptodon* are most abundant, yet neither in this nor in any other land has the Chalk formation yielded a single specimen. Their absence may be due to either of two reasons: one, that the shell-structure is of so delicate a nature that it has been unable to resist disintegrating influences, and the other, that these genera were non-existent during that period. The first hypothesis may account for the absence of these Pelecypoda, owing to the fragility and delicacy of their tests; the last, however, cannot hold good in the case of *Pleurotoma*, seeing that its specific development during the Tertiary period was so rich and varied that it would be strange if it had not already been well established in Cretaceous times.

Closer examination into the distribution of the Mollusca reveals facts of the highest scientific interest, not only tending to prove that even in Cretaceous times their life-provinces were well marked and defined, but also giving evidence of the individual migration of species and of the gradual northern advance of whole groups. It seems beyond doubt, from study of the Upper Cretaceous of southern Germany, that the carnivorous Mollusca, such as *Voluta* and *Conus*, genera so characteristic of the present tropical and southern seas, had at the early part of that period obtained but a slight footing. But in Upper Chalk times they form a striking feature, being rich in species and widely distributed along the shores of the old Cretaceous continent. It is a remarkable fact that, notwithstanding the varied character of these occurrences in Germany, none of these genera had been able to migrate either to Great Britain or France, the reason evidently being that the great depression had proved an effectual barrier to their advance, whether westward or northward. Only when the elevation that closed the Cretaceous period had begun was this barrier removed, and how suitable were the climatic conditions for their extension at that time is evident from the great variety and specific richness of these genera in the Tertiary strata.

It may not unjustly be advanced that a discussion of this kind should deal, not only with genera and species, but likewise with the size and abundance of individuals. On these points, while fully recognising their great importance, I regret that I have been unable to obtain any really reliable and definite information as regards the German fauna, though what I have gathered tends to confirm my views; indeed, the very wide distribution of so many species, both of Gastropoda and Pelecypoda, especially in the more southern districts, renders it in the highest degree probable that the molluscan fauna was rich, not only in species, but also in individuals, though not comparable in this respect with the subsequent Tertiary fauna.

A recent examination of the series of forms from the Blackdown beds which is preserved in our national collection, has confirmed my conclusions as to generic distribution; for the Pelecypoda, especially *Trigonia*, *Cyprina*, *Cucullæa*, and *Natica*, are represented by specimens of great size, while the Gastropoda, *Turritella granulata*, *Murex calcar*, and the beautiful little *Aporrhais calcarata*, are also in great abundance. In the higher beds of the Cretaceous series both the Gastropoda and Dimyaria rapidly diminish in size as well as number, the genus

Pleurotomaria alone persisting and presenting a few isolated examples sparsely scattered throughout the Chalk strata.

The questions as to the distribution of these larger molluscs, and as to the bathymetric range of littoral or shallow-water animals, especially in their relations to oceanic currents, are of great interest; but having confined my remarks in this paper to a comparative analysis of two oceanic periods separated by a wide interval of time, I would now merely summarise the general deductions.

1. In Upper Cretaceous times the principal gastropod genera, which subsequently became so prominent in the early Tertiaries, were fully established on the shores of the South German Continent, and attained gigantic proportions yet further to the south at Gosau in the Tyrol, and in the Hippuritic Limestones. Outside European areas, gigantic *Helcions* have been found by Schmidt in Saghalien, and a rich gastropod fauna occurs in similar deposits in India and Natal, including such types as *Fasciolaria* and *Chemnitzia*. The rarity of Gastropoda and Dimyaria in the Chalk strata of Britain is due to the physical conditions under which they were deposited. The presence in Ireland of a more abundant molluscan fauna is evidenced by some thirty gastropod specimens from Lisburn and elsewhere, now in the Jermyn Street Museum. The principal genera are *Trochus*, *Turritella*, *Rostellaria*, *Turbo*, *Pleurotomaria* and *Scalaria*, which are a further proof that shallower-water conditions prevailed in those localities during Upper Chalk times.

2. The "Challenger" Expedition has revealed to us the general characters of the bathymetric distribution of the Mollusca, and has shown that, instead of these being divided into several classes differing from each other according to the depth, a few genera only, having many shore-line representatives, are capable of extending their range to the greater depths. The reasons for such extension are at present uncertain, but the fact is clear that the trochoid Gastropoda (*Trochus* and *Bacilissa*), *Dentalium*, *Pleurotoma*, and the thin-shelled Pelecypoda, *Neæra*, *Callocardia*, with *Arca*, have special abilities for overcoming these unfavourable conditions, while Monomyaria are most independent of external circumstances.

3. The molluscan fauna from the Upper Cretaceous of Northern Europe has a general distribution markedly similar to that existing in the present oceans. In the Cretaceous strata adjacent to the continental shores, the Gastropoda and Dimyaria have a preponderance over the Monomyaria, similar to that observed at the present day, while in the deeper-water strata these latter assume the lead in a most striking manner. Further, many of the genera extending their range under present conditions, more especially *Dentalium* and *Arca*, are identical in character and habits with those of past ages. The evidence, therefore, tends to establish my thesis, that the distribution of the Mollusca has presented in the main the same features ever since Upper Mesozoic times.

4. Additional evidence is brought forward to show that molluscan life-provinces were marked out even before these remote periods, and that any subsequent changes have arisen mainly through the variations in climatic conditions, and the alteration in the character of the barriers that separate the marine areas into different well-marked basins.

This article, then, has attempted to show that the laws governing the distribution of the Mollusca and Foraminifera, even so far back as Cretaceous times, were similar to those now in force, and that consequently the deductions from a study of present ocean life may be applied in determining the general features of ancient oceans. If this be conceded, a simple comparison of faunas may enable us to determine variation in bathymetric conditions, even where lithological characteristics are of no assistance. Thus, tracing step by step the history of an ancient oceanic area, many inquiries may be suggested which can only be answered by researches pursued in the future on well-marked scientific lines like those of the "Challenger" Expedition

W. F. HUME.

Royal College of Science,
London, S.W.

II.

Murray's Mud-Line.

THE quotations from Professor Herdman, contained in an editorial note in the October number of NATURAL SCIENCE, do not convey a quite correct idea of what Dr. Murray has written with regard to the position of the mud-line off continental shores. As the "Challenger" volumes are not very readily available, the following extracts bearing on the subject will, I feel sure, be interesting to many of your readers:—

"Notwithstanding some exceptions, due to special conditions, as, for instance, on deep ridges between oceanic islands, where gravelly deposits are found, or in bays, fjords, and enclosed seas, where mud is met with in shallow water, it may be said that, along all coasts situated in or fronting the great oceans, 100 fathoms is the average depth at which fine mud or ooze commences to form. At about this depth the deposits on the whole assume a greater uniformity of composition and grain, and the signs of mechanical action tend to diminish or completely disappear. The greater the extent and depth of the ocean, the greater the depth to which wave-movement extends, and consequently the greater is the depth at which the mud-line is formed around the coasts, but the average depth of this mud-line may be taken as approximately about 100 fathoms." . . . . "We have seen that while the depth at which these muds form in enclosed seas or estuaries may be only a few fathoms, yet along all the continental shores facing the great ocean basins the average depth of the mud-line may be taken at 100 fathoms." ("Deep-Sea Deposits," pp. 185, 228, 229.)

"The terrigenous deposits are chiefly made up of materials derived from the disintegration of the land masses. In shallow depths, where the bottom is swept by waves and currents, these deposits consist chiefly of sands, gravels, and boulders; but in all hollow or cup-shaped basins within the 100-fathom line, and in all the greater depths beyond 100 fathoms, the deposit is rarely disturbed by the motion of the water, and generally consists of a fine plastic Blue Mud or Clay. The depth at which a fine mud may form in the sea depends entirely on the depth of water and the extent of the basin; or, in other words, on the height and length of the waves. In harbours it may be deposited not deeper than 1 or 2 fathoms, while along the western coasts of Scotland and Ireland, which are exposed to the waves of the wide and deep Atlantic, the true mud-line may be situated at a depth of about 150 or 200 fathoms." (*Trans. Roy. Soc. Edin.*, vol. xxxvii., p. 482.)

"In the shallower reaches of the ocean the materials on the bottom are assorted and distributed by currents in a way that produces a great variety of conditions. In some places there are siliceous or calcareous sands, in other places dead shells and pebbles; on submarine banks, rocks and boulders prevail; in depressions, fine muds and clays. On each of these bottoms there is usually a very different assemblage of animals. So that, although the trawl may not in shallow water bring up such a variety of organisms in any single locality as from deeper water, still the total number of genera and species inhabiting the whole area of depths less than 50 fathoms is recognised as much greater than in deeper water. With increasing depth, not only the nature of the deposits, but the other physical conditions, become more and more uniform, till a depth is reached along the continental shores facing the great oceans immediately below which the conditions become nearly uniform in all parts of the world, and where the fauna likewise presents a great uniformity. This depth is usually not far above nor far below the 100-fathom line, and is marked out by what I have elsewhere designated as the *Mud-line.*

"In all modern seas the depth at which minute particles of organic and detrital matters in the form of mud begin to settle on the bottom of the ocean is important both from the physical and biological points of view. This depth is determined by the distribution of land and water. It is dependent on the depth and extent of the ocean or basin, and varies temporarily with seasons of strong winds and calms. In small enclosed arms of the sea, like those of the west of Scotland, the mud-line is situated at depths of from 5 to 20 fathoms; but where currents rush through narrow passages or over submarine barriers, it is much deeper. In the North Sea, the oceanic mud-line to the north occurs at a depth of about 80 fathoms, but on the coasts of Scotland facing the great stormy Atlantic it is often found at a depth of over 100 fathoms. In the Faroe Channel the currents rush over the Wyville-Thomson Ridge with sufficient force to prevent mud forming on the summit, and the mud-line is met with on either side of this ridge at about 300 fathoms. In basin-like depressions within the 100-fathom line—like the Silver Pits of the North Sea—mud is formed, while it cannot rest on the rims of these basins. All the minute organic particles washed down from the land, carried away from the shallow waters by currents, or derived from the decay and death of pelagic organisms, ultimately find a resting place on the bottom in deep water, principally just about and beyond the mud-line." ("Summary of Results," pp. 1433-1434.)

These quotations show that Murray fully recognises the fact that fine mud may be found at a great range of depth, and that he considers

100 fathoms to be about the *average* depth at which it is formed on continental shores facing the great ocean basins. Alexander Agassiz, one of the greatest living authorities on deep-sea dredging and marine zoology, in a review of the *Summary* volumes of the "Challenger" report, says with reference to the position of the mud-line:—

"Undoubtedly the 100-fathom line is an important limit of depth and indicates usually the edge of the oceanic continental slope. Yet it seems to us as if the more limited deep-sea explorations of the *Blake* and the *Albatross* along continental slopes indicated that in many localities there was considerable variety in the nature of the bottom, as, for instance, in volcanic and coral-reef districts and off rocky shores, where faunal conditions of very great variety extend to depths considerably beyond the mud-line and approach very near the 500-fathom line. We should be inclined to extend the limit of uniformity into greater depths than 100 fathoms along the oceanic continental slopes—certainly to 150, and often to more than 300 fathoms.

"While we fully agree with Murray in considering the fauna living near the 100-fathom line as probably that from which the deep-sea faunæ were derived, it seems somewhat hazardous, in our present state of knowledge, to affirm as emphatically as he does that the majority of the animals living within the 100-fathom line have pelagic larvæ, while the majority of those living at the mud-line have a direct development like those found in very deep water."

Thus, while Professor Herdman appears to argue that the mud-line should be placed at some depth less than 100 fathoms, Professor Agassiz thinks that it should be placed at a greater depth. But, making allowance for local conditions and variations, Dr. Murray is probably near the truth in assigning an average depth of about 100 fathoms to the mud-line off continental shores bordering the great oceans. Dr. Murray says that in and on the thin red watery surface-layer of a blue mud there are many living organisms, while in the stiff blue layers beneath organisms are much less abundant.

James Chumley.

"Challenger" Office, Edinburgh.

III.

On the Darwinian Hypothesis of Sexual Selection.

II.—The Case of the Wall-Lizard.

MESSRS. HUDSON AND STOLZMAN have already urged against sexual selection that an argument based on a number of cases selected from all quarters of the globe is obviously unfair. I propose in the following to examine as a test case, and in the briefest possible manner, some of the decorative variations of *Lacerta muralis*, undoubtedly a "higher animal," in order to see what light can thereby be thrown on this problem.

As the vivid green or blue tints that sometimes adorn the body of the male during the breeding-season cannot claim to be more than "general brilliancy" as opposed to a "disposition of colours," I will enumerate only, without admitting the justice of this distinction, some less ephemeral embellishments.

The lower surfaces, generally white, are often marked with a delicate and symmetrical net-work, sometimes with a rich profusion, of pink or yellow or black. The throat also varies. It is often spotted half black and half red, and its colours occasionally contrast with those of its under parts. The outer ventral scales generally have a blue or black centrepiece, now and then a green one, and not rarely the plates are alternately coloured blue and black, or green and orange, etc. Or, again, the outer row of ventrals may be blue and the next green. To show how complicated these patterns may become, I will describe one male captured on the Filfla rock, near Malta. The first row of ventrals on both sides of the body was blue on the outer half and black on the other, the demarcation being sharply defined, the next row was precisely similar, while the inner two rows were of a rich ochre yellow. Thus there were five parallel lines of regular and most attractive coloration. The throat and collar of this specimen were symmetrically spotted with sky blue. The large *scutum anale* was jet black, and the soles of the feet spotted black, with the single joints of the toes marked green.[1] Another

[1] This is something like the *var. Rasquineti*, described by Bedriaga: "Beiträge zur Kenntniss der Lacertiden Familie," p. 177.

ornament is made by the ocelli at the root of the front legs. They display no less eccentricity. As a rule, we find only one eye-spot, sometimes two, or even indications of a third. Or there may be two on one side and only one on the other. Like the other decorative colours, these ocelli are most pronounced in the male sex, and they are, as anyone acquainted with this species will admit, distinct from the ground-colour, ranging through every shade of cobalt, sea-green, and bronze, and generally framed in a ring of black.

These examples will suffice to show that the matter is not one of "heightened coloration," but essentially of ornamental design. To anyone who has observed the animal in its native haunts another fact will have become equally clear: that the surprising variability among adult individuals, even from one locality, demonstrates that these designs cannot be adaptive in any sense of the word.

If, therefore, this manifold ornamentation of *L. muralis* be due to preferential mating, we can only conclude that the females vary much in their tastes, and that these tastes must be of an order high enough to appreciate the minutest differences. To take an instance. Supposing two varieties of birds or of butterflies were distinguished by blue and green ocelli respectively, sexual selection would be called in to account for their differentiation. On applying the same hypothesis to *L. muralis*, the formation of *var. viridi-ocellata* out of *cœruleo-ocellata* (or *vice versâ* : it is immaterial which of the two has the priority) must be explained by assuming divergent tastes, and an ability to humour them, on the part of the females. Or, again, the non-adaptive *var. rubriventris* that occurs often singly among the (older) white-bellied form, but has elsewhere established itself to the exclusion of all others (a "local fashion")—this variety can only have arisen through long-continued "selection" of the red under-surfaces.

If so, we might expect to see something in the shape of display on the part of the male, or of choice exercised by the female. I have detected nothing of the kind, and am aware of no recorded observations to this effect. On the contrary, my experience goes to show that the individuals interbreed freely, without consideration for colour, and this agrees with other accounts.[1] It is true that Professor Eimer has explained facts like that adduced by Giglioli,[2] of two distinct varieties occurring together on a small islet by the suggestion that a "profound antipathy" exists between them which prevents their interbreeding and to which the frequent battles bear testimony,

[1] "The so-called races commingle freely" (Bedriaga, "Die Faraglione-Eidechse," 1876, p. 12). "Il y a peu de fidélité dans la gent Lézard, et les deux sexes aiment également le changement" (Fatio, "Vertèbres de la Suisse," vol. iii., p. 65). Professor Leydig informs me that he has never observed anything in support of the sexual selection theory with lizards. Mr. Boulenger writes in the same sense.

[2] In *Nature*, no. 475, vol. xix., p. 97.

"while the similar individuals breed together."[1] But I venture to think an easier explanation lies at hand. The "distinctness" of the adults may be referred to what is a common enough phenomenon among animals and plants, namely, that the offspring of two varieties is not intermediate between them (or only so while young), but assumes the character of one or the other parent form. As to the contests, they take place indiscriminately between the individuals of either variety and are generally provoked, no doubt, by disputes over food. This is a *vera causa* for enmity between individuals as between races, when brought into contact by identity of requirement; but there is no reason whatever why, in the case like the present one, the individuals of var. *a* should be more hostile to those of var. *b* than towards each other. As a rule, pugnacity in lizards is an individual matter, but *L. muralis*, as a species, is certainly more pugnacious than many. Two males may often be seen rushing at each other without the slightest apparent reason. Perhaps the feeling of rivalry is also strong; but I should like to say, in order to avoid misunderstandings, that the female takes no art or part in the contests of the males—it is quite by accident if there happens to be a female spectator—and even supposing some form of courtship to be decided by wager of battle, she would be compelled to accept the victor, however distasteful his style of ornamentation might be to her preconceived notions of beauty.

The whole question of sexual selection, therefore, with this species, and innumerable others, turns on this simple matter of observation. I submit that wherever such promiscuity among the individuals exists as with *L. muralis*, it is a contradiction in terms to state that decorative colours have been evolved through the choice of particular males by the other sex.

I might add that the same difficulty of analogous variability, previously mentioned, presents itself in another shape. The wall-lizard of the islands of Malta and Seriphos is apt to assume a brilliant yellow patch on the throat. Unless this is adaptive in some way it would imply a curious coincidence in taste on the part of the females of these widely-separated races. The *var. nigriventris*, a recent form, whose colour cannot be adaptive in any sense of the word, occurs at Genoa and at Algiers: can it be presumed that an identical change of female æsthetic conceptions has taken place in these different localities? The same applies to the *var. flaviventris*.

There is, lastly, a difficulty on what may be termed mechanical grounds. I have purposely described the detailed colour-pattern on the lower surfaces of a specimen from Malta. How is the female to see it?

[1] Eimer, "Organic Evolution," translated by J. T. Cunningham, p. 42; "Variiren der Mauereidechse," 1881, p. 79. The author attributes a certain influence in the colour development of this species to sexual selection. "Zool. Studien auf Capri," ii., *passim*. "Variiren etc.," pp. 22, 27, 158.

Thus one species of "higher animal," at all events, must content itself with any physiological makeshift it can find to explain the production of its ornamental colours. Perhaps others of its order fare no better. And whoever is inclined to generalise from this conclusion will feel how difficult it is to assume, on the Darwinian hypothesis of preferential mating, that the æsthetic faculties attributed to female birds, and employed by them in the improvement of male fashions, should lie dormant throughout the next Order, Reptilia, and afterwards suddenly reappear, in their full complexity, among the Lepidoptera and Arachnida. Such an assumption must, indeed, be rejected, if only on the ground of the close analogy between the secondary sexual characters of birds and those of reptiles.

I should like to append one or two remarks on the melanic insular races of *L. muralis*, whose genetic development has some bearing on the question of sexual selection. In speculating on the origin of their strange coloration, it would be satisfactory if we could dispense with the all-explaining "external influences"; for their—biologically—isolated position becomes more apparent if neither physical nor economic conditions have contributed to this result.

Now, as to the first of these, although dark coloration in this class of animals has been ascribed in some instances to moist surroundings, in others to the action of light-rays (whose irritating influence on the smaller vessels may induce a deposit of pigment under the epithelial layers), yet, in the case of island varieties, exterior agents such as these must affect either all of them or none. Nor have economic or social causes, arising out of the relation of these races to other organisms, played a part; the "protective coloration" hypothesis which has been advanced does not seem tenable, for the following reasons:—(1) If the dark upper surfaces of the Faraglione-lizard are adaptively-imitative of the fissures, etc., in the rock,[1] it is surprising that the lizards on the neighbouring and similarly coloured islet should be, not black, but sky-blue[2] on that portion of the body. (2) The summit of the outer rock is covered with vegetation, and has a certain depth of soil (the elder Spadaro, who used to ascend it, planted a crop of potatoes there). Thus the adaptation could refer only to the sides. (3) On other Mediterranean islets of the same colour and geological structure as the Faraglione the lizards are differently coloured. (4) The fact that the Faraglione race is exceptionally tame (more so than any other insular or continental race with which I am acquainted), and that (5) the females are almost as brightly tinted as the males, indicate they have few, or no, enemies, and therefore stand in no need of protective coloration.

I must apologise for this digression. It would be interesting if races like *L. lilfordi*, *L. cærulea*, etc., could be shown to have been

[1] Eimer, "Studien auf Capri," ii., pp. 36 *et sqq.*

[2] Eimer, "Variiren, etc.," p. 154.

formed, so to speak, of their own sweet will, and free from the restraint of Natural Selection. This seems to allow wider scope to sexual preferences. But I can find no particle of evidence that the curious tints of these varieties or certain structural peculiarities have been thus acquired. The males are exceptionally pugnacious,[1] of large size (due to a succession of combative ancestors), and in unusual preponderance over the females[2]; but this is negative evidence.

To obtain some idea how these insular races have gradually deviated from the parent stock, one may compare the lizards on the town-walls of ancient Paestum, a comparatively isolated area, with the common Neapolitan form. Both the *var. maculata* and *elegans* are here represented, but they are larger in size, and the throat and lower surfaces are suffused in early spring with a decided blue tinge. Perhaps they would become a biological species analogous to the Faraglione race, if the innate tendency to increase the supply of normal pigmentation were uncontrolled; as it would be, if greater isolation destroyed the equilibrium between competing species and rendered superfluous all protective coloration. This, I think, is what has taken place with the Faraglione lizard and others; but such changes are not effected even on small islands of the size of Capri or Malta, for here the struggle for existence, so far as *L. muralis* is concerned, is as severe as on the mainland.

Whoever turns to these melanic races to elucidate the problem of sexual selection will find them instructive from at least two points of view. They illustrate, in the first place, a change in the direction of variation. I do not propose to criticise Professor Eimer's suggestive "Law of Undulation," beyond saying that even if the archetype of this species was longitudinally barred, and if these bars show a tendency to break up into vertical markings, it does not necessarily follow that all other forms are intermediate in the sense of "less advanced," and represent so many stages of standing still (*Genepistasis*) in the course of phyletic development. The principle of evolution seems to be broader. The *var. elegans*, for instance, or the Faraglione lizard, whose primordial [?] stripes can be plainly detected on speci-

[1] Five out of ten males from the Filfla rock had their tails broken off short, presumably during occasional encounters. This is far above the average of such mutilations. Bedriaga and Eimer testify to the combativeness of the Faraglione lizard. The females are said to be almost as bellicose as the males.

[2] This is as yet only a supposition, and remains for future observers to determine. The numerical proportion of the sexes in many animals depends, to some extent, on climate, nutrition, etc. On the Filfla rock the proportion obtained was ten males to four females, and from the Faraglione four males to two females, although the females are everywhere more easily caught. This disproportion is not borne out by the small material in the British Museum, but Professor Eimer notes that "much fewer" female Faraglione lizards came into his hands than males, a fact which he attributes to their greater shyness. I have found, on the contrary, that the male wall-lizards are always more shy and active than the other sex, and this accords with the experience of Professor Leydig ("Die in Deutschland lebenden Arten der Saurier," p. 157).

mens that have lain some time in spirits of wine, have suspended the further development of all markings. They have abandoned the "predestined" line of modification and are tending each to accentuate its own (uniform non-striped) varietal type. Another case. The males of *L. agilis* generally obliterate in spring all traces of their usual darker markings in a glow of vivid green, yet some of them embellish, particularly at their season, their longitudinal dorsal stripe. This would signify retrogression and more than arrested development. The same with batrachians. The spots of *Salamandra maculosa* are apt to coalesce, with approaching maturity, either into vertical or horizontal lines. The one type is commoner in the North, the other in the South of Europe, perhaps for a similar reason to that why the varieties of other reptiles and batrachians are striped in the East and become ocellated towards the West. Whatever this reason may be, the second of these processes is directly opposed to the theory of the undulatory progression of markings.

In objecting, therefore, to its wide applicability,[1] I take my stand on cases like the *var. elegans* or *bi-fasciata* of the wall-lizard. The nisus of the variety, quâ *elegans*, etc., is more conspicuous in the male than in the female or young. If the latter portray more faithfully than the males the ancestral coloration, the present race must be assumed to advance along new (male) lines of variation, a process which involves a discontinuance, partial or complete, of whatever may have been *the* one original direction followed by the parent stock. Such considerations point rather to a progressive divergent development, though, of course, some species are more conservative than others in the matter of variation, both as to its degree and its direction.

The bearing of the class of facts briefly hinted at upon the theory of sexual selection is obvious. If the decorative stripes of antelopes and tigers,[2] the delicately pencilled markings of many birds, the eye-spot of the peacock-butterfly, or the dark streaks of the swallowtail have been formed according to sets of rules similar to those that have regulated the differentiation of the innumerable striated, speckled, ocellated varieties of the wall-lizard, where sexual selection is shown to be out of the question, what is their value as proof of such selection?

This relates only to the modification or suppression of markings. The insular races of *L. muralis* are noteworthy also as exemplifying the process whereby mere heightened coloration can become permanent. The late G. J. Romanes joined issue with Mr. Russel

[1] Eimer's conclusions as to the origin of vertebrate markings have not remained uncontested (v. *Zool. Jahrbücher*, 1893, p. 382). The new edition of Brehm's "Thierleben" classifies the Felidæ according to the method suggested, and it seems to be a useful one for this purpose. I am not aware whether Professor Eimer has adduced, in favour of his theory, the very interesting changes which the five lines on the heads of certain newts undergo so as to form, finally, an almost vertical pattern.

[2] "Descent of Man," p. 544.

Wallace on what he considered a most important point, namely, the distinction between "general brilliancy" and a "particular disposition of colour."[1] The former, he admitted, might readily enough accompany an increase of vigour; but the latter "exists for the sake of ornament." This difference, I venture to think, is more apparent than real. Speaking of animal tints in general, every gradation can be traced between the most volatile hues produced under the influence of love, jealousy, etc., in one sex, and the intensified coloration peculiar to the whole breeding season. The latter, in its turn, may not rarely be retained and become a fixed character in both sexes all the year round. Further, if there is any truth in the biogenetic law, it is probable that what is a "design of colours" nowadays was, at one time, only "heightened coloration," and that a complete transition has existed between the one and the other. This is, naturally, not easy to demonstrate, as we have no written record of the ancestral coloration of any animal; but a clue can be obtained from what is going on at the present day. I have elsewhere drawn attention to the fact that the emerald lizard in certain localities displays an evanescent bluish tinge about the head and shoulders which may be regarded as an intermediate stage leading to the true *mento-cœrulea* form, adding that "the distinguishing blue patch on the throat of the latter is, in many localities, of the most ephemeral nature; in others, it is retained long after the honeymoon, and in some, again, the lizards are perpetually thus coloured. Finally, this same feature is not rarely peculiar to the male sex, but elsewhere equally conspicuous in both."[2] Now, the bluish tinge first noticed is clearly nothing more than heightened coloration; but whoever has examined typical specimens of the *mento-cœrulea* variety will admit that it exhibits a particular disposition of colour, and a very pretty one, and one that has evidently crystallised, in the course of time, out of ill-defined brilliancy. Unless this is a unique case, unsupported by anything in the natural history of birds and mammals, I do not see the force of the objection raised by Romanes.

The bearing of facts such as these upon the question of sexual selection is simply this: If the delicate green ocellus at the root of the *hinder* leg of the Faraglione lizard or the complicated design on the lower surfaces of the Filfla lizard, has developed without the assistance of female preferences, why invoke their agency to account for the patch of colour on the bluethroat's breast or on the head of the woodpecker?

If the tendency of biology is to become a more exact science every day, the processes involved in the formation of animal pigments will soon be, if not reducible to a scale, at all events familiar enough to show whether order cannot be brought into the "fortuitous

[1] "Darwin and after Darwin," i., p. 394.

[2] "Herpetology of the Grand Duchy of Baden," p. 9.

concourse of atoms of colouring matter" without external (female) sanction. I think it will be found that the harmonious distribution of tints on the feather of the argus pheasant merely continues a principle which the bilateral and radiate forms of all living organisms illustrate—the coincidence of symmetry with economy; and that, although "likes and dislikes" will always exist, sexual selection, from being an efficient cause, becomes an untimely *deus ex mâchina* like so many others.

So far the remarks have not been constructive, but one suggestion, at least, of a positive nature may be gleaned from two facts in the life-history of *Lacerta muralis.*

The first of these is that, considering the number of enemies, four-footed, winged, and creeping, that persecute this species, the struggle for existence must obtain as severely here as with any other animal. The second fact relates to the predominance of some varieties over others, and becomes apparent if we trace their manner of colour development. In the *nigriventris* form, for instance, we see that the black is first visible in the shape of minute spots on the throat, each scale being often prettily marked with a black centre. The next stage consists in the entire under-surfaces being thus covered with minute spots that afterwards, in the true *var. nigriventris*, Bonap., expand to the exclusion of all other colouring. In localities where this variety has become dominant, the first gradation of colour-development has been abbreviated, and the young already display the intermediate stage. The young and females are not so darkly tinted as the males.

From these circumstances we conclude that the parental stock was less strongly pigmented, and also that the present scattered *nigriventris* forms are not the discontinuous residue of a once all-prevalent race, for, in that case, the young would have this feature most pronounced. They must, therefore, have arisen spontaneously, so to speak: independently of each other. Nor can their mutual resemblance be explained by identity of external conditions, for this form occurs sporadically on a variety of soils on different shores of the Mediterranean and on some of its islets, as well as further north.

By what obscure selective process has this preëminently *indifferent* character of black colouring on the lower surfaces been perpetuated and intensified? Considering our ignorance of the causes of variation it would be rash to state that the whole polymorphic cycle of varieties of this species are distinguished by equally non-adaptive characters, but this certainly applies to some other recent forms like the *rubriventris*, *flaviventris*, etc.,[1] whose characteristic tints are of the "useless" class.

[1] The phylogeny of these races is corroborative of the general rule that animal beauty tends to increase, a fact that is sometimes attributed to "growing taste" on the part of the female sex. The effects of sunlight (Eimer, "Organic Evolution," p. 91) cannot explain brighter colouring on the lower surfaces of *L. muralis.*

Viewing together the three varieties mentioned, it looks as if they had diverged from, and multiplied at the expense of, an older stock, by virtue of something inherent in the additional outlay of colouring matter, the precise shade of which seems to be immaterial.

I think that the two facts of the severe struggle for existence and of the predominance which races like *nigriventris* have been able to assert over less pigmented forms afford demonstrative evidence that abundant pigmentation, the expression of intense metabolism,[1] *must* be associated with superior physical vigour. That is, that the most ornamental varieties (*ceteris paribus*) necessarily must—not generally do—increase. If the survival of the physically fittest has coincided, as is here the case, with that of the most intensely coloured, the indifferent characters of this species cannot be regarded as mere awkward bye-products of growth: their formation seems to have been conditional, rather than incidental, to continued existence.

It appears from this that "useless characters" and "characters of no active utilitarian significance" are not interconvertible terms. And unless this conclusion is applicable only in the matter of the production of superabundant colour, and only to the case of *L. muralis*, I think its bearings are not easily appreciated.

Speaking apart from structures and anything else that may possess a life-preserving value, it may be said that an unbroken gradation exists from the most decorative ornaments of higher animals, peculiar to one sex, to the wider class that contains the ordinary non-ornamental useless characters of higher and lower animals of both sexes. And it has been remarked with surprise that representative or allied species of animals and plants often differ from each other in respect of such non-utilitarian (morphological) characters, whence the awkward question has arisen how they ever came to be differentiated, seeing that it mattered nothing to their ancestors, as varieties deviating from another type, whether they possessed this or that non-adaptive feature. Why should they have survived while others perished?

The sphere of utility would be extended if, reviewing them as we now do the dominant sub-species of *L. muralis*, we could demonstrate that their ascendency over innumerable, afterwards extinct, connecting forms had been determined by a physical superiority, to which the "useless" character, whatever it be, still bears testimony.

G. Norman Douglass.

[1] Geddes and Thomson, "The Evolution of Sex," p. 23.

IV.

The Swedish Marine Zoological Station.

A MISTY day last summer found me steaming up the west coast of Sweden to the little village of Fiskebäckskil, on a wild-goose-chase after some friends who had left before I arrived. Landed here, in a place without an inn, and without another steamer to take me away that day, I cast about for somewhere to spend the night. Then on the other side of a little bay I saw some white buildings and a vane-capped tower which they told me belonged to the zoological station of Kristineberg. Relying on the freemasonry of science, I at once sought the good offices of the director, Professor Hjalmar Théel. Nor was I disappointed. Fortunate circumstances rendered it possible for me to find a bed there for a couple of nights, and to make the acquaintance of the laboratories and those working therein. The somewhat remote position of this station and the rule that forbids other than Swedes to work there, render it less known to Englishmen than its scientific importance demands; and it occurred to me that a short account thereof might interest the readers of NATURAL SCIENCE. It so happened that Professor Théel had just brought out a little 48-page pamphlet "Om Sveriges Zoologiska Hafsstation Kristineberg" (Stockholm: Norstedt & Söner), with a map and four plates; and with his kind permission the present article draws largely on both his text and his illustrations.[1] For his hospitality and his help he has my warmest thanks.

The island of Skaftö, on which Kristineberg is, lies on the south side of the Gullmar-fjord, near its mouth, and is about half-way between Gothenburg and Uddevalla, with which places the neighbouring village of Fiskebäckskil is in daily communication by steamer. This situation offers many advantages: the fjord cuts deep into the land, and has a varying bottom of clay, gravel, rock, *Zostera*, algæ, shells, and mud; immediately outside Kristineberg it reaches a depth of thirty fathoms, and six miles further up a little over eighty fathoms. A number of rocky islands shelter the mouth of the fjord against the sea (Fig. 1). Animal and vegetable life is richly represented and provides a boundless field for research. Hence Kristineberg early was a

[1] This pamphlet also contains a list of the marine biological stations of the world and a bibliography.

FIG. 1.—Sketch-map of the Coast near Kristineberg.

favourite resort of Swedish naturalists, and became a recognised zoological station by a process of natural evolution.

It was Bengt Fries who in 1835 first visited Kristineberg, and was so pleased with the place that he returned there in 1837 and 1838 with W. v. Wright to study and to collect specimens for the State Museum. In 1839 Sven Lovén paid his first visit to Kristineberg, and it subsequently became the place where he carried out many of the beautiful researches of which some account was given in the October number of NATURAL SCIENCE. Dredges and other apparatus necessary for investigating the life of deep-sea animals gradually accumulated; moreover, Lovén trained two of the local fishermen, Bengtsson and Jacobsson by name, not only to manage the dredge and collect specimens, but also to know the names of the commoner forms. These advantages induced many other naturalists to spend their summer holidays at Kristineberg, and among them may be mentioned Anders Retzius, C. J. Sundevall, J. E. Areschough, Johannes Müller, W. Lilljeborg, G. Lindström, T. Thorell, O. Torell, F. A. Smitt, Chr. Lovén, R. M. Bruzelius, A. J. Malmgren, and O. T. Sandahl. In a word, Sweden had a sort of zoological station earlier than any other country.

But a real Zoological Station, with authority and endowment, was required. This was recognised by Lovén, and it was owing to his exertions that the station of Kristineberg was founded. The capital was obtained from Anders Fredrik Regnell, who, while making his fortune as a physician in Brazil, often remitted large sums of money to the scientific institutions of Sweden, and, on his death, bequeathed to them the remainder of his wealth. From him the Royal Academy of Science received in all rather more than £3,000, in order to found a zoological station that should belong to the Academy; and Lovén was requested to put this into effect. Naturally, the Kristineberg locality was selected; the land was supplied by the trustees of the Royal and Hvitfeld Scholarship at Gothenburg, and in July, 1877, a bargain was concluded with Captain E. Bengtsson for his house, with boathouses, store-sheds, quays, and half of a brewhouse. Nothing more was needed than to take over the arrangements already made; the station was at once thrown open to researchers, and in August of the same year we find five young students installed there, namely, T. Tullberg, F. R. Kjellman, Hj. Théel, Chr. Aurivillius, and J. Brattström.

Another factor aided in no small degree the first development of the station. Sven Lovén for many years had sought to get up expeditions to study the animal life of the Swedish seas, and specially to investigate the comparatively great depths, up to 400 fathoms, that are to be found in the Skagerack. At the request of the Academy, Parliament appropriated £555 to this purpose, and during the summers from 1877 to 1879 placed at its service the gunboat "Gunhild," completely equipped and commissioned. The scientific men that took part in these expeditions were Hj. Théel, who was on all three, C. Bovallius, F. Trybom, C. Forsstrand and J. Brattström. The expeditions, which started from the station of Kristineberg, were richly supplied with apparatus from the naval station of Karlskrona, and at their close all this was handed over to the zoological station.

The buildings belonging to the station are the following. On the right-hand side of Plate XX. one sees the dwelling-house, a long building of rough-hewn timber and boards, facing north-east. On the ground-floor are the large sitting-room, smaller dining-room, one small and two large bed-rooms, kitchen, and servants' bed-room. The upper storey consists of five bedrooms opening upon the large top-landing that is characteristic of Swedish houses. An uncovered verandah stretches along the front of the house, and on it one drinks one's coffee after dinner and admires the extensive view over the Gullmar-fjord. Board and lodging can here be offered to nine or ten people at once, and for it one pays two kronor (2s. 3d.) a day. The house on the left-hand side of Plate XX. is the so-called Villa, the residence of the director, with three rooms, a kitchen, and a glass-covered verandah on the ground-floor, and two attic rooms above. Behind it are seen the necessary outhouses. To the right of it is seen a cottage, containing a workshop and a mangle-room. The wooden boathouse, not shown in the Plate, is down by the water's edge on the right; in it the dredges are stored, and rough work carried on.

The laboratory building and its adjoining water-tower were not completed till 1884. The main building, which is seen in the middle of Plate XX., of two storeys and built of wood, is 18 metres long and 10 wide. It has one entrance at the east end and one in the middle of the south or landward side. All the inner walls are panelled and varnished. The floors of the lower storey are soaked with tar and linseed oil, while those of the upper are varnished and somewhat noisy to walk on. A notice on the south entrance informs the would-be intruder that this door is only for workers. The east entrance, however, is at certain times open to the public. We enter through a lobby (*Ö F* in Fig. 2) up a short staircase directly into the large so-called "washing-room, *sköljrummet*," 10.5m. by 6.3m. (*S* in Fig. 2). On its north side are three windows, in front of which runs a broad platform, on which are placed five aquaria (*a*, *a*, *a*), each containing 175 litres. This platform is made of strips of planking, between which rubbish can fall down onto the underlying rock and be washed into the sea. Immediately under the windows a long table (*vb*), fastened to the wall, runs the whole length of the room. It is used for the coarser dissections, for picking out animals from the seaweed and so forth brought in by the dredgers, and for spreading out masses of clay, which are left untouched during the night so that the animals living therein may crawl to the surface. Between two of the windows is fitted a washing apparatus for sifting the clay and discovering the small and often microscopic animals that inhabit it.

In the table is also a sink (*s*), while from it small lifts (*h*) ascend to the work-rooms above. Along the room is a row of pillars supporting the ceiling.

From the small eastern lobby, two other doors on the right hand lead to the large cement aquaria (A_1 and A_2), containing 3,000 and 1,000 litres respectively. By a third door on the left one enters a fair-

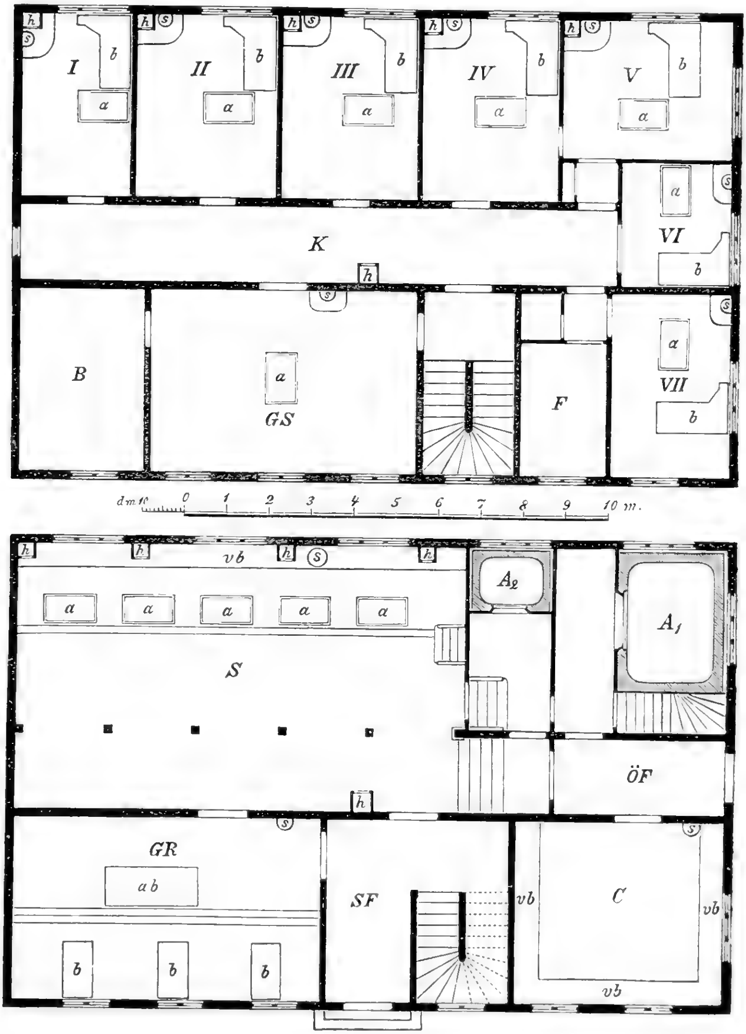


FIG. 2.—Plan of the two storeys of the Laboratory at Kristineberg. For explanation of letters, see the text.

sized sorting- and store-room (*C*), with three windows, and with tables fastened to the walls round three sides (*vb*). In this room is kept the stock of reagents and alcohol, and here the catch brought by the dredgers is daily delivered and is sorted for division among the different workers or for preservation at the Natural History Museum.

In the south-west part of the lower storey is a general working room (*GR*), 7·34m. by 4·4m. with three windows and with exits to the washing-room and the south entrance-hall (*S F*). It has three work-tables (*bb*), and in the middle a large aquarium-table (*ab*). This room is set apart for younger students, who stay at the place in order to get a general idea of the flora and fauna of the sea.

From the south entrance-hall, which is more spacious than the other, and which has doors into the general room and the washing-room, a stair leads to the upper storey, which contains the laboratories proper. A long corridor (*K*) divides this storey into two halves, and from it doors open into the seven studies (*I.–VII.*), which face north and east, into a smaller store-room (*F*) for glass and reagents, and into a large common room (*G S*), lit by three windows facing south, and opening into a small corner room (*B*), also facing south, which is intended to contain the library of the station at some future day. In the common room is a work-table, reserved for emergencies, a warming oven, microtomes, a named collection of animals from the neighbouring sea, and so on. This room is principally to be regarded as a common study for those who wish to use the collection for comparison, to use the warming oven for imbedding in paraffin and such like work, and to use the microtomes. Each private study has on an average an area of twelve square metres and a height of a little over three metres. Each contains a large, excellent work-table (*b*) with solid oak top, a treadle arrangement for the lens-stand after Sven Lovén's model, and a set of drawers. Each is provided with a dissecting microscope, a bookshelf, a copper-covered aquarium-table (*a*) with waste pipe, a sink (*s*), water supply to the aquarium-table and sink, a set of glass vessels and aquaria of different sizes, a lift (*h*) from the washing-room, and all necessary reagents, which are supplied on demand. Microtomes, balances, warming ovens, a Hartnack microscope of high magnifying power, and similar apparatus, are kept for the common use and are lent out as required.

From the upper storey a staircase ascends to a light and spacious attic.

Altogether the laboratory furnishes working room for ten persons at once, the common room not being included, since it ought to be accessible to all, and its only work-table is kept in reserve in case some eminent naturalist should turn up unexpectedly.

The whole building is traversed by pipes, which supply the aquaria and the studies with fresh sea-water; the supply to the upper storey and to the large cement aquaria consists of iron pipes enamelled on the inside. The supply of the lower storey, which was installed in 1894, consists of very wide, thick-walled glass tubes surrounded by a somewhat larger cover of brass, while the space between the two is filled with a mixture of wax and Venetian turpentine. All the T-pipes and angle-pipes of this new supply are constructed of well-tinned brass, and the cocks are of ebonite.

The water-tower is hexagonal, about 30 feet high, and has at the top an enormous wooden tub with a capacity of 35,000 litres (7,700 gallons). There are two pumps worked by wind-motors, which, in order to catch the wind more easily, are placed about 10 feet above the roof, that is to say, 40 feet from the rock on which the tower stands. The sea-water is pumped up into the cistern and thence distributed all over the laboratory. It happened that while I was at the station there was a day or two of calm, so that the motors did not work, and, to prevent harm to the animals in the aquaria, the pumping had to be kept up by human labour. Such an occurrence is not uncommon in the summer, and it is probable that some safer motor, such as a petroleum engine of two-horse power, will be substituted at an early date.

The station has within its grounds two landing stages, one of which projects far into the water, as well as a stone quay where a steamer can lie.

As already mentioned, the station possesses a rich supply of dredging apparatus, among which may be mentioned nets that can be opened and closed in deep water, and a vertical net after the Kiel model. The fleet of the station consists of two trawlers, to which a new larger one will be added next summer, a smaller sailing boat, and a little rowing boat. It often happens that material for research is not to be obtained in the neighbourhood of the station, but has to be brought from such distant places as the Väder Islands or Koster. For this purpose the boats of the station are too small, and a strong, full-decked yacht has to be hired. But the limited means of the station often make these expeditions impossible, however desirable they may be. A steam yacht is also greatly needed, especially for studying the movements of the plankton, but this also is prevented by want of means.

The staff of the station is composed as follows: The Keeper of the Lower Invertebrata at the State Museum is *ex officio* the Director. In this post Sven Lovén was worthily succeeded three years ago by Hjalmar Théel.

The Overseer takes general charge of the station and its property during the whole year, and, while the station is open, has to see to the boats, pumps, etc., and make himself generally useful.

The Housekeeper lives all the year round at the dwelling-house, taking care of the furniture and properties of both houses; and, while the station is in work, she looks after the living-rooms, cooking, and household duties.

The Dredgers, originally two in number, have now been raised to four. It is their duty to go every day to different parts of the coast to procure the necessary material. Their long training has given them a considerable knowledge of the mode of life, occurrence, and appearance of marine animals.

The station is, as a rule, only open during the three summer months, since want of funds does not permit it to be open at other times. But during that period it offers considerable advantages to the investigator that is a Swede. With no other expenses than those for his board and lodging, he receives a work-table, all necessary materials and reagents, and the use of all the apparatus and appurtenances that have just been described. That is to say, his total expenses for a month's stay would amount to £3 10s.

Natural Science has occasionally suggested that if a similar generosity were extended to the student by our own Marine Biological Association, no great harm would be done. It is interesting to learn the results of Sweden's experience. Some have, indeed, thought that a fee should be charged in return for these great advantages. But the Swedish student, like many others, is, as a rule, poor. The mere journey to and from the station and the cost of living there are a considerable expense to him. And, as Professor Théel very justly points out, if a fee large enough to benefit the station even to a small extent were charged, that would necessarily react as a hindrance to the pursuit of science. What science gained with one hand she would lose with the other. The learned Director, than whom no one has had a longer experience, therefore thinks that the Academy will best perform its duty of encouraging the development of science in general, and especially of Swedish science, by according to the investigator facilities no less than those he can obtain at Bergen or at Dröbak in the sister-kingdom of Norway, or at the laboratories of Arago and Roscoff in France.

Its generosity might lead one to suppose that the finances of the station were in a flourishing condition. This is by no means the case. The original donation of Regnell, and later donations made by Baron Oskar Dickson with his wonted liberality, have been spent in fitting up the station. The yearly income which the Government grants to the Academy for carrying on the work is not great. In 1878, £55 was allowed; and since 1879 this sum has been doubled. In comparison with the sums spent on similar institutions in our own country, this seems quite ridiculous. Sweden is not a rich land; but it is richer than Norway, which spends just twice that amount on its marine laboratories. When one considers the valuable and beautiful work that has been produced at this station and printed in the memoirs of the Royal Academy of Science and in other Swedish publications, by such men as Lovén, Théel, Tullberg, Kjellman, G. Retzius, the two Aurivillius, Appellöf, Wirén, Nathorst, and many others, one can but express the fervent hope that no shortsighted parsimony may check a stream of so much value to Sweden and to the world.

Among the advantages of this station—its scientific work, its increase of a practical knowledge of marine life, its furnishing of material and museum-specimens to the schools and universities of the country, its enlightening and vivifying of scientific teaching and teachers, and its promotion of intercourse between workers scattered for the rest of the year—there is one not alluded to by Professor Théel in his pamphlet, for the simple reason that it does not exist. One of the great advantages of such institutions elsewhere is that the worker at them meets with his colleagues from other countries, that the misunderstandings caused by distance are cleared away, and that one is brought out of one's parochial groove on to the broad highway of the world's science. There are, no doubt, excellent reasons why the advantages of Kristineberg should have been reserved for students of Swedish nationality, and chief among these one must reckon want of space and want of funds. Possibly the tax that the Academy wisely refuses to impose on the poor Swedish student might be laid on the foreigner; for I am sure that there must be many who, like myself, would be glad to have a closer acquaintance with the renowned and genial school of Swedish naturalists.

F. A. Bather.

V.

The Use of Formalin as a Preservative Medium for Marine Animals.

EARLY in the present year, my attention was drawn to the use of Formalin as a preservative fluid, by a short account of some experiments carried on by Professor Paulino de Oliveira[1] at the University of Coimbra. Since then, I have conducted in the laboratory of the Jersey Biological Station a series of very extensive tests, having the action of the fluid in question under daily observation. As the original investigation was conducted by Professor de Oliveira on rather restricted lines, and further, as my results differ considerably from his, it may be useful to workers at other stations and elsewhere if I bring together the chief of my methods and state the principal results obtained.

As to the nature of the fluid, it is sufficient to mention that formalin is the name given to an aqueous solution containing 40 per cent. of formic aldehyde. Its chief commercial use at present is as an antiseptic, and from its great bactericidal powers it takes high rank as such.

As a fluid designed to preserve marine organisms permanently, formalin is best used in an aqueous solution of strength ranging from two to eight per cent., and while a two per cent. solution will in many cases give satisfactory results, in practice I find it advantageous, in order to avoid any risk, to employ no solution of less strength than three per cent. Where the animal is bulky, or contains much water, I prefer to use a five per cent. solution. Hence in the following notes, unless otherwise stated, the strength employed must be understood to be that last named. It is to be noted that these percentages are calculated by considering the commercial fluid, formalin, as being of full strength (100 per cent.), although really it is but a 40 per cent. solution of the active principle.

For convenience in referring to these methods, I will treat of the various phyla and classes separately—I will also premise that the use of formalin does *not* do away with the employment of the ordinary fixing agents if the object is wanted for histological purposes. For dissection and museum purposes, there is, however, no need of other fixation than the action exercised by the formalin itself.

[1] *Annaes de Sciencias Naturaes*, vol. 2, no. ii., p. 69. (Porto; 1895.) (*See* also NATURAL SCIENCE, vol. vi., p. 229, April; 1895.)

Protozoa.—Perfect preservation, with cilia distinctly shown, is attained in a six per cent. solution. For microscopical fluid-mounts of these organisms, carbolised water and allied fluids may be advantageously discarded for this new medium, and by the use of aqueous staining fluids containing a percentage of formalin, good differentiation can be obtained; weak bismarck brown is one of the best stains to employ.

Porifera.—For histological details, formalin preparations are inferior to such as have been thoroughly well fixed and passed carefully into spirit, but the former are infinitely superior to such spirit specimens as have not had the *utmost* care bestowed upon them. The same observation applies fairly universally to other groups.

For ordinary dissection, formalin preparations are equal to the most carefully prepared spirit ones; while for museum preparations, those in formalin are greatly superior, showing absolutely no contraction, and in those where delicate filmy tissue is present the lovely transparency of life is retained almost unimpaired.

Hydroidea.—For microscopical manipulation, spirit is superior, as, when staining is employed after subsequent grading into alcohol, there is found to be a lack of differentiation not present in specimens prepared in the ordinary way. As a killing agent, I have, however, successfully employed formalin upon the Gymnoblastic Hydroids, and find that imperfect staining can be obviated by the immediate transference of the animals, after death in the formalin, to an ordinary fixative, with subsequent grading into spirit.

For dissecting and museum preparations, formalin is much more satisfactory than spirit, giving exquisite transparency, very marked in contrast with the dull opacity of spirit-preserved specimens. Specially fine are the fleshy medusæ of the *Sarsia* type, preserved by simple transference, while alive, into the fluid.

For the Calyptoblastic Hydroids, formalin has no special advantage.

Actinozoa.—These, as a whole, give excellent results in formalin, provided they be kept in not less than six per cent. strength. For those with very thin-walled tentacles, *e.g.*, *Tealia crassicornis*, a seven per cent. or even an eight per cent. solution is preferable; preparatory hardening in corrosive sublimate is also beneficial, but this somewhat impairs the transparency.

Discomedusæ.—The larger medusæ have long been considered well-nigh the most difficult of organisms to preserve satisfactorily. By the employment of formalin, all difficulty disappears, as after a number of experiments this summer I discovered that simple immersion in a five per cent. solution is all that is necessary. To-day, after the lapse of six months, the specimens are as good as, and indeed considerably tougher than, the first day they were placed in the medium. They (*Aurelia* and *Rhizostoma*) are glassy transparent, with the radial canals showing conspicuously in a delicate opalescent white.

The Lucernariidæ—except for histology—should always be preserved in formalin, the results are so good. In this case, previous stupefaction is necessary.

CTENOPHORA.—*Cydippe* and *Beroë* are not satisfactory in formalin; they seem unable to attain sufficient toughness to allow them to sustain their own weight in the fluid.

ECHINODERMATA.—Spirit and formalin are about equal in results.

ENTEROPNEUSTA.—*Balanoglossus* is worthless in formalin, as it secretes too great an amount of mucus, and spirit is necessary to coagulate this.

VERMES.—The Turbellaria can only be preserved in spirit. Nemertines and Polychætes, if previously well fixed, are very satisfactory in formalin, but the use of 50 per cent. spirit fortified with 5 per cent. formalin is even better. Such, however, of the Polychætes as secrete much mucus, *e.g.*, *Chætopterus*, must be preserved in the ordinary way by passing into strong spirit. *Formalin has little or no hardening action upon mucus.*

Some of the smaller Nemertines are killed very well extended by being thrown into formalin.

Rotifers preserve beautifully in formalin if previously fixed in corrosive sublimate.

POLYZOA.—For fleshy forms, such as *Alcyonidium*, formalin is most useful, obviating the dull opacity of spirit specimens.

CRUSTACEA.—For all except those with a well-marked carapace (*Leptostraca*, *Thoracostraca*, etc.), an 8 per cent. solution gives beautiful results, transparency and pliability. Where, however, a carapace is present, this frequently rises, giving an unnatural gap between the posterior margin of the carapace and the succeeding segment. For museum purposes, this is unsightly, but for dissection work there is the counterbalancing advantage of giving the preservative fluid freer admission to the organs beneath the carapace—always a difficult point in the preservation of crustacea.

MOLLUSCA.—Almost without exception formalin is vastly superior to spirit for these animals, and ordinary fixing is quite immaterial—without becoming intensely hard, as they do in spirit, an agreeable firmness, very useful in dissection, is produced. While previous anæsthetising is in no way superseded in the majority of cases, the cephalopods are simply magnificent if transferred direct to a 4 per cent. solution, and I dare prophesy that when once these formalin preparations are seen by our museum authorities there will be a general turning out of the old spirit specimens.

TUNICATA.—Very good and natural results are here obtained if the animals be previously thoroughly stupefied. A weak solution of formalin must be avoided with the delicate species, say anything less than a 6 per cent. strength. *Botryllus* in spirit is a depressing object-lesson of how not to preserve naturally, and though the greater part of the colour fades in formalin, yet the way in which all distortion of the parts through shrinkage is avoided gives a life-like appearance as satisfactory as any that can be hoped for.

FISHES.—For these a 4 per cent. solution is ample to produce the finest results.

Amphioxus is best killed by plunging direct into the fluid. The result is most beautiful; the natural transparency is so completely retained, that the internal organs can easily be traced, and the buccal cirri protrude gracefully as in life, and not in the state of tangled retraction seen in spirit specimens. Shrinking is quite obviated, and until one can compare a formalin prepared specimen with one fixed and preserved in spirit in the ordinary way, it is impossible to comprehend how much shrunken the latter are.

Elasmobranchs, such as *Scyllium*, are also beautifully preserved for dissection by simple immersion in a 4 per cent. solution of formalin, provided the viscera, heart, and brain be freely exposed by cutting away the abdominal wall and opening the pericardium and brain case. In two days the viscera attain the consistency of gutta-percha. Objectionable smell is quite obviated, the muscles assume a snowy whiteness, and the preparation as a whole becomes so clean and sweet that it is a real pleasure to dissect it. Anyone who has dissected an old-time *Scyllium* can understand what an improvement this means.

RECAPITULATION OF RESULTS.—For histological details, preservation by simple immersion in a strong solution of formalin gives fair results; prior fixation by one of the accepted and appropriate methods gives even better, but both are unmistakably inferior to those produced by fixing and grading into spirit in the ordinary way.

A minor and very useful employment of formalin in microscopical technique is, I find, to add 3 per cent. to aqueous staining fluids, to obviate any chance of the maceration of objects placed therein. Again, it may be employed as a 3 per cent. solution, in place of pure water, in the washing out of ordinary fixatives. I have known many valuable preparations spoiled in the washing out, some by being inadvertently left in too long, and others, again, deteriorated through lack of sufficient washing, due to a fear of possible maceration. By the employment of a formalin washing solution, ample time can be allowed for getting rid of the fixative without the least fear of maceration, as, even if the preparation be left washing longer than intended, the formalin will prevent any ill effects.

For dissecting and museum specimens, simple immersion in formalin solution gives, except in the case of Ctenophora, Turbellaria, *Chætopterus* and allied worms, *Balanoglossus*, and a few others, results not inferior to those obtained by ordinary fixation and grading into strong spirit, while in the majority of cases the results are greatly superior.

Professor de Oliveira believed that formalin would preserve natural colouring little impaired, but my prolonged experiments negative this, for while the loss of colour proceeds much more slowly than in spirit, still it is but a question of time ere it vanishes. This extraction is most marked and rapid in the highly-coloured sponges and tunicates. Crustaceans, however, retain their colours well.

In addition to the foregoing, I have further experiments with formalin in progress, and trust to present the results at an early date.

Taking every consideration into account, formalin may be regarded, for the majority of purposes, as superior to spirit in the results obtained, and when we remember its greater cheapness—a gallon of strong solution costs on an average but 1s.—and the ease with which we can apply it, it being miscible with water, spirit, and other fluids in any proportion, we may account its introduction as one of the greatest services ever rendered to the working biologist, while to the naturalist in remote places, to whom restricted baggage is a paramount consideration, formalin in its concentrated form will prove an inestimable boon, bringing the formerly unattainable within easy reach—all to the enrichment of our great museums and the advancement of zoological knowledge.

James Hornell.

SOME NEW BOOKS

EARTHWORMS.

A MONOGRAPH OF THE ORDER OF OLIGOCHÆTA. By F. E. Beddard, F.R.S. Quarto. Pp. xii., 769, with 5 plates. Oxford: Clarendon Press, 1895. Price £2 2s.

WHILE the reviewer was preparing his work, "System und Morphologie der Oligochæten," he perceived considerable gaps in our knowledge of the morphology of the exotic Oligochæta, and could refer only to E. Perrier's works, which in this respect may be termed pioneer. Simultaneously, however, with the appearance of the reviewer's book, a pleasing revolution in our knowledge of the higher exotic Oligochæta began, to which, among others, F. E. Beddard, Benham, Bourne, Horst, Michaelsen, Spencer, and Rosa have personally contributed. Through the works of these authors we have materially increased our knowledge of the structure of the Oligochæta, and when the reviewer brought out his "Entwicklungsgeschichtliche Untersuchungen," in which, especially, the embryology and organogeny of *Rhynchelmis* and some Lumbricidæ are worked out, the morphology of the Oligochæta was very much more cleared up than can be said of the organisation of the Polychæta, Gephyrea, or even of the Hirudinea. It was only necessary, so to speak, to collect several already published data and facts into a whole, in which all that goes under the name Oligochæta should be placed in a bright light. Beddard took upon himself this work, and in a large quarto volume of 769 pages and 5 plates has sketched an almost complete and correct picture of the organisation of the Oligochæta.

The work divides itself naturally into a general part of 173 pages, and a remaining disproportionately larger part, which is given up to a description of the genera and species. The author has manifestly given only a passing attention to the historical representation. In the following pages I shall endeavour to give a short *resumé* referring chiefly to the general part, while I intend to describe the special part in another place.

The smallest representative of the Oligochæta is *Aeolosoma* (about 1 mm. long), the largest, *Microchæta rappi* and *Megascolides australis* (4 to 6 ft.); the number of the segments varies from 6 to 600. The first segment forms a flap or lobe, the prostomium, which in some forms, as *Stylaria lacustris*, *Rhynchelmis*, and *Rhinodrilus*, is elongated; in others, as in *Deodrilus*, it may be absent. The prostomium, therefore, cannot be regarded as a special segment, especially as the reviewer has shown that it first develops in the embryos supplementarily as a growth of the first segment.

With the exception of *Anachæta*,[1] all Oligochæta are armed with bristles, which rise from the epiblast; in *Anachæta* these are reduced to simple hypodermal glands.

[1] *Branchiobdella*, though generally regarded as a degenerate Oligochæte, is not mentioned in Beddard's work.

The form and variations in their distribution are described in detail by the author. The first segment in all cases is without bristles. In the Geoscolicidæ they are wanting in several of the more anterior segments; in *Kynotus*, for example, there are twenty segments without bristles. A "cephalisation" is caused, partly through this lack of bristles, partly through the absence of dissepiments in two or three of the front segments, and through the development of countless muscles in the peripharyngeal body-cavity. Even the nephridia are deficient or modified in this respect.

Referring to the epidermis, the author cites the well-known relationships of the higher families, and, as in the case of the structure of the clitellum, he refers by name to the works of Claparède, Horst, Mojsisovics, and Cerfontaine, while the communications of the reviewer are not mentioned. Special elements of the epidermis are modified into the sense-cells, particularly in the prostomium[1]; in *Slavina* the sensory elevations are present on each segment. Further, the goblet-shaped organs of the Lumbricidæ, and the sense-girdle in *Rhynchelmis* are described. Also the large gland-like cells in the hypodermis of *Pontoscolex* and *Onychochæta* are held by Beddard to be sense-cells. Finally, Beddard and Horst describe in *Eudrilus* oval bodies in the epidermis in connection with nerves, and compare them to the corpuscles of Pacini.

With regard to the structure of the muscles and their development, the author refers to the works of Cerfontaine and of the reviewer.

The nerve-system shows very primitive relationships only in *Aeolosoma*, while in the rest of the Oligochæta independent cerebral ganglia and a ventral cord are present. The former lie in the first segment in the lower forms, and in the fourth in the higher, where they are at the same time proportionately smaller than in the lower species. The peripheral nerves of the brain are present in varying number; in the Lumbricidæ, as Pisarovic has recently shown, in one or two pairs. Usually it is said that three pairs of nerves proceed from the ventral cord, but according to the data of the last-named author, there are in the hinder segments of *Allolobophora fœtida* only two pairs, the hinder one of which (præseptal, corresponding to the double nerve-segment) stands in a very interesting relationship to the dissepiment and nephridium (=septonephridial nerve). The visceral nerve-system of the Lumbricidæ is so far not known, but in *Megascolides* Spencer,[2] and *Pontodrilus* Perrier, it has been shown. One can feel most secure about this part of the nerve-system in *Chætogaster*, and in the Enchytræidæ, as I have elsewhere shown. The lateral ganglion-cell strings of the lower Oligochæta have lately been declared by Hesse to be unmodified parts of the so-called "nematoid" muscle-fibre. The histological structure of the nerve-system is represented according to the data of Retzius, Friedländer, and the reviewer, and its development according to Wilson, Bergh, and the reviewer.

The lymphoid corpuscles of the body-cavity are thought to be phagocytes.[3] In the cœlom of some Oligochæta special sacs have been discovered, in which the vascular system is enclosed. Beddard calls them "perihæmal spaces," and mentions such in *Deinodrilus*, where

[1] Compare the interesting essay on this matter by Fanny Langdon, *Journ. Morph.*, 1895.

[2] From my own personal researches I can confirm Spencer's data.

[3] Compare the recent communication of Lim Boon Keng "On the Cœlomic Fluid of *Lumbricus terrestris* in Reference to a Protective Mechanism." *Phil. Trans. Roy. Soc. London*, v., 186 (1895), pp. 383–399.

they surround the dorsal vessel. According to Spencer, they are found in *Megascolides*, where a row of diverticula are connected with the body-cavity through a special fissure. Both subintestinal vessels in *Libyodrilus* (Eudrilidæ) possess similar sheaths, as does the supra-intestinal vessel in *Heliodrilus* and *Hyperiodrilus*. These spaces are filled with lymphoid corpuscles, and therefore may represent lymphatic vessels, such as the reviewer has shown to exist also in the sexual-segment of *Allolobophora*.

The pores by which the cœlom communicates with the outer world in Lumbricidæ and some Enchytræidæ have till now remained problematical in function. Beddard describes very closely the excretory organs of Oligochæta. These exist, as the reviewer has shown, in various shapes, according to the stage of evolution of the worm. In the cleavage stage of most Lumbricidæ, three colossal cells function in this manner; the larvæ of the Lumbricidæ possess larval pronephridia; in the segmented embryos, on the other hand, we find embryonic pronephridia. In the first segment the first pair is wanting, which in the Polychæta is known as "head-kidney." These degenerate in Lumbricidæ and *Rhynchelmis*, but Beddard found, on the other hand, that the pronephridia of the first segment of *Octochætus multiporus* persist, and coalesce with the pronephridia of the next segment, forming, in this way, the peptonephridia or salivary glands, which then discharge into the cavity of the mouth. The pronephridia of the next segment and their transformation into the real nephridia or segmental organs, are treated of in my "Entwicklungs-geschichtliche Untersuchungen." With the exception of *Uncinais littoralis* (Bourne), nephridia are known to exist in all Oligochæta; Beddard depicts their form after the classical researches of Benham in *Lumbricus*, as well as the structure of those of *Psammoryctes*. They show the variations of their openings through the contractile vesicle, which last is supposed to be wanting in *Gordiodrilus*. In other respects the nephridia undergo manifold modifications, of which the change of the original paired nephridia to a large number of small, tuft-like excretory organs, which Benham has described as plectonephridia, is the most remarkable.

In the adult Oligochæta the alimentary canal falls into the following parts: the mouth and mouth-cavity, the pharynx, œsophagus, and gut. The mouth-cavity of the Enchytræidæ is worth remark because of the presence of two styles, which the reviewer originally thought to be organs of taste, but which he has lately found reason to believe serve for the digging up of fine roots. In some forms special salivary glands discharge into the pharynx; these were first set down by the reviewer as organs arising from the nephridia (in Enchytræidæ and *Peripatus*). Moreover, the septal glands of the Enchytræidæ discharge themselves into the pharynx; however, these last are known even in higher Oligochæta. The œsophagus of many forms is provided with a gizzard, which usually fills one segment only (in *Lumbricus*, the eighteenth); sometimes, however, several gizzards are present—in *Digaster* and *Dichogaster*, two; in *Perissogaster*, three; in *Moniligaster*, *Heliodrilus*, etc., three to ten. The œsophagus of numerous Oligochæta is provided with calciferous glands, which may be present to the number of from one to eight pairs; in some instances, *e.g.*, Eudrilidæ, etc., they are unpaired, in which case they are related to paired glands, which Michaelsen terms "Chylus-taschen." With the latter the diverticulum from the œsophagus of some Enchytræidæ and *Gordiodrilus* is probably homologous.

The vascular system of the Oligochæta is accurately described.

The author starts from the histological structure of the vessels; he treats first of the chief trunk, namely, the dorsal vessel, which is often paired, and thus retains the embryonic character; next of the supra-intestinal vessel, the ventral vessel, the subintestinal and subneural vessels, and last describes the peripheral circulation with the epidermis-capillaries. Only a few forms possess special respiratory organs, such as *Dero*, *Alma*, *Chætobranchus*, *Branchiura*, and *Hesperodrilus*.

The Oligochæta are all hermaphrodite, and their sexual organs are formed on one and the same plan. The elements present are: (1) the ovaries and testicles; (2) the generative passages, oviduct, and sperm-duct, with egg- and sperm-sacs; (3) the spermathecæ and penial setæ. The position of these varies greatly, but they are always metamerically arranged. Except in *Aeolosoma* the gonads are everywhere paired, the ovaries being present usually in one pair (seldom two), and always situated behind the spermaries. The lower Oligochæta, described by Claparède as "Limicolæ," produce large eggs provided with abundant yolk, while the earthworms possess small eggs ill-provided with yolk. From the latter arise the larvæ swimming in the albumen of the cocoon, while from the richly-yolked eggs come directly segmented embryos (as in Gnathobdellidæ and Rhynchobdellidæ respectively). As to the formation of the egg, compare the data of Horst, Beddard, and the reviewer. The spermatozoa develop completely in special organs, which were formerly described as *vesiculæ seminales*, instead of which the reviewer, for weighty reasons, has proposed the name sperm-sacs. The same function and origin is possessed by the egg-sacs, which are unpaired only in rare cases (Enchytræidæ), but usually present in one to two pairs. Special sperm-ducts are known in all Oligochæta, for in the opinion of the reviewer the statement that *Aeolosoma* discharges the spermatozoa through the nephridia lacks confirmation. The ducts are developed in one or two pairs, and consist of a funnel and a long canal which usually passes into a terminal chamber, the "spermiducal gland." When the sperm-ducts are present in two pairs, they join into a common canal and open outwards through a pair of outlets. One species, called by Beddard *Phreoryctes smithii*, forms an exception; here the four ducts open outwards independently of each other. The originally-described species of *Phreoryctes* (*P. menkeanus* and *filiformis*) are quite unknown in this respect. Special oviducts are not found everywhere; in *Aeolosoma* and Naidomorpha simple openings function as oviducts; these, according to the opinion of the reviewer, correspond to the original funnels, as is the case in Enchytræidæ and Tubificidæ.

With regard to the homology between the nephridia and the sexual ducts, Beddard seems to have superseded E. R. Lankester's old view, according to which each segment contained several pairs of nephridia, one pair of which took upon themselves the functions of the sexual ducts. On the contrary, he turns to the newer developmental researches of the reviewer, according to which the funnels of the ducts proceed from the peritoneum, so that there is no homology between these organs.[1]

As auxiliary organs to sexual intercourse in the various Oligochæte families there are the atria (spermiducal glands, Beddard), the setæ, and the penes, which are all described in detail by Beddard, as are also the manifold relationships of form and position of the spermatophores, of the spermathecæ, of the clitellum, of the sexual papillæ, and of the cocoon.

[1] Compare also Goodrich's last paper "On the Cœlom, Genital Ducts, and Nephridia." *Quart. Journ. Micros. Sci.*, 1895, pp. 477–510.

In the chapter on the geographical distribution of the Oligochæta, the author first describes the factors, which may be the cause of the migrations of the terrestrial forms (our knowledge about aquatic forms is, in this respect, much too scanty). *Allolobophora* and *Lumbricus* belong to the most widespread species, then follow *Eudrilus eugeniæ*, *Pontoscolex corethrurus*, and some species of *Perichæta*. In respect to species, the Nearctic and Palæarctic regions show the greatest similarity. This is also true of the Oriental and Australian forms; here the Cryptodrilidæ and Perichætidæ are the principal forms. The Neotropic and Ethiopic regions are the richest in genera (15, 11), the Oriental and Australian are almost equal, then comes the Palæarctic (4, 5), and, finally, the Nearctic.

Writing of the classification of the Oligochæta, Beddard starts with the comparison of the characters of Claparède's groups, Limicolæ and Terricolæ, with the family Moniligastridæ, and states with justice that these earthworms are a family of the Limicolæ, which, following Benham, he describes as Microdrili. Equivalent to this group are the two remaining Megadrili of Benham (Terricolæ sens. str.) and the Aphanoneura of the reviewer, which division may be deemed a very happy one. That the last-named group of the Aphanoneura takes the lowest place among the Oligochæta—lower, indeed, than the so-called " Archiannelida "—has been already stated by the reviewer. On the other hand, it is very hard to agree with Beddard's view that the Phreoryctidæ represent one of the primitive families of the Microdrili. The chief representatives of this family, *Phreoryctes menkeanus* and *P. filiformis*, are very little known in respect of their sexual organs, and *P. smithi* must perhaps be referred to some other genus than *Phreoryctes*. In the same way, the derivation of the remaining families of earthworms does not seem permissible to the reviewer, especially as the Naidomorpha represent a much earlier group than the rest, from which the Tubificidæ, Enchytræidæ, and Lumbriculidæ can easily be derived. The Chætogastridæ, a very distinct and characteristic family, which at any rate can easily be derived from the Naidomorpha, Beddard, without reason, associates with the latter; and, on the other hand, he gives no reasons why the Discodrilidæ (with *Branchiobdella*) are separated from the system of the Oligochæta. Even the description of the individual genera of Naidomorpha, which are much better characterised than the modern genera of Enchytræidæ, seems to the reviewer not allowable. In this respect—but in this only—Beddard's system will have to be revised; in other respects his book represents a model monograph, which all future workers must consult, whether they intend to work at the morphology of animals or to advance the special study of the Oligochæta.

Prague University. F. Vejdovsky.

A Would-be Legislator.

The Migration of British Birds, Including their Post-Glacial Emigrations as Traced by the Application of a New Law of Dispersal, being a Contribution to the Study of Migration, Geographical Distribution, and Insular Faunas. By Charles Dixon. Pp. 320, with maps. London: Chapman & Hall, 1895. Price 7s. 6d.

Mr. Charles Dixon, or his publisher, is a good-natured man, willing to relieve the reviewer of the tedium of reading his book; for there is inserted behind the title-page an agreeable little printed slip—a skeleton review in which the main points of the book and their importance are pleasantly set forth. We must reluctantly decline, however, to take the book at the estimate provided, and by the addition of a few complimentary phrases to expand an advertisement into an apparent appreciation. In Mr. Dixon's eyes the great point of his book is that it sets forth a "new law of dispersal." To be brief, this new law is that species never extend their range southwards. It were unnecessary to enter upon a little disquisition as to what a law means, and as to the folly of supposing that a generalisation from facts is any explanation of the facts. Mr. Dixon, we fear, would not understand us; and we should be performing a task unnecessary in the case of most of our readers. A single quotation, from many hundreds that might be made, will show that Mr. Dixon is really making this elementary mistake. He writes (p. 57) "we need no 'persistence through long epochs of barriers, isolating the greater part of Africa from the rest of the world,' as Dr. Wallace insists, to account for the absence of such groups as bears, moles, camels, deer, goats, sheep, or such genera as *Bos* and *Sus*: a law forbidding the southern emigration of such types is sufficient to explain the facts, without invoking more or less hypothetical geographical obstructions." Cannot Mr. Dixon see, even if he had succeeded in showing completely that southern dispersal never does, or never has, taken place, that we should have found out no more than a very interesting circumstance to be explained? Dismissing, however, as unworthy of notice what Mr. Dixon considers the point of his book, we shall find in it a very judicious selection of facts and arguments in support of the view that the dispersal of species has taken place in a northerly direction. In the earlier part of his book he concedes so much to common-sense as to endeavour to find a rational basis for this absence of southerly dispersal. He holds that species do not retreat from unfavourable conditions, at least in the ordinary sense of the word. When the Glacial period came on, the inhabitants of the ice-covered regions were simply exterminated. Only those species survived which had a range extending far enough south to avoid the ice. The rest of the species were, so to say, wiped off the slate. He thinks that there were three great "refuge-areas," or "range-bases," for inhabitants of North Europe during the periods of glaciation. The northerly limit of one was the extreme southern edge of the ice, and it extended across the English Channel, then dry, and along France to the ice of the Alps and the ice of North Spain. It was a land similar to the inhabitable Arctic regions of to-day. The second refuge-area extended from south of the first to the Sahara Sea. In this region, probably, most of the birds now in England were preserved. The third area was to the south and east of the second, extending down the Soudan to the Cape. In it were preserved a smaller number of contemporary English species—those chiefly with very wide and eccentric ranges of migration to-day. All birds, thinks Mr. Dixon, which bred north of these refuge-areas, were exterminated by the glaciation. All the birds of existing North Europe have appeared there by a post-glacial, northern extension of their breeding-grounds.

Here is the whole subject-matter of Mr. Dixon's book; and by a vast array of facts and discussions of existing distributions and migrations he attempts to support it. The maps and the facts are both useful, and, as every intelligent reader will see that the "law" part of the book is pure nonsense, we may honestly commend the rest to discriminating persons. But we must admit that even such will find the continual irruptions of the law very distracting, and rather adapted to make them throw the whole thing aside.

A Manual of Ethnology.

The History of Mankind. By F. Ratzel. English edition. In thirty monthly parts (1s. each). Parts I. and II., Oct. and Nov., 1895. Macmillan & Co.

One of the greatest desiderata in the literature of natural science in England is a reasonably complete modern manual of ethnology. The English text-books on this subject have long since been hopelessly out of date, and students have had to rely on foreign works, and notably on Professor Ratzel's "Volkerkünde (three vols., Leipzig, 1887–1888). This work consists of a long introduction devoted to the principles of the science, after which it gives an account of the ethnography of Africa, of Asia and Australasia, and then of the Americas. Professor Ratzel's work is marked by a thorough acquaintance with the literature of the subject, and it supplies a remarkably complete abstract of existing knowledge. It is an indispensable book of reference to every student of ethnology, and it has long been a matter of regret that the absence of an English translation rendered it inaccessible to a large proportion of British travellers. We are glad to find that this want is now being supplied by Messrs. Macmillan, who are publishing a translation in monthly parts. The illustrations, which are an important feature in the original, are being admirably produced; and as the paper and printing are better than the German, the work is in some ways an improvement. So far as we have tested the translation, it is accurate; but the English might easily be improved, as it is often so literal as to be awkward and confusing. "Thus Herder"—as a complete sentence, is rather too Teutonic. "Out of 570,000,000 estimated of monotheists, 440 confess Christianity. Of the remaining 900,000,000 of the earth's inhabitants, the Buddhists, with 600, occupy the largest area, and the most inaccessible to Christian teaching"—is not a model of precise English. "And besides that, the emitted light of faith radiates back warmth"—is not very lucid. This is not the sort of English that we expect from such a well-known writer as Mr. A. J. Butler. As so little trouble is taken over style, it is needless to say that the matter has not been brought up to date. Ratzel draws a large percentage of his illustrations from Africa, where the progress of research is so rapid that many statements made in 1886 are now absurd. Thus on pp. 91 and 95 there are figures of women belonging to the tribes of the Nyam-nyam and of Unyoro, and the remark is retained that "the lady of Uganda or Unyoro. . . . stands in general no higher than the Nyam-nyam negress." The illustrations show differences in physiognomy which alone might have suggested doubts of this view, and recent information shows that it is far, indeed, from the truth. Moreover, some of the terms are used with such different meanings from those accepted for them by English ethnologists, that they cannot but confuse English readers; and it is a pity that they were not explained in footnotes. The editor contributes a few suggestions on general questions, but these are not a valuable addition to the book.

A Guide to the Rocks.

An Introduction to the Study of Rocks. British Museum (Natural History), Cromwell Road, London, S.W. Mineral Department. Printed by order of the Trustees. 8vo. Pp. 118. London, 1895. Price 6d.

The Department of Minerals of the British Museum, of which department Mr. Lazarus Fletcher is the head, has identified itself with practical education of the best kind. This is the third so-called guide-book to its collections that has appeared. As in its well-known predecessor, "The Study of Minerals," Mr. Fletcher has struck out an entirely original line. Those who expect to find in this book merely the cheapest text-book of petrology that they can purchase to prepare themselves for some elementary examination, or even to give themselves a sound knowledge of the necessary facts and figures of the science, will be disappointed. Shortly to characterise the plan of the book, we should say that it provided an introduction to the methods of all science, especially to those departments of science that concern themselves with the orderly arrangement or classification of things or facts, and that the study of rocks was brought in rather as an illustration of scientific methods than as the principal aim of the book. Perhaps this would be going a little too far, for there can be no doubt that whosoever chooses to master this little book will also have gained no inconsiderable acquaintance with the facts and principles of petrology. Roughly put, the author's method in this guide is to set before the student a miscellaneous assortment of rocks, and to ask him to classify them. The incorrectness and impracticability of the classifications that at first suggest themselves from such superficial characters as colour, texture, or weight is exposed, and the student is then initiated into the various means of investigating the inner structure, the affinities, and the modes of origin of rocks, and so has placed before him—clear to his understanding, though as yet unattainable—the ultimate goal of a natural classification. Although the book is of interest and even of value when taken by itself, yet its real worth will not be apparent until it can be read in connection with the splendid series of teaching specimens that the Department is gradually accumulating and now beginning to arrange in the table-cases adjoining those that contain the series introductory to the study of minerals. The book is in fact what it professes to be—a Museum Guide. Not indeed a description of exhibited specimens, or a barren list of more obscure treasures, but a book that should enable every intelligent person to proceed for himself to the true appreciation of the contents of one section of our great Museum.

For those who wish to acquire knowledge, the British Museum is fast becoming more than a mere storehouse, and it will be to the teaching collections more than all else that the growth of the scientific collections will be due in the future. We congratulate Mr. Fletcher and his assistants, Messrs. Miers, Prior, and Spencer, on the thoroughly practical arrangement of the collections under their charge.

THE GEOLOGY OF IRELAND.

GUIDE TO THE COLLECTIONS OF ROCKS AND FOSSILS BELONGING TO THE GEOLOGICAL SURVEY OF IRELAND, arranged in Room III.E. of the Museum of Science and Art, Dublin. By A. McHenry, M.R.I.A., and W. W. Watts, M.A., F.G.S. Dublin (for her Majesty's Stationery Office): Alexander Thom and Co. Price 9d.

DESPITE the publications of the Mineral Department of the British Museum, fraught with such originality and freshness, and the admirable treatises on art issued under the auspices of the South Kensington Museum, it appears that there is still room for surprises among official handbooks. Messrs. McHenry and Watts, in place of a dry catalogue, have produced a manual of the Geology of Ireland which will be even more valuable to those engaged in research than to the ordinary visitors in the museum. The rocks collected by the

Geological Survey of Ireland have for some years been arranged, according to geographical areas, in upright cases in a room of the Dublin Museum; while the fossils have been displayed in table-cases associated with them. The arrangement of these flat cases is, of course, stratigraphical, and the figured and type-specimens have been removed to a special collection. The geology of the country has been further illustrated by a series of the one-inch maps of the Survey hung in the upright cases, so as to correspond with each geographical group of rocks, and by photographs and water-colour paintings, exhibited to such advantage or disadvantage as the lighting of the building will permit. To crown their labours, Mr. McHenry, who chipped out so many of the specimens with his own hands, and Mr. Watts, who for a time had charge of the petrographic investigations, have drawn up in an unpretentious form a systematic account of the collections.

Both the petrological and palæontological portions of this guide show evidence of regard for recent literature, and the former section has afforded scope for many original observations. Workers, intent on elucidating some one of the local problems of Irish geology, will again and again find that they have been anticipated by the careful but comprehensive work of Mr. Watts; while Mr. McHenry has long possessed a capacity for attacking difficult areas and bringing home a mass of useful information. An index of localities would have improved the present guide as a work of reference; but it will at once take its place in the library and not only as a guide to the museum.

While the petrological portion presupposes a certain amount of geological knowledge, and even a familiarity with some of the generic names of rocks evolved in German laboratories, an attempt has been made to preface the palæontological pages by an outline of the animal kingdom. This, we think, is a mistake, especially as there is a well-equipped department of zoology close at hand. It would be ungracious to criticise details where so much compression of material has been effected; but some revision may be possible in a new edition. Thus (p. 99) the occurrence of corals in the American *Olenellus*-fauna is overlooked; nor can an ophiurid be aptly described as "pentagonal in outline." On page 101, we read "the Eurypterids were large crustaceans, most of whose abdominal segments were devoid of limbs." There is, moreover, a great vagueness in the reference to the King-crabs; whether the concluding sentences refer to *Limulus* or to the Limuloids, one or other of the statements made must be incorrect. On p. 116 we may quarrel with the description of *Asterophyllites;* but slips and misprints are delightfully rare throughout the work.

Full use has been made of the most recent researches on Irish geology, although space would not permit of reference to more than the authors' names. But the work of Messrs. McHenry and Watts, in the field and in the office in Hume Street, has contributed a host of new details, which appear here in the most modest manner. As an example of the skilful treatment, on the other hand, of a mass of older information difficult to correlate, we may cite the description of the Old Red Sandstone in Munster, on pp. 83–85.

This little paper-covered volume, the price of which is a few pence, not shillings, is unquestionably the best informed work on Irish geology extant. It is not a museum-catalogue, but a readable guide, indispensable to those who would have an accurate knowledge of the stratigraphical geology of our islands. G. A. J. C.

ATLASES.

PHILIP'S SYSTEMATIC ATLAS. Physical and Political, specially designed for the use of High Schools and Private Students, etc. By E. G. Ravenstein. School Edition, 11 × 8 inches. 41 double pages containing 170 maps and diagrams and an Index of 12,000 names. London: G. Philip & Sons, 1894. Price 10s. 6d.

PHILIP'S HANDY-VOLUME ATLAS OF THE WORLD. By E. G. Ravenstein. New and enlarged edition, 6 × 4 inches. 72 maps and Index. London: G. Philip and Sons, 1895. Price 5s.

IN April, 1894, we had something to say about the first of these atlases, and though our remarks may not have been pleasing to the compilers or to the publishers, they might well have been listened to for reputation's sake. The School Edition of the Systematic Atlas, it is true, omits the nonsensical geographical distribution map as well as the inadequate geological map of Europe; but it includes the absurd little hemispheres of religion, and those showing the races of mankind. "Tit-bits of inaccurate folly" we called them then, tit-bits of inaccurate folly we call them now. We have no good word for publications in which absurdities once pointed out are persistently reproduced, even though Messrs. J. Scott Keltie, H. J. Mackinder, and E. G. Ravenstein vouch for their accuracy. We hope this atlas was not exhibited at the Geographical Congress for the delectation of our foreign visitors.

The Handy-volume Atlas, with its seventy-two maps, is much more useful. It seems to have been brought up-to-date carefully, and is clearly printed, and not overcrowded with names. The impertinence of classifying religions into *Heathen*, Hindus, Bhuddists, [*sic*] Mohammedans, and Christians is repeated, but the races of mankind here fall into the following heads: Aryans, Semites and Hamites, Mongols, and American Indians, though others are shown in the two little hemispheres. On the backs of each map is printed a variety of information of use for reference, and there is a good index.

CATS.

A HANDBOOK TO THE CARNIVORA. Part I. By R. Lydekker, F.R.S. Allen's Naturalist's Library. Edited by R. B. Sharpe. Pp. viii., 312, with 32 plates and woodcuts. London: Allen & Co., 1895. Price 6s.

DR. SHARPE, the editor of the series, has wisely entrusted to Mr. Lydekker the preparation of a large number of the mammalian volumes of the Naturalist's Series, a task for which he is well fitted by reason of his special acquaintance with the group and his phenomenal fertility in the production of results. We imagine that there are few writers upon zoology who can show so magnificent a total in the way of published work as can Mr. Lydekker. So far as we can judge of the present volume, we cannot accuse the author of having sacrificed accuracy to speed. His clear descriptions are borne out by plates which we cannot actually term excellent, but which are fair representations of the animals which they illustrate; but in making this criticism the low price of the book must obviously be taken into consideration. For our part, we would have preferred fewer and better pictures; but that is a matter of taste concerning which there might be disputes. The figure of the *Cryptoprocta*, for example,—which we are glad to see Mr. Lydekker includes without any fuss among the Viverridæ, a proceeding in which he is supported by Mr. Beddard in his memoir upon the anatomy of the animal published in the last number of the *Proceedings* of the Zoological

Society,—contrasts unfavourably with the beautiful coloured drawing of the Fossa from the pencil of the well-known animal painter, Mr. Nettleship, which adorns Mr. Beddard's paper. Still, we cannot expect everything for six shillings, and the wonder is what a great deal the publishers have given us for that modest sum. If the editor could be induced to urge Messrs. Allen to treat of the invertebrates in the same liberal and thorough fashion in which the vertebrates are being treated, the Naturalist's Library would be a work without which no naturalist's library would be complete.

Animals of the Coast of Normandy.

Recherches sur les faunes marines et maritimes de la Normandie. Par H. Gadeau de Kerville. Pp. 184, with 2 plates and 4 woodcuts. Paris: Baillière. Price 5 francs.

This is a careful faunistic list of the coasts of Normandy, preceded by a bibliography—large in itself and terminated by an "etc."—of the author's works. Maps as well as figures of animals constitute the plates, while the author apparently neglects no group, but includes the land vertebrates as well as the marine invertebrates. A special feature of the work is an appendix upon the copepods of the region by E. Canu, and upon the mites by E. L. Trouessart, in which latter report the anatomy of several species is gone into at some length.

Recent Writings on the Foraminifera.

The Zoological Society has just published (*Proceedings*) an important paper by Mr. Frederick Chapman "On some Foraminifera obtained by the Royal Indian Marine Survey's s.s. 'Investigator' from the Arabian Sea, near the Laccadive Islands." The area from which the material was obtained is sufficiently out of the path of former expeditions to make the list useful. The samples were dredged from a depth not exceeding 1,238 fathoms. Exact depths were not recorded, but the temperature at 1,130 fathoms was 37° F., while that at the surface was 78°–80° F. Two hundred and seventy-seven species are noted, of which eight are new to the list of recent forms. These eight were recorded by Schwager for the Kar-Nicobar Pliocene clays (Novara Exped., Geol. Theil ii., 1866), and we are now enabled, with the assistance of Brady's Monograph, to compare very closely the foraminiferal fauna of these Pliocene deposits with that of the present surrounding sea. An interesting point too, in Chapman's paper is the canal system described in *Amphistegina radiata*, and this and other features mentioned in the paper, strengthen the evidence in favour of this form being truly referred to *Amphistegina*. Another point of even more interest is the section of *Amphistegina* showing a young shell in one of the chambers.

Dr. V. Madsen, of Copenhagen, continues his work in recording occurrences of Foraminifera from the Pleistocene beds of Rügen and West Prussia (*Med. Dansk. geol. Foren.*, 3); Dr. F. Karrer, in a further paper on the Tertiary beds of the Vienna basin (*Jahrb. k. k. geol. Reichs.*, 1895), carefully lists the occurrences in the various clays and sands that have come under his observation; G. A. De Amicis has published (*Nat. Sicil.*, xiv., 1895) a valuable paper on the Foraminifera of the Pliocene beds of Bonfornello, in Sicily. One hundred and sixty-three forms are enumerated, of which several are new; one plate is given. There is an interesting new *Cyclammina*, while *Ramulina* is recorded for the first time from Pliocene deposits. Carlo Fornasini contributes to the *Memoria R. Acc. Sci. Bologna*, vol. v., a continuation of his notes on the Italian Tertiary forms, dealing with the Frondiculariæ and Cristellariæ in particular. He figures a large series of the compressed varieties of the *C. cymba* group. In a single sheet, privately printed, Fornasini describes *Lagena felsinea*, an entosoleniform *Lagena*, in which the test is botelloid and the aperture lateral.

Besides these recent papers, there are two which were published in 1892 by Jaroslav Perner, of Prague, which appear to have escaped notice on account of their inaccessibility. The first is "Predbezny kriticky seznam Foraminifer z brezenskych vrstev," and was published in *Vestnik Krakovske Ceske Spol. Nauk*, 1892, at Prague. This is an account of the forms found in the Priesener Beds of the Bohemian Chalk, and is valuable for comparison with Reuss's list of the same district, and with those of other Chalk deposits. The other paper is entitled "Ueber die Foraminiferen des böhmischen Cenomans," and will be found in the quarto publications of the *Ceska Akademie Cisare Frantiska Josefa* (Trida ii.) under the Czech title, "Foraminifery Ceskeho Cenomanu." With this paper are published a series of ten excellent plates, which contain a number of valuable sections. The author has evidently been handicapped by the absence of previous literature in Prague, but in the future this want can easily and willingly be supplied by his English colleagues. Borings of parasitic organisms are shown in many of Perner's figures, and what is apparently an aperture of *Ramulina* is seen on pl. 5, fig. 19*b*.

Photograms.

We are really indebted to the editors of *The Photogram* for sending us their beautiful annual "Photograms of '95. A Pictorial and Literary Record of the Best Photographic Work of the Year" (Dawbarn & Ward, Ltd.). It contains beautiful examples of photography, of half-tone process, and of printing. Especially are we struck by the absurdly-named "Chemigraph" process, which consists in printing two or three impressions from the same block—one in a strong body colour, and the other or others in a pale tint, and very slightly out of register. Some of the photograms from abroad are a little older than the title of the volume warrants—at least, the pretty picture of some Japanese women on the balcony of a tea-house in Tokio has a familiar aspect. "The photographic study of animal life has," we are told, "been greatly advanced. A. G. Wallihan and his wife in Colorado, and W. H. Wright in Montana, have added considerably to their invaluable studies of the fast-disappearing native fauna of the United States; and J. Turner-Turner has published his intensely interesting records of hunting, trapping, and natural history in Canada." In our own country, not to mention Mr. Gambier Bolton, some of the chief workers are R. B. Lodge and R. and C. Kearton, who have devoted themselves to birds and their nests. Workers in natural science will also be glad to hear of the cyclograph, an instrument invented by A. H. Smith, of the British Museum, to take a view all round a circular object. We wish that we could treat of some of the photograms, such as E. Calland's wonderfully composed and lighted "Brompton Road—Late Afternoon," F. H. Evans' restful and exquisite "Stairway in Lincoln Cathedral," or "Harvesting Osiers," by A. J. Jeffreys. This our scope does not permit, but we should be failing in our duty did we not inform the bewildered critic that the "streak of light in the centre of" C. Millard's "After Lessons" is clearly a microscope tube, which interpretation is confirmed by the condenser alongside. In short, this is a well written, well illustrated, and cheap two shillings-worth.

OBITUARY.

ROBERT BROWN.

BORN MARCH 23, 1842. DIED OCTOBER 26, 1895.

ROBERT BROWN ("Campsterianus"), the well-known botanist and editor of popular works on science, was born at Campster, Caithness. He was educated at Edinburgh University, and in later life visited Leyden, Rostock, and Copenhagen for educational purposes. At Rostock, he read his thesis "Species Thujæ et Libocedri quæ in America Septentrionale gignuntur." From 1860 to 1875 Dr. Brown was a great traveller, visiting Jan Mayen, Spitzbergen, and Greenland in 1861; the West Indies, the Pacific, Vancouver, and Alaska in 1863–66 as botanist to the British Columbia Expedition; Greenland in 1867, in company with Mr. Whymper; and after 1868 he travelled in Northern Africa. He was the author of numerous papers, but the public will remember him best by his editorship of "Peoples of the World," the "Story of Africa and its Explorers," and "Science for All."

THE HON. WALTER B. D. MANTELL, son of Gideon Algernon Mantell, and himself a geologist of considerable merit, died at Wellington, New Zealand, on September 7. Mr. Mantell was born in 1820, but left England for New Zealand about 1840, where he became a man of great public importance, holding the posts of Minister for Native Affairs and of Postmaster-General and Secretary for Crown Lands. He was ever mindful of the interests of the Maoris. Mantell was the first to explore the Waikonaiti and Waingongoro Moa beds, and his collections ultimately found a resting-place in the British Museum. He retained to the end his interest in geology, and possessed many specimens that had belonged to his father, some of them possibly of historic interest.

ABRAHAM VIKTOR RYDBERG, who died at his home near Stockholm on September 21, at the age of 67, was not merely the greatest writer both in prose and poetry that Sweden has known since the days of Tegner, but a learned authority on the history and development of art and culture. It is chiefly through his researches into the myths of the Teutonic peoples that he is known to the narrower scientific world. His great work on the subject gave rise to much discussion among specialists, and a translation of it by R. B. Anderson was published in London in 1889, under the title "Teutonic Mythology." The last writing from his pen was an essay on the future of the white race, prefixed to the Swedish translation of Mr. Kidd's "Social Evolution." Himself an earnest student, a friend of science, and, while member of the Riksdag, a promoter of scientific education, it was nevertheless his life-work to protest against a cold, materialistic interpretation of nature, and to set before the younger generation the half-forgotten claims of the ideal.

Among other deaths which it is our misfortune to record, are those of: Phillip Henry Lawrence, the mineralogist, and translator of von Cotta's treatise on Lithology, who died towards the end of October; Professor H. Hellriegel, the agricultural chemist, director of the agricultural experiment station at Bernburg, best known for his discovery of the fixation of free nitrogen by leguminous plants, by the micro-organisms in the root nodules, who passed away on September 24, aged 64; Dr. Ernest Baumann, the African traveller, at Cologne, on September 4, at the early age of 24; Ephraim W. Bull, the agriculturist, on September 26, aged 89; Professor F. Bertè of Catania, on September 9; J. Kostal, malacologist, and assistant in the Bohemian Polytechnicum, on September 26, at Prague; Dr. E. Slizenberger, lichenologist, at Constance, on September 27; the aged student of Lepidoptera, J. Fallou, in Paris, on June 19, in his 84th year; Dr. Riva, botanist and African traveller, in Rome, on August 24; Dr. Gustav Wilhelm, Professor of Agricultural Botany in the Technische Hochschule at Graz, on September 30; P. Bertkau, Professor of Zoology at Bonn; Professor L. Duda, student of Hemiptera, in Prague, last August; and Dr. Jas. E. Garretson, dean of the Philadelphia Dental College, on October 27, aged 67.

Our readers will find a portrait and a full and appreciative account of the life and work of the late Professor C. C. Babington in the September number of the *Journal of Botany*, by the editor; and in the *Botanical Gazette* for August a biographical sketch by G. E. Davenport, also with a portrait, of another botanist, Daniel Cady Eaton, of whom we published a short obituary notice in our September number.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments are announced:—Dr. Marshall Ward, Professor of Botany at Cooper's Hill Engineering College, to be Professor of Botany at Cambridge in place of the late Charles Babington; James Wilson, Lecturer in Agriculture at Aberystwyth, to be Fordyce Lecturer in Agriculture at Aberdeen University; F. F. Blackman, Demonstrator of Botany at Cambridge University, to be a Fellow of St. John's; V. H. Blackman, to be Assistant in the Botanical Department of the British Museum; M. D. Hill, to be Junior Demonstrator in Zoology at Owens College; Thomas Midgley, son of the Curator of the Chadwick Museum, Bolton, to be on the permanent staff as Assistant-Curator and Taxidermist; Dr. F. Marés, to be Professor of Physiology at the Bohemian University, Prague; J. Gad, to be Professor of Physiology and Director of the Physiological Institute in the German University, Prague; Dr. M. von Lenhossek, of Warzburg, to be Prosector in the Anatomical Institute at Tübingen; Dr. Joseph Disse, of Halle, to be Professor of Anatomy at Marburg; Dr. Beck, of the Geological Survey in Leipzig, to be Professor at the Mining College of Freiberg, i.S.; Dr. Hillebrand, to be Assistant-Professor of Experimental Psychology at Vienna; Dr. Schuchardt, to the newly-founded Professorship of Psychiatry at Rostock; Dr. J. Wortmann, Director of the Experiment Station in Plant Physiology at Geisenheim, to be Professor; Dr. A. Rothpletz to be Extraordinary Professor of Geology and Palæontology in Munich University; Carl A. Redlich, as Curator of the Brünn Museum; Dr. Dogiel, Professor of Anatomy at Tomsk, to be Professor in the University of St. Petersburg; Professor F. Ficallei, of Cagliari, as Professor of Zoology at Messina; Daniel F. MacDougal, to be Assistant-Professor of Botany in Minnesota University; H. Landes to be Professor of Geology in the Washington State University; Richard E. Dodge to be Instructor in Geography and Geology in the Teachers' College, New York. Dr. Albert Mann has taken up work in Biology at the Ohio Wesleyan University. Dr. W. Biedermann has gone to Graz University.

THE Burdett-Coutts' Scholarship in Geology, of Oxford University, has been awarded to W. B. Prowse, of Pembroke. R. M. Brydone, of New College, has been awarded the Scholarship which was not given last year, tenable for one year only.

A CURATOR is to be appointed for the Fielding Herbarium at Oxford. He will be under the Professor of Botany, and will be paid by income arising from a bequest of £900 under the will of the late Mrs. Fielding, and from other funds at the disposal of the Fielding Curators.

MINNESOTA UNIVERSITY is building a laboratory for bacteriological, histological, and pharmacological research.

THE late Sir Jerome Murch bequeathed £50 to the Bath Literary and Scientific Institution, of which he was sometime president. Colonel Chase has left

5,000 dollars to Harvard College, to found a medical scholarship, to be called the C. B. Porter Scholarship. The Spring Garden Institute, of Philadelphia, has received a gift of 100,000 dollars from the heirs of Samuel Jeanes, himself a great benefactor during his lifetime. Earlham College, Richmond, Indiana, has received from Messrs. M. H. and F. T. White, of Cincinnati and New York, 25,000 dollars as a memorial of their father, John T. White. The Royal College of Physicians of London has received £3,000 from Dr. H. Weber, to found a triennial prize for research on the prevention and cure of tuberculosis. Mrs. Mary Putnam Bull has given to the Davenport Academy of Natural Sciences ten thousand dollars in memory of C. E. and J. D. Putnam. This sum will ensure the continued publication of the valuable *Proceedings* of the Academy.

Some of the work done this year at the Marine Laboratory of the U.S. Fish Commission at Wood's Holl is summarised in *Science* for October 25 by Professor J. I. Peck. H. V. Wilson has studied the sponges from the Gulf of California and the Galapagos Islands, collected by Agassiz on the "Albatross." W. Patten has investigated some abnormal developments of *Limulus* embryos, which are expected to throw light on the physiology of embryonic growth. L. Murbach has had the luck to obtain the eggs of the medusa *Gonionemus* in various stages of development, while G. Lefevre has made interesting observations on the fixation of the tailed larva of *Perophora*. Important work on nervous systems, and specially on ganglion cells, has been conducted by I. Van Gieson, I. Strauss, J. E. Peabody, and others. T. H. Montgomery has studied the histology of nemertines and the development of their proboscis. Professor Peck himself has found out what the youngest fish-fry feed on. He concludes with some remarks, which specially appeal to us, on the relations of the Laboratory to educational bodies. The work of the young students, he says, "seems more important each year than it did the year before." Since no definite instruction is given at the Laboratory, such students should be furnished in advance with "definite ideas of what forms to select for work, how to proceed, and what to read." "An advantage of the presence of students who are doing work of a more general character is the custom of regular towing, and of constantly bringing into the Laboratory fresh supplies of living material of many kinds. . . . This keeps all the men engaged in special research in association with general phenomena of the most attractive kinds." The collection of material by teachers for class demonstration has also greatly benefited "biological work in all of the twenty universities, colleges, and secondary schools represented here this season."

Mr. Andrew Carnegie has, at a cost of £200,000, built a free library, with museum, art galleries, and four branch libraries, at Pittsburg, U.S.A.

The Owen Memorial Committee has decided that the statue to Owen, to be placed in the British Museum (Natural History), shall be in bronze.

The changes at the British Museum (Natural History) on the retirement of the Keeper of Zoology, Dr. A. Günther, are as follows:—Professor Sir W. Flower assumes the office of Keeper of Zoology in addition to his post as Director, without addition of salary; Dr. Bowdler Sharpe becomes Assistant-Keeper of Vertebrata, his department consisting of Messrs. Thomas, Boulenger, and Grant; Mr. Edgar A. Smith, Assistant-Keeper of Invertebrata, associated with Professor Jeffrey Bell, Mr. Pocock, and Mr. Kirkpatrick; Dr. A. G. Butler, the head of the Entomological Department, with his juniors, Messrs. Waterhouse, Kirby, Gahan, Heron, Austen, Hampson, and a new Assistant appointed to fill the vacancy. Mr. Pocock becomes a first-class Assistant. Changes have also been begun in the galleries. For instance, the larger fishes will be slung up to the roof, so as not to cumber the valuable floor-space, and a more definite arrangement will be made of fishes; similar alterations are contemplated in the reptile gallery, where seventeen crocodiles have for many years enjoyed palatial quarters on the floor. The public gallery of birds will gradually be improved on the plan adopted already in one of the bays, and in the mammalian gallery certain arrangements are contemplated which will show the finer specimens to great advantage.

The Trustees have recently purchased for the Department of Geology important series of fossils selected from the collections of the Rev. P. B. Brodie, Rowington, Warwick, and of the late Mr. James W. Davis, Chevinedge, Halifax. Mr. Brodie's collection, the result of a long and active life devoted in all intervals of leisure to geological work, comprises a large number of type-specimens described by various authors; and all of these are included in the British Museum selection except those in his unique cabinet of fossil insects, which he still retains. The collection of the late Mr. Davis contains some very fine fishes from the Lower Lias of Lyme Regis and a large number of fragmentary fish-remains from the Yorkshire Coal-measures, described and figured in his own writings.

Mr. Oldfield Thomas, whose health for some time has been unsatisfactory, has received six months' leave of absence, for an extended foreign tour. Mr. E. E. Austen has also received four months' leave from the British Museum in order to join a cable expedition of Messrs. Siemens up the Amazon. We look forward confidently to the time when every man on the staff will be sent out, not on leave, but officially, for the purpose of studying foreign collections and life in the field.

WE are glad to note that the Treasury has generously decided to present a complete series of the "Challenger" Reports to the Bristol Free Public Museum. This is a graceful recognition of the valuable educational and scientific work now being carried on by that museum, which has made remarkable progress since it came under the control of the City Corporation.

POPULAR lectures are, as usual, being given at the Manchester Museum. W. E. Hoyle lectures on Geology, F. E. Weiss on Botany, Boyd Dawkins on Geology, Burghardt on Mineralogy, and S. J. Hickson on Anthropology. These lectures are aided by an annual grant of £400 from the Corporation of Manchester, drawn from the Free Library rates.

We have received from Mr. Hoyle another of the useful museum handbooks. This is a "Catalogue of the Hadfield Collection of Shells from Lifu and Uvea, Loyalty Islands," by James Cosmo Melvill and Robert Standen (price 1s.), and it is nothing more or less than a reprint, retaining the original pagination and plates, of a paper published by those authors in the *Journal of Conchology*. So long as proper references are given and dates not tampered with, we have nothing to say against such a form of re-publication. Indeed, if proprietors, editors, and authors are willing, we see no reason why this useful course should not be followed by other museums. Many papers are published, and readers of NATURAL SCIENCE especially can call to mind no few such, that would be most acceptable to the public if reprinted and sold by museum authorities at a small charge.

THE Epping Forest Free Local Museum, established by the Essex Field Club, in Queen Elizabeth's Lodge, Chingford, was opened on November 2 by Mr. R. C. Halse, Chairman of the Epping Forest Committee of the London Corporation. There was a large attendance of members of the Club, and Sir William Flower, Director of the British Museum (Natural History), was among the invited guests. In the evening a formal meeting was held in the Royal Forest Hotel, and Mr. A. Smith Woodward delivered an appropriate address on Local Museums. The Essex Field Club, as is well known, has already established a County Museum at Chelmsford; but it has long urged the importance of a smaller museum within the Forest area, and all difficulties in the agreement with the Committee of the London Corporation have at last been overcome. This new museum is established mainly to serve two purposes, namely (1), to afford plain information about the animals, plants, geology, and antiquities of the district, and so promote a love for the out-of-door study of Natural History among the intelligent visitors to the Forest, and (2) to form ultimately a store-house for the preservation of authentic series of Forest specimens, not only as a matter of scientific importance, but also as aids to the studies of the many amateurs who frequent the Forest as one of the best "all-round" hunting grounds for the naturalist in the London district. With the permission and enlightened recognition of the usefulness of such an exhibition by the Epping Forest Committee of the Corporation of London (who have met the wishes of the Club in the kindest way), the collections have been housed in the Banqueting-room of the antique building known as "Queen Elizabeth's Hunting Lodge," which was transferred by the Crown to the Corporation at the passing of the Epping Forest Act, to be preserved "as an object of antiquarian interest." The arrangement of the cases has been admirably carried out by Messrs. W. and B. G. Cole, with the co-operation of an enthusiastic Committee, and an interesting series of specimens is already displayed. Mr. T. Hay Wilson has contributed a small collection of rock-specimens from the gravels of the Forest area, and derived fossils from the Boulder Clay. Mr. J. E. Greenhill has a series of bones of mammals and shells of molluscs from the surface deposits of the Lea valley, also numerous stone and bronze implements. The investigations of the Essex Field Club itself have provided late Celtic objects from the Ambresbury and Loughton Camps. Mr. Chalkly Gould has arranged a collection of Romano-British pottery, etc., from Chigwell, which is described in the first of a proposed series of Museum Handbooks. A collection of dried fungi, made by the late Mr. English, of Epping, occupies a wall-case; and near it is a valuable volume of about 500 coloured plates of fungi by Dr. M. C. Cooke. The flowering plants collected and dried in an uncrushed state by the late Mr. English occupy numerous cases, and large plates of dissections from Oliver's "Botany" are conveniently placed near them. The insects are mainly from the collections of Messrs. W. and B. G. Cole, while the land and fresh-water shells, beautifully mounted, have been contributed by Mr. W. Crouch. An almost complete collection of the eggs of birds nesting in the Forest is exhibited, and the birds themselves are not only represented by many actual specimens, but also by a series of woodcuts from Saunders' "British Birds." On the staircase are shown some interesting maps and various views of the Forest. The museum is open to the public each week-day, and all communications respecting it should be addressed to Mr. William Cole, the Honorary Curator.

We understand that the Belgian Government, not satisfied with the extent of its new Royal Museum of Natural History, is already contemplating the addition of a special gallery for the reception of the unique series of Iguanodons and other fossil vertebrates from the Wealden of Bernissart.

During a recent visit to the West Prussian Provincial Museum, at Danzig, Dr. A. Nehring identified a portion of skull of the Saiga Antelope obtained from a superficial deposit near Graudenz, where many other fossil bones have been found. This is the first definite record of the occurrence of the Saiga among the "Diluvial Fauna" of Germany.

A new public museum has recently been opened at Kasan. The collections, says *Nature*, comprise numerous ornaments of gold and silver, various arms and implements from the former kingdom of the Volga Bulgars, modern decorative art of the Kasan Tartars, dress and implements of the Chuvashes, Cheremisses, and Mordves, and nearly 1,500 stone implements from the basins of the Volga and Kama. Alexandria also has opened a public museum, chiefly devoted to Greek, Roman, and Coptic antiquities.

The cost of Lieutenant Peary's last expedition to Inglefield Gulf will, says the *American Naturalist*, be repaid by his observations and collections in ethnology, meteorology, and other branches of science. The scientific results of the relief expedition are also of great value, and the large collections made by it will go to the American Museum of Natural History in New York, and the Museum of Kansas University.

THE medals of the Royal Society are awarded as follows:—the Copley Medal to Professor Karl Weierstrass for his investigations in pure mathematics; a Royal Medal to Professor J. A. Ewing for his researches on magnetic induction in metals; a Royal Medal to John Murray of the "Challenger"; and the Davy Medal to Professor W. Ramsay for his share in the discovery of argon, and for his discoveries regarding the gaseous constituents of minerals.

The following are recommended for election as officers and council for 1896:—President, Sir Joseph Lister; Treasurer, Sir John Evans; Secretaries, Professor Michael Foster and Lord Rayleigh; Foreign Secretary, Dr. E. Frankland; other members of the council, W. Crookes, Sir Joseph Fayrer, L. Fletcher, Dr. W. H. Gaskell, Dr. W. Huggins, Lord Kelvin, Professor A. B. W. Kennedy, Professor H. Lamb, Professor E. Ray Lankester, Professor C. Lapworth, Major MacMahon, Professor J. H. Poynting, Professor A. W. Rücker, O. Salvin, Professor Marshall Ward, and Admiral Wharton.

ON the evening of Thursday, October 31, the Royal Society opened its Session with an informal social meeting of Fellows only. The come-as-you-please arrangement was much appreciated, and is likely to be repeated. There were a few exhibits, but the main purpose of the evening was conversation. It must have occurred to many people that the rooms and organisation of many of our learned societies might well be utilised a little more for purposes of good-fellowship. The Cosmos Club at Washington broaches a barrel of beer and hands round long clays. With us, early closing is in force, and thirsty ones are put off with the presidential announcement that "tea and coffee are served upstairs."

MISS JOSEPHINE E. TILDEN has been awarded the Albert Howard Fellowship for her work on American fresh-water algæ. The Baly Medal of the Royal College of Physicians has been awarded to Dr. W. H. Gaskell, of Cambridge.

THE Royal Academy of Belgium offers a gold medal for the best original memoir, written either in French or Flemish, on each of the following subjects:—(1) The intervention of phagocytes in the development of Invertebrata. (2) The phosphates and carbonates in the soil of Belgium, giving the horizons and localities of all minerals referred to. (3) The peripheral nervous system of *Amphioxus*, especially the constitution and genesis of the roots of the sensory nerves. (4) The mechanism of the cicatrisation of plants. The manuscripts must be sent to "M. le secrétaire perpétuel, au Palais des Académies, Bruxelles," before August 1, 1896, signed, not with a pseudonym, but with a device, which must be repeated on a card containing the name and address of the author and sent with the MS. in a sealed envelope. We note with pleasure that the Academy insists on exactness of quotation: authors must give the editions and pages of the works cited. We recommend this earnestly to our own contributors.

THE Royal Society of New South Wales offers a medal and a sum of £25 for the best communications on original research in the following subjects:—"The Origin of Multiple Hydatids in Man"; "The Occurrence of Precious Stones in New South Wales, with a description of the Deposits in which they are found"; "The Effect of the Australian Climate on the Physical Development of the Australian-born Population"; "The Physiological Action of the Poison of any Australian Snake, Spider, or Tick"; "The Chemistry of the Australian Gums and Resins"; "The Embryology and Development of the Echidna or Platypus"; "The Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales"; "The Mode of Occurrence, Chemical Composition, and Origin of Artesian Water in New South Wales." Particulars can be obtained from the honorary secretary, 5 Elizabeth Street, Sydney.

THE *Standard and Diggers' News* publishes in its number for September 7 portraits and biographies of Dr. A. H. Exton (president), Dr. Guybon Atherston (vice-president), and Mr. David Draper (secretary), the three principal officers and founders of the Geological Society of South Africa.

The third French Congress of Medicine will be held in 1896 at Nancy, under the presidency of Dr. Pitres, Dean of the Faculty of Medicine of Bordeaux.

Professor E. D. Cope has been elected President of the American Association for 1896. The meeting will be held at Buffalo in August. B. K. Emerson will preside over geology; Theodore N. Gill over zoology; N. L. Britton over botany; and a woman, Alice C. Fletcher, over anthropology.

A telegram from Aden, dated November 3, announces the safety of the Donaldson-Smith expedition. Letters have been received from Dr. Forsyth Major, dated August 27, from Central Madagascar, announcing the welfare of himself and his companion, Mr. Robert.

The German Committee for the exploration of the South Polar regions has decided to send two vessels southwards from Kerguelen Island, and to leave full liberty of action to the leaders. The total sum to be allotted for the expedition, which is to last three years, is fixed at 950,000 marks.

Dr. W. J. McGee, of the Bureau of American Ethnology, has started, says *Science*, to explore the hitherto unknown portion of Sonora county in Mexico, and Tiburon Island on the coast of Mexico, inhabited by the treacherous and bloodthirsty Seri Indians.

Payment by results has long been the bugbear of those trying to do good educational work under an official system. We are therefore glad to hear that the Science and Art schools and classes throughout the country have been informed of a minute of the Committee of Council on Education sanctioning attendance grants, at least as an experiment for a limited time. According to this plan, the grant will depend partly on attendance and partly on examination results. The adoption of the scheme by any local committee is optional, but only those schools or classes whose teaching and equipment are reported to be thoroughly satisfactory can elect to come under it.

ERRATA.

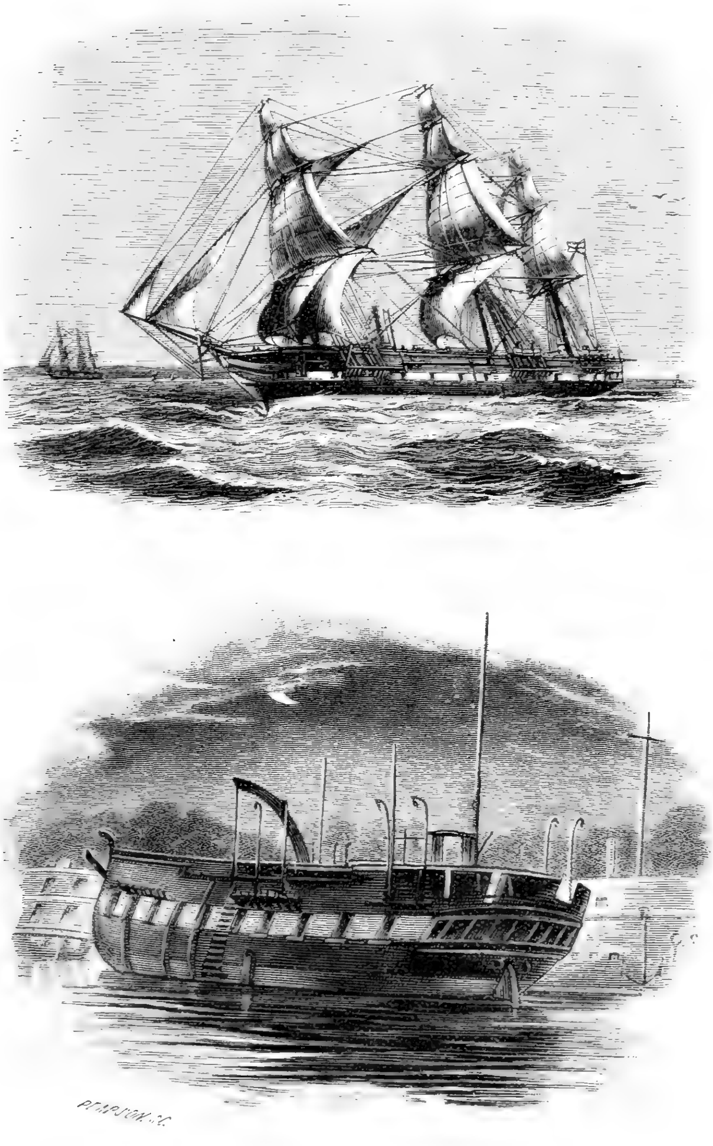
We regret that on the wrappers of recent numbers two gentlemen have been assigned to posts which they do not occupy. Mr. H. N. Dickson, one of the assistant secretaries during the meeting of the Geographical Congress, was described as its Secretary; and Mr. H. A. Miers, the editor to the Mineralogical Society, was called its Secretary. We apologise to the rightful holders of the titles in question.

NOTICE.

To Contributors.—*All communications to be addressed to the* Editor *of* Natural Science, *at* 22, St. Andrew Street, Holborn Circus, London, E.C. *Correspondence and notes intended for any particular month should be sent in not later than the 10th of the preceding month.*

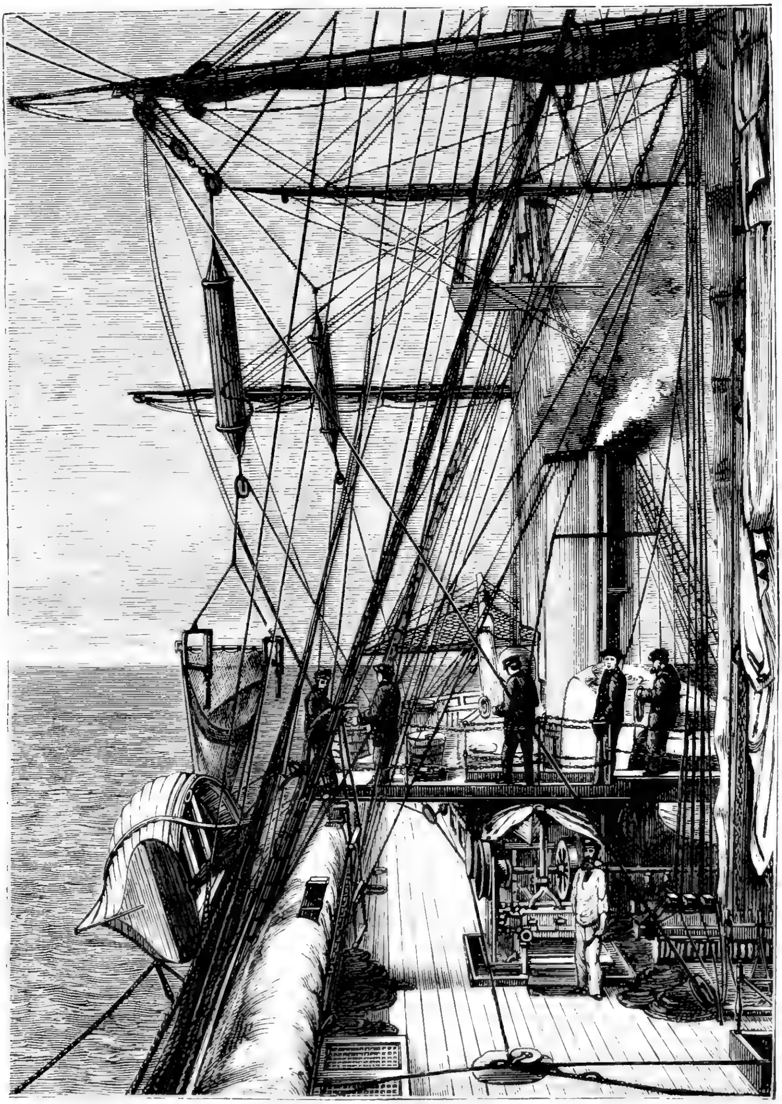
To the Trade.—Natural Science *is published on the 25th of each month; all advertisements should be in the Publishers' hands not later than the 20th.*

The "Challenger" Number.—*In reply to enquiries, we remind our readers that, although the* First *edition of this ran out of print immediately, there are still some copies of the* Second *edition to be obtained at the usual price—* One Shilling. *No more will now be printed, so orders should be sent at once.*

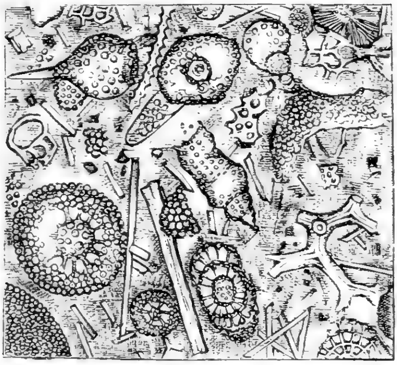


H.M.S. "CHALLENGER."

1872-1895.



DREDGING AND SOUNDING ARRANGEMENTS ON BOARD THE "CHALLENGER."



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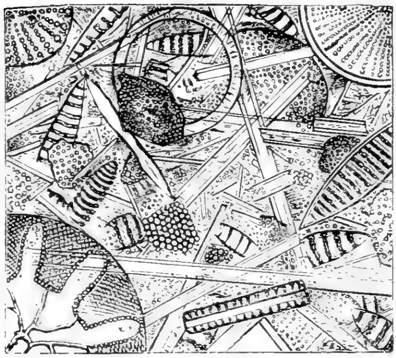

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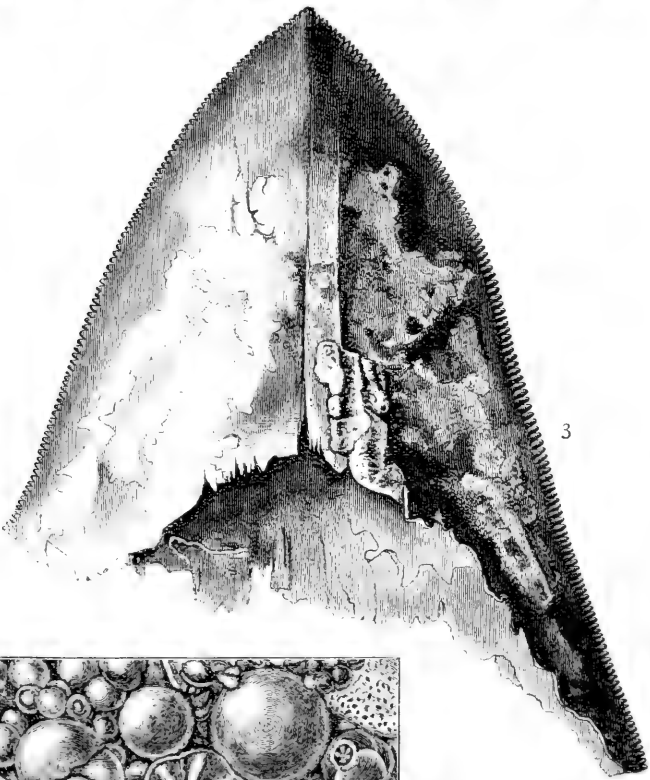

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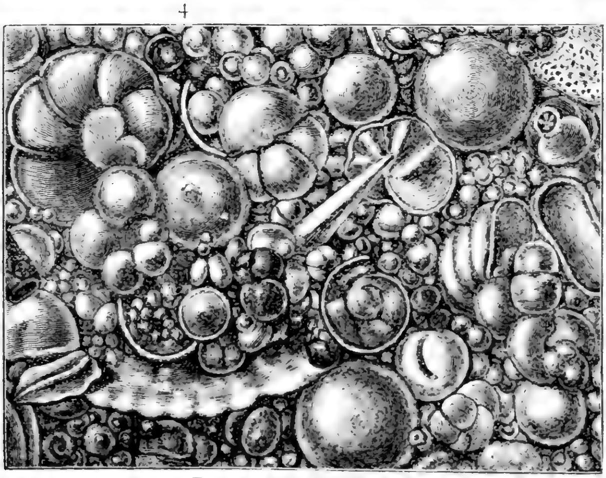


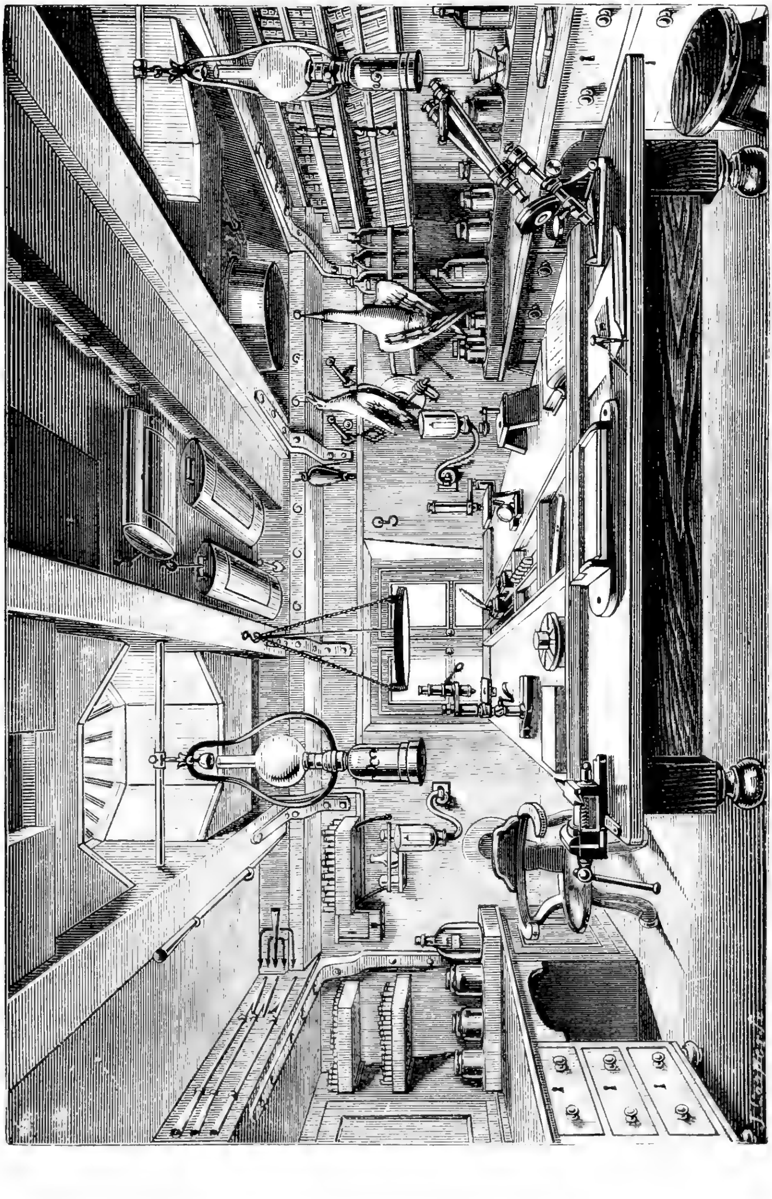
DEEP-SEA DEPOSITS.

Fig. 1. Radiolarian Ooze, Central Pacific, 4,475 fms. × 100.

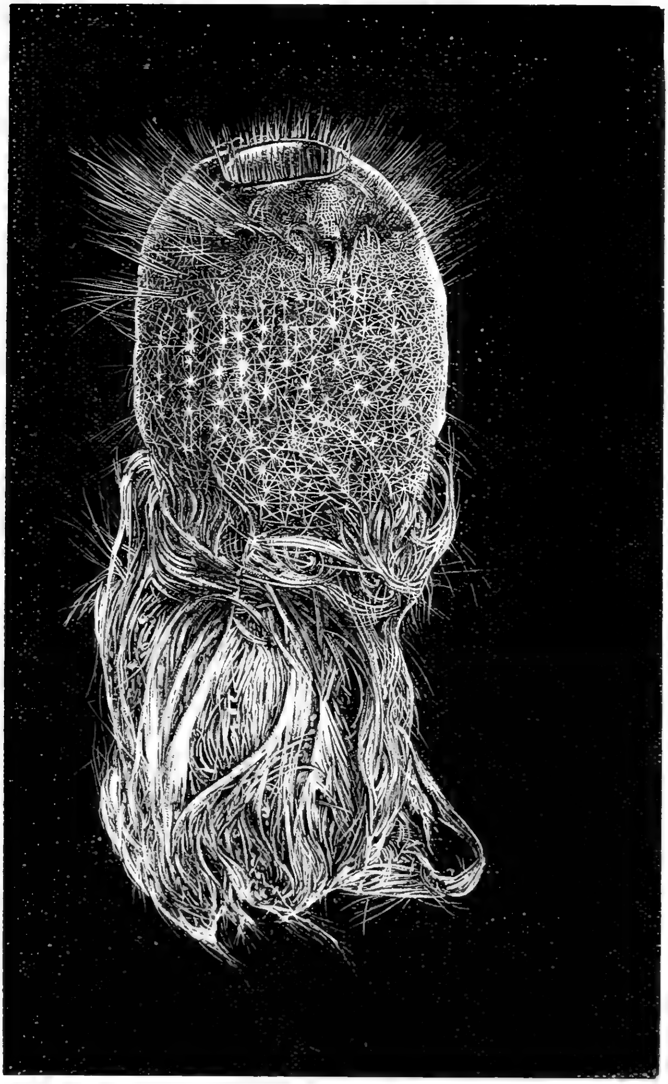
Fig. 2. Diatom Ooze, Antarctic Ocean, 1,900 fms. × 200.

Fig. 3. Tooth of an extinct species of *Carcharodon*.

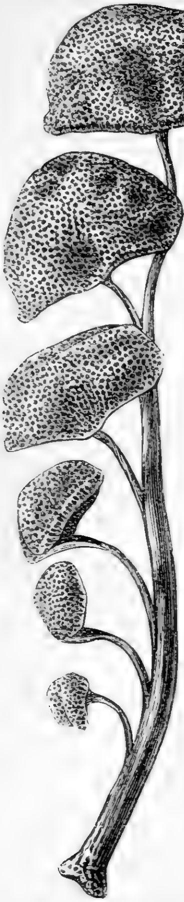
Fig. 4. Globigerina Ooze, North Atlantic. 1,900 fms. × 50.



ZOOLOGICAL LABORATORY ON THE MAIN DECK OF THE "CHALLENGER."



Pheronema Carpenteri (Thoms.).
A Hexactinellid Sponge.



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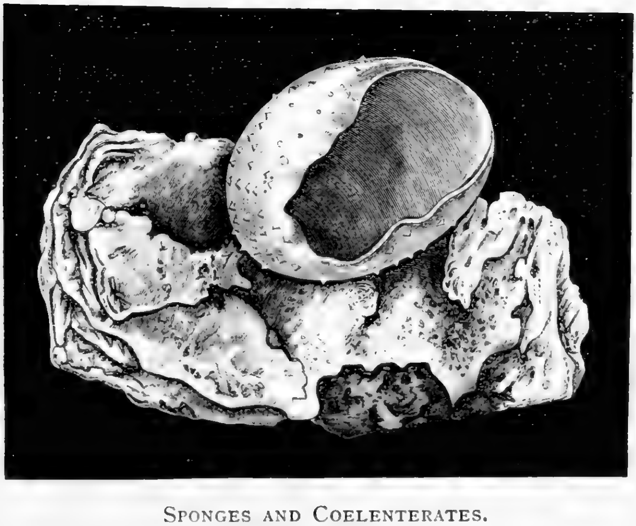
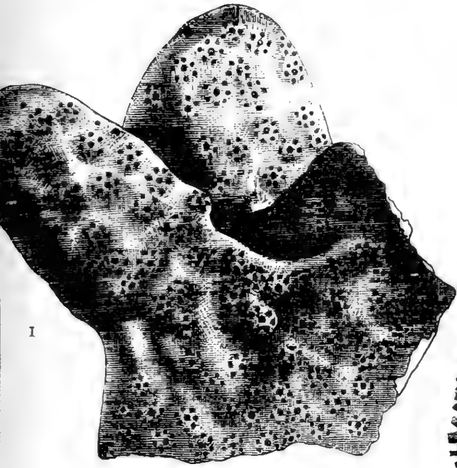


Sponges and Coelenterates.

Fig. 1. *Amphilectus challengeri*, Ridley; a monaxonid; Molucca Sea; × ½.
Fig. 2. *Eilhardia schulzei*, Poléjaeff; a calcareous sponge.
Fig. 3. *Umbellula thomsoni;* 2,125 fms., near Madeira. The stem, 36 inches long, is cut short.



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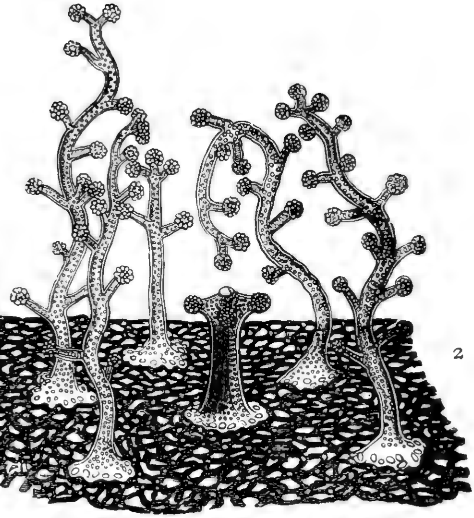

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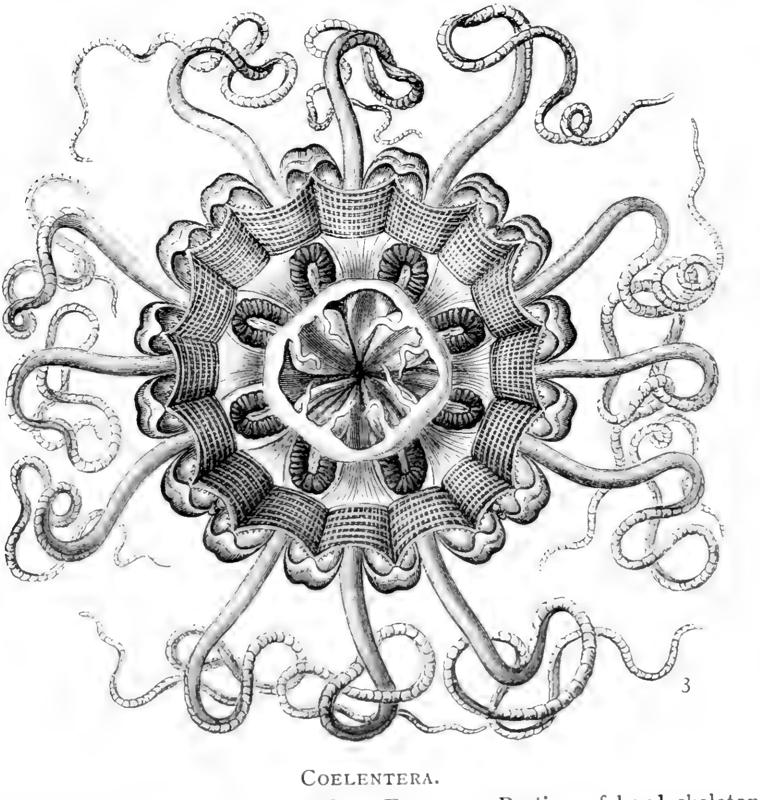

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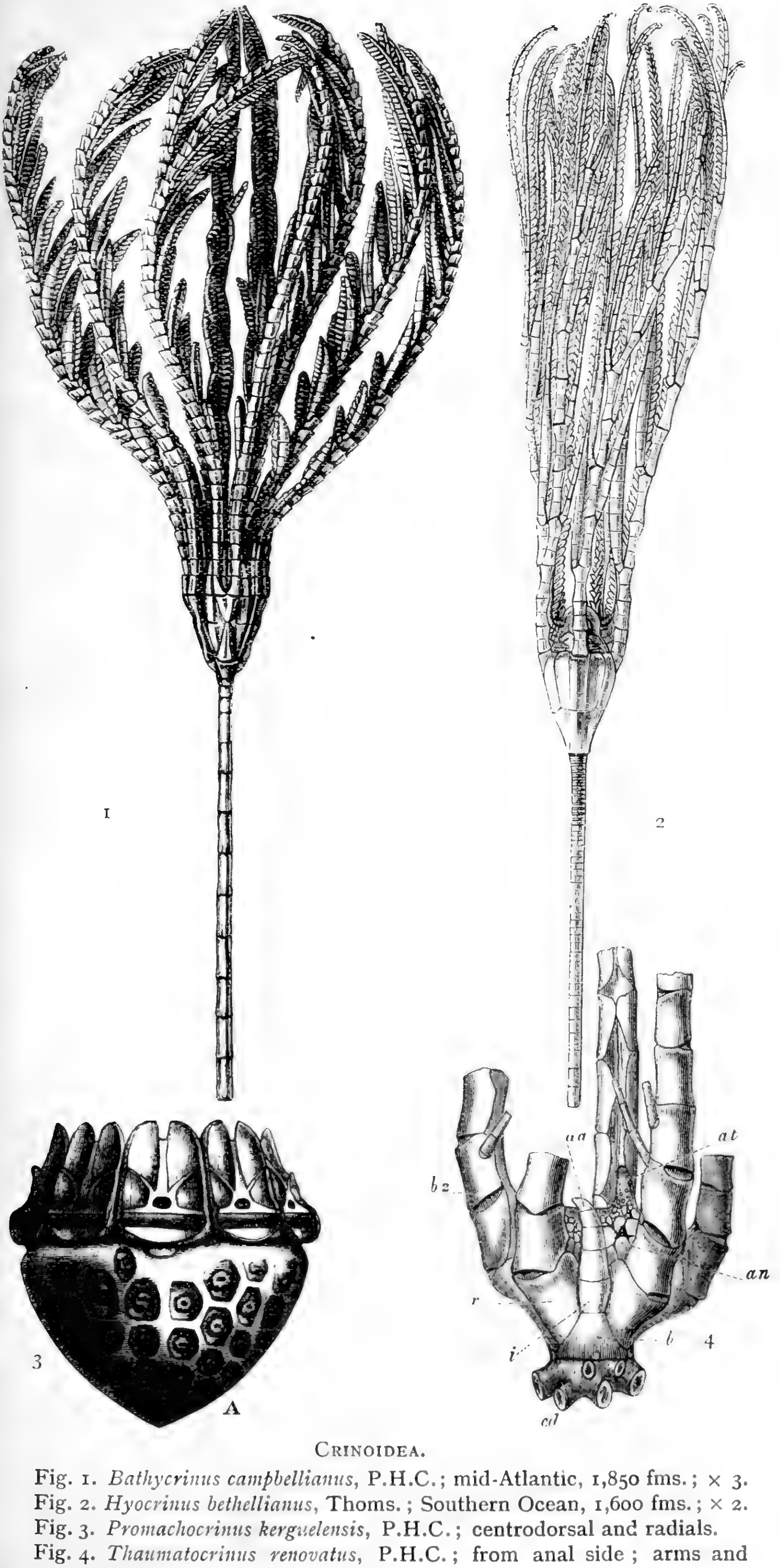
COELENTERA.

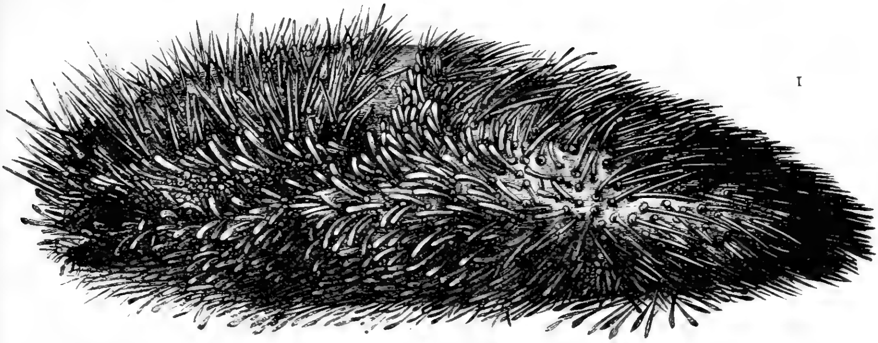
Figs. 1 and 2. *Millepora nodosa.* Esper : 1. Portion of hard skeleton, twice nat. size; 2. system of zooids expanded (the five mouthless dactylozooids bring food to the single gastrozooid in the centre).

Fig. 3. *Periphylla mirabilis*, Haeckel; New Zealand; half nat. size.



CRINOIDEA.

Fig. 1. *Bathycrinus campbellianus*, P.H.C.; mid-Atlantic, 1,850 fms.; × 3.
Fig. 2. *Hyocrinus bethellianus*, Thoms.; Southern Ocean, 1,600 fms.; × 2.
Fig. 3. *Promachocrinus kerguelensis*, P.H.C.; centrodorsal and radials.
Fig. 4. *Thaumatocrinus renovatus*, P.H.C.; from anal side; arms and cirri broken off.



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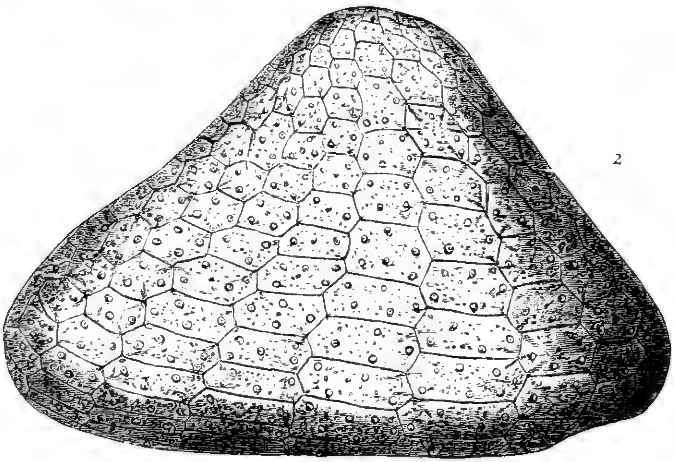

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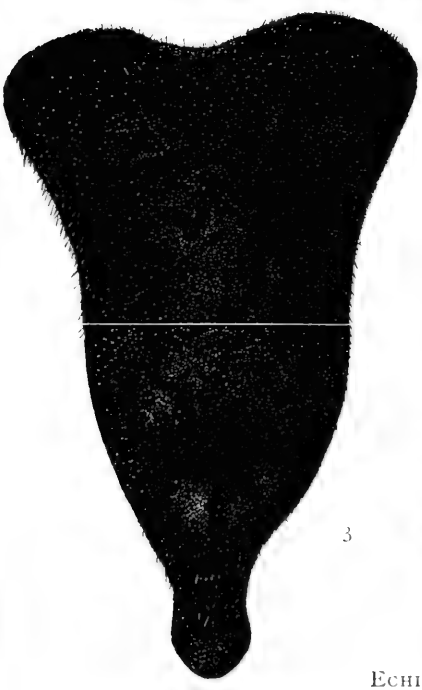

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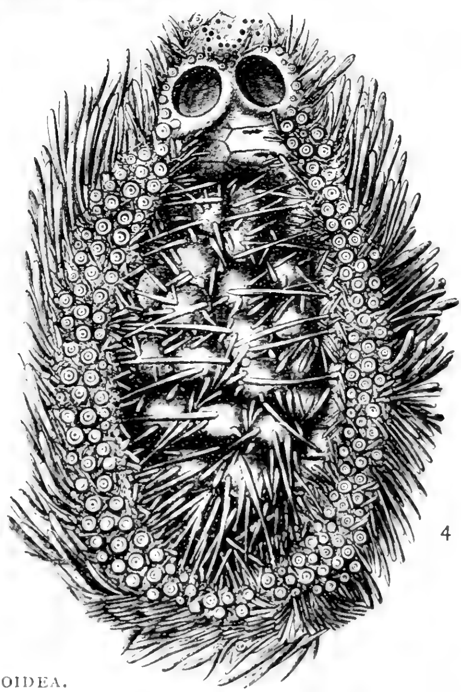

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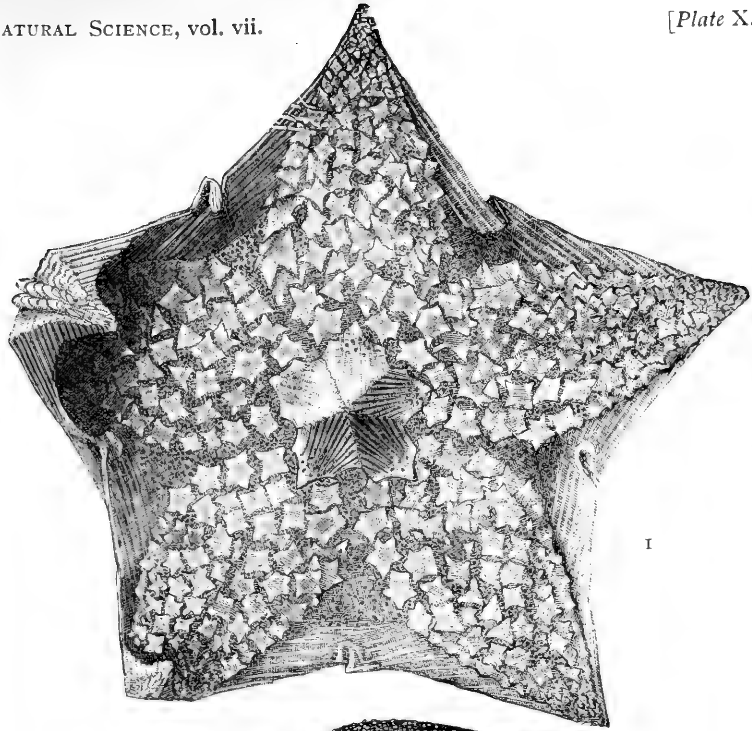
ECHINOIDEA.

Fig. 1. *Aërope rostrata*, Thoms. Fig. 2. *Cystechinus wyvillei*, A. Ag.; spines removed. Fig. 3, *Pourtalesia ceratopyga*, A. Ag.; the abactinal surface, covered with spines. All nat. size. Fig. 4. *Hemiaster cavernosus* (Phil.); one of the marsupial recesses, with eggs inside. × 5.



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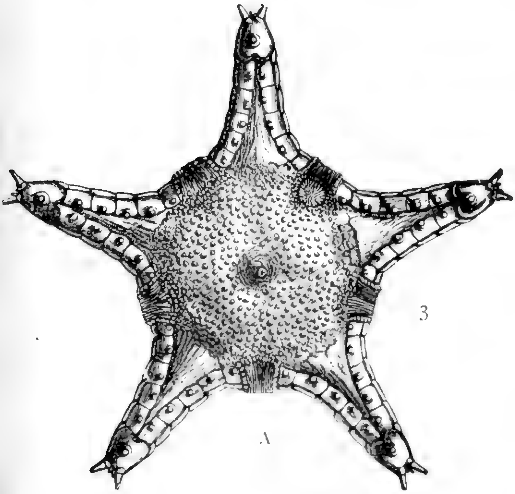

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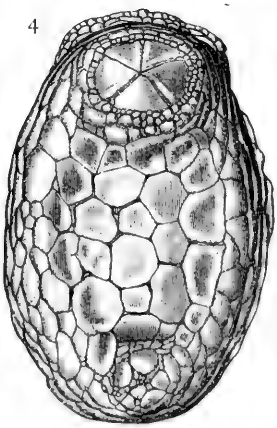
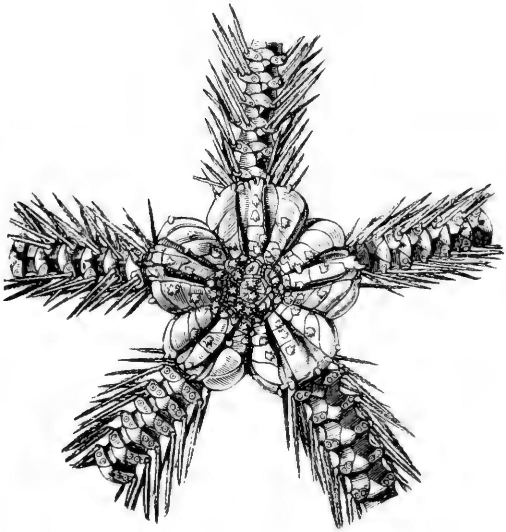


Asteroidea and a Holothurian.

Fig. 1. *Hymenaster sacculatus*, Sladen; abactinal aspect, with marsupial tent in centre; slightly enlarged. Fig. 2. *Pythonaster murrayi*, Sladen; abactinal aspect; × ¾. Fig. 3. *Porcellanaster cœruleus*, Thoms.; abactinal aspect; nat. size. Fig. 4. *Psolus ephippifer*, Thoms.; showing plates of dorsal marsupium; × 3.



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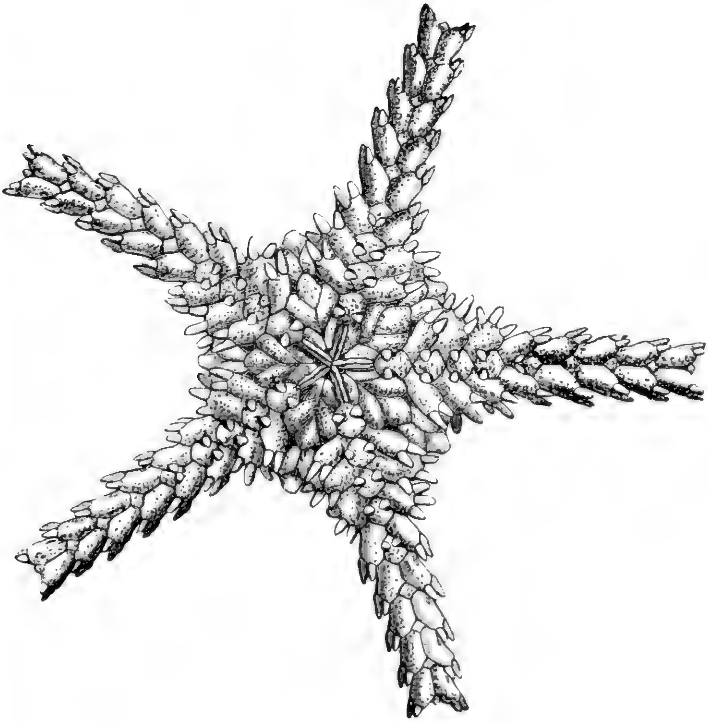

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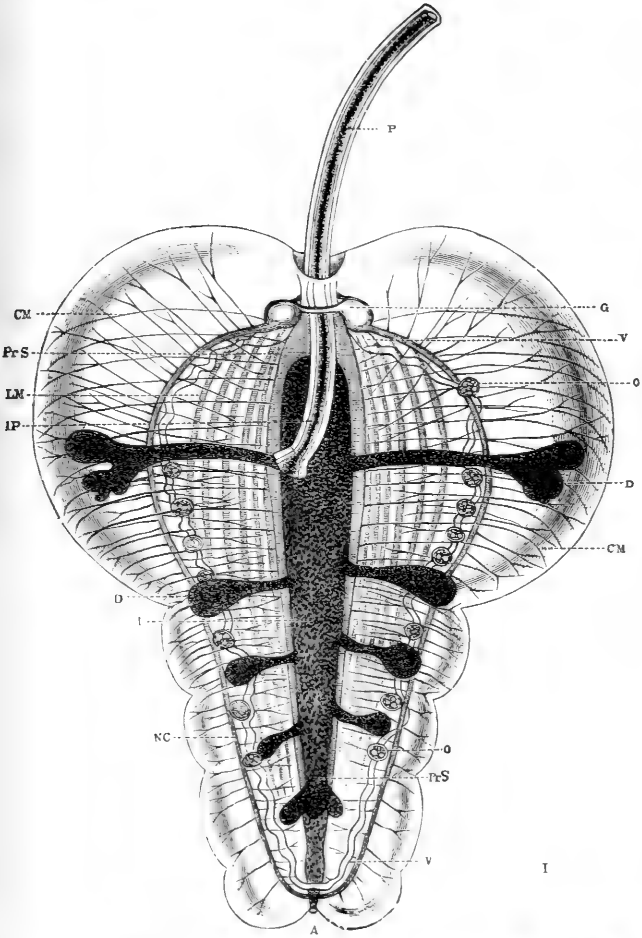
OPHIUROIDEA.

FIG. 1. *Ophiomitra chelys* (Thoms.); dorsal aspect of the disc; × 4.
FIG. 2. *Ophiomusium pulchellum*, Thoms; oral aspect of the disc; × 7.



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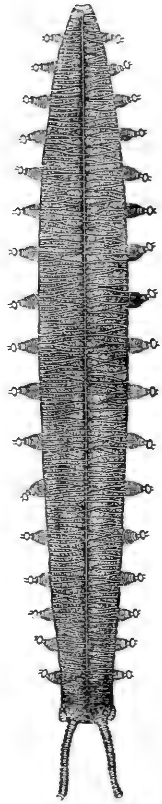

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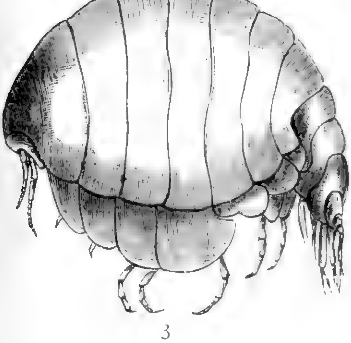

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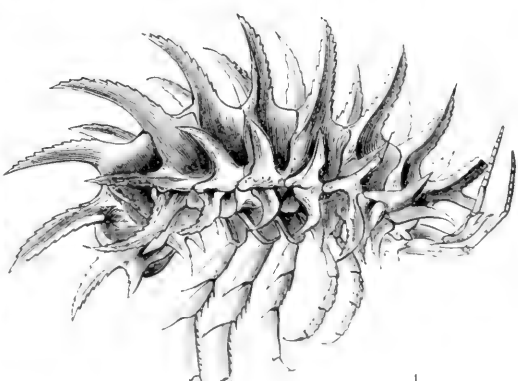
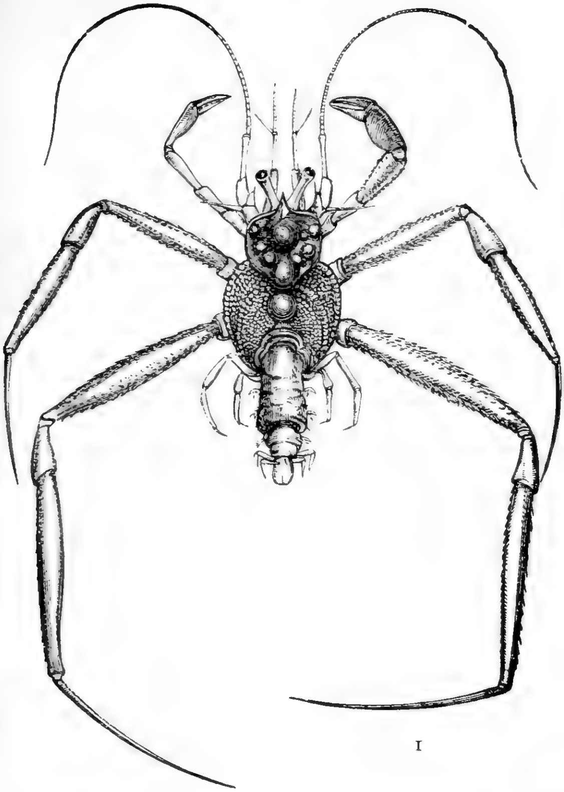


4

WORMS AND ARTHROPODS.

FIG. 1. *Pelagonemertes rollestoni*, Moseley; from dorsal surface; enlarged. P, proboscis, partly extended. I, intestine with diverticula (D). G, superior nerve ganglion. V, vascular trunk. O, ovaries. CM, circular muscles. LM, longitudinal muscles. FIG. 2. *Peripatus capensis*, from the dorsal surface. Fig. 3. *Andania gigantea*, Stebbing; an amphipod; nat. size. Fig. 4. *Acanthozone carinata*, Stebbing; an amphipod; enlarged.



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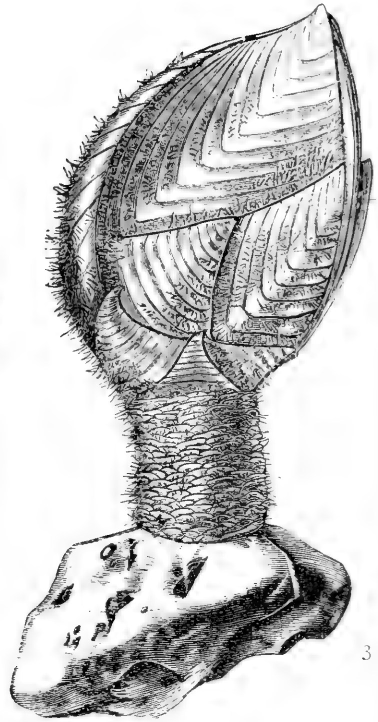

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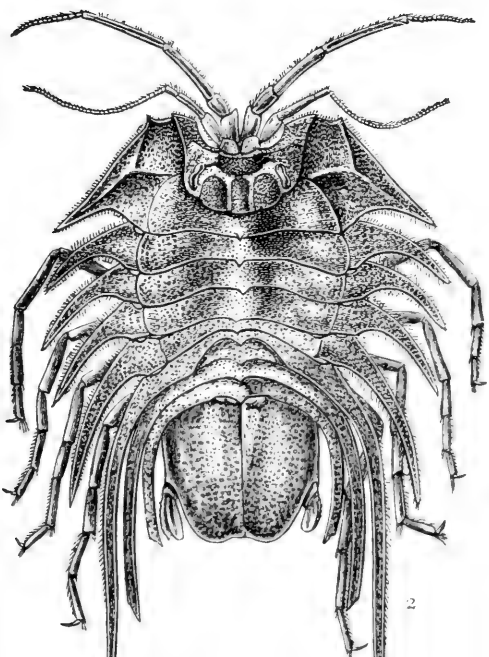

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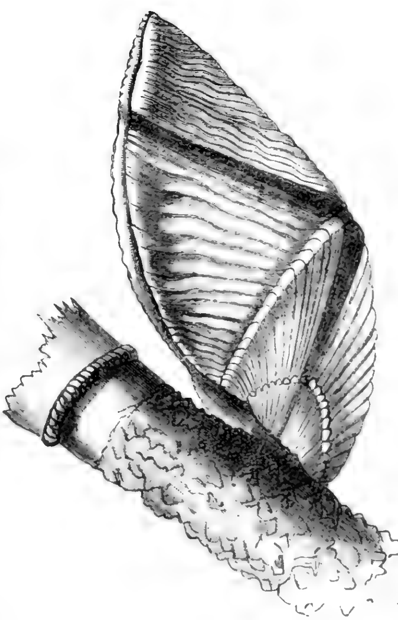
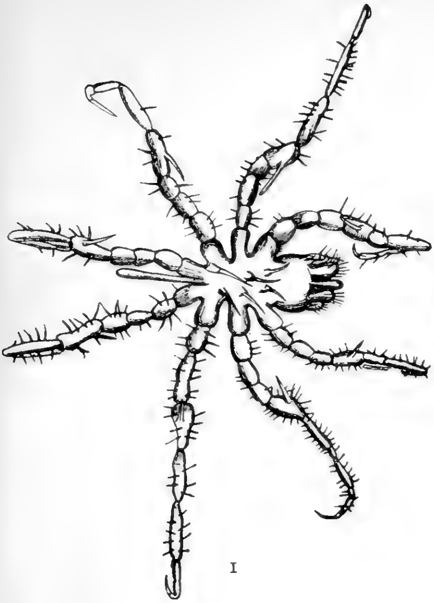


4

ARTHROPODS.

Fig. 1. *Tylaspis anomala*, Henderson; a Pagurid; S. Pacific, 2,375 fms. Fig 2. *Serolis bromleyana*, Suhm; an Isopod; Antarctic, 1,975 fms. Fig. 3. *Scalpellum regium*, Hoek; a stalked Cirripede, with complemental male (*a*). Fig. 4. *Megalasma striatum*, Hoek; a stalked Cirripede; off the Philippines.



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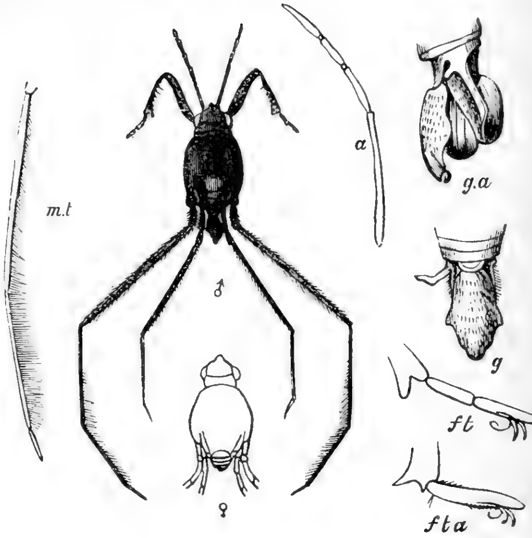

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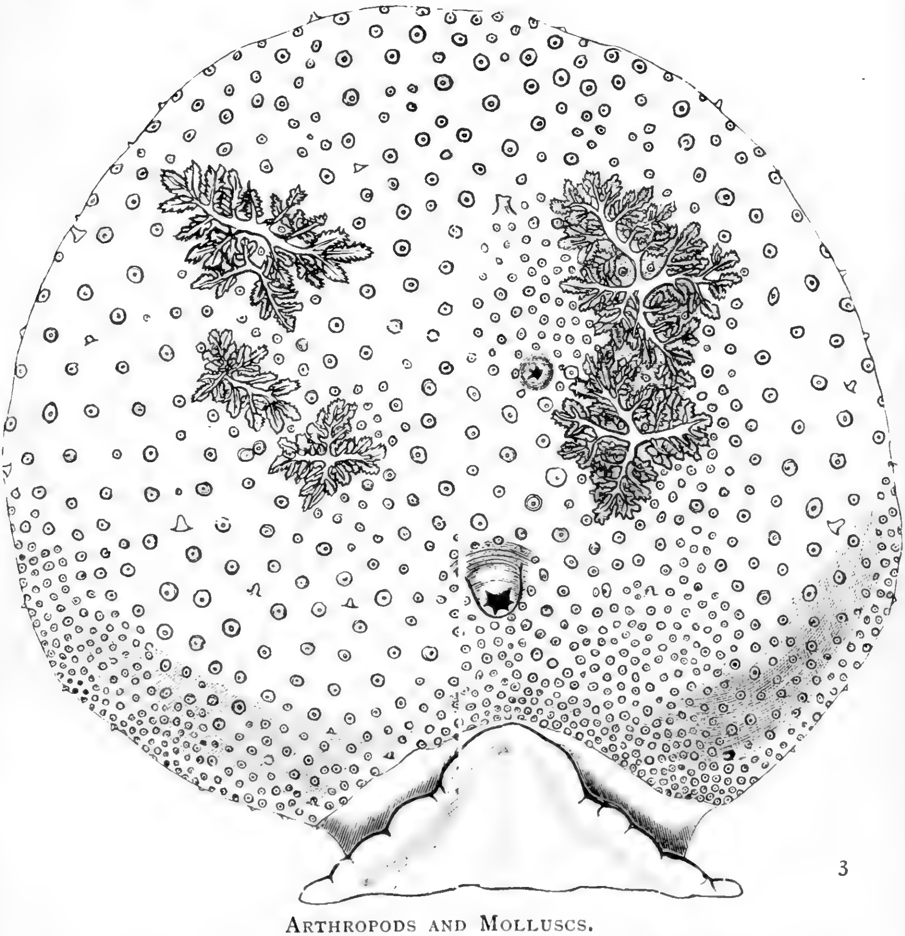

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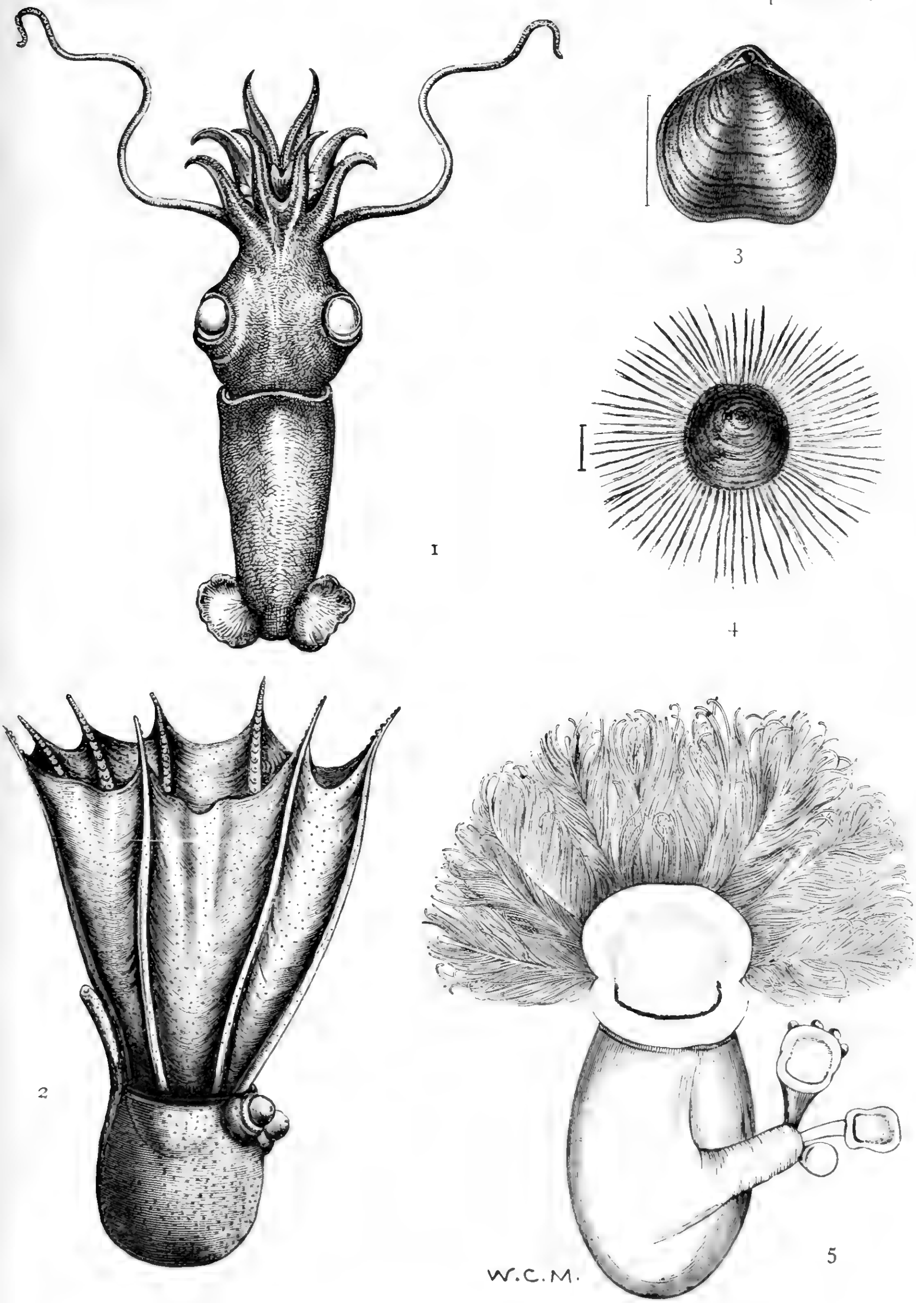
ARTHROPODS AND MOLLUSCS.

Fig. 1. *Oorhynchus aucklandiæ*, Hoek; a Pycnogonid; 700 fms. × 7½. Fig. 2. *Halobates wüllerstorffi*, Frauenf.; pelagic hemipteron, male and female. Fig. 3. *Bathydoris abyssorum*, Bergh; showing the five branchial tufts, one probably lost from the right side; near branchiae on right is the renal pore; below, in the middle line, is the anal papilla; at the bottom is the expanded foot; nat. size.



CEPHALOPODS, BRACHIOPODS, CEPHALODISCUS.

Fig. 1. *Bathyteuthis abyssicola*, Hoyle; Southern Ocean, 1,600 fms.; nat. size. Fig. 2. *Amphitretus pelagicus*, Hoyle; Kermadec Is.; somewhat enlarged. Fig. 3. *Terebratula wyvillei*, Dav. Fig. 4. *Discina atlantica*, King. Fig. 5. *Cephalodiscus dodecalophus*, M'Int.; ventral view. The proboscis is seen surrounded by the tentacular arms. The mouth is concealed by the posterior half of the proboscis.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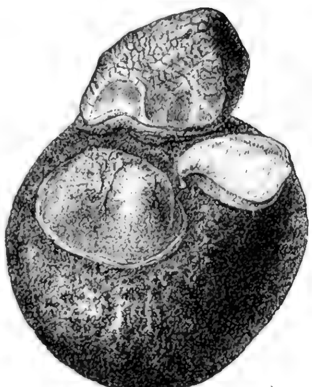
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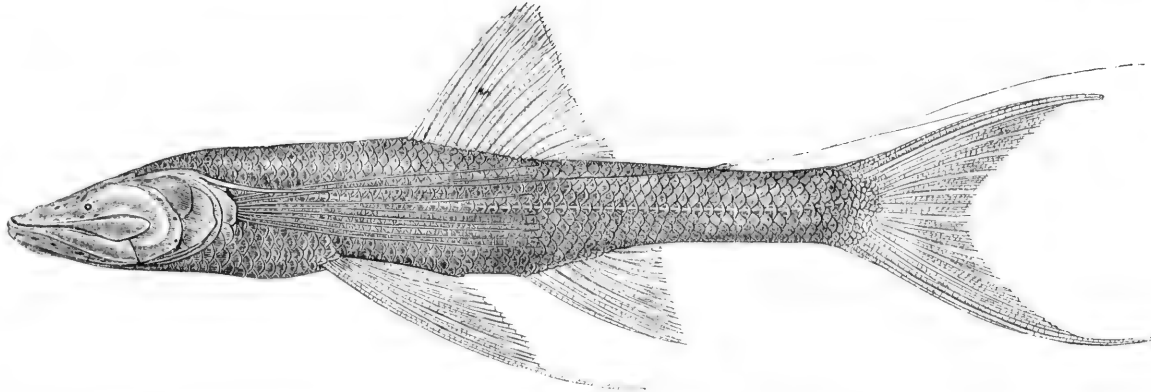
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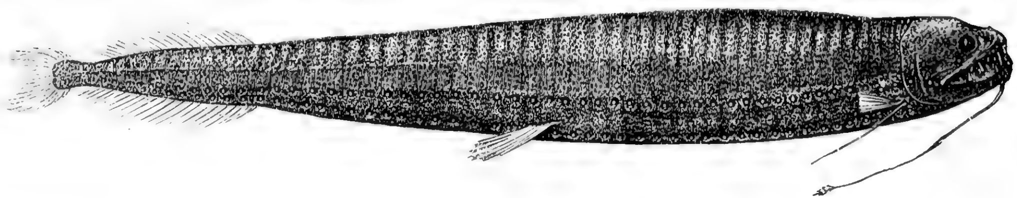
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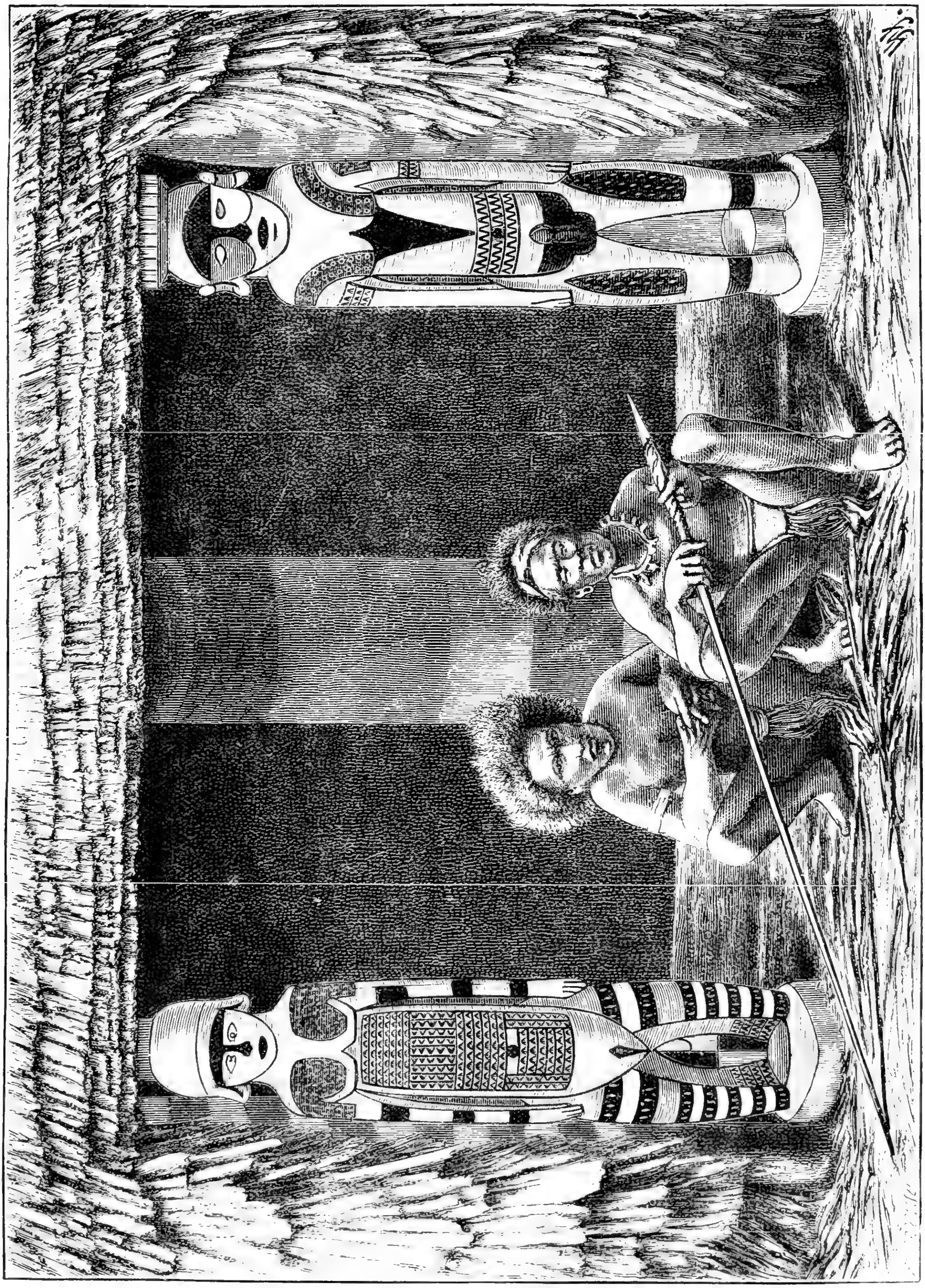
Fig. 1. Manganese nodule containing ear-bone of *Mesoplodon*.

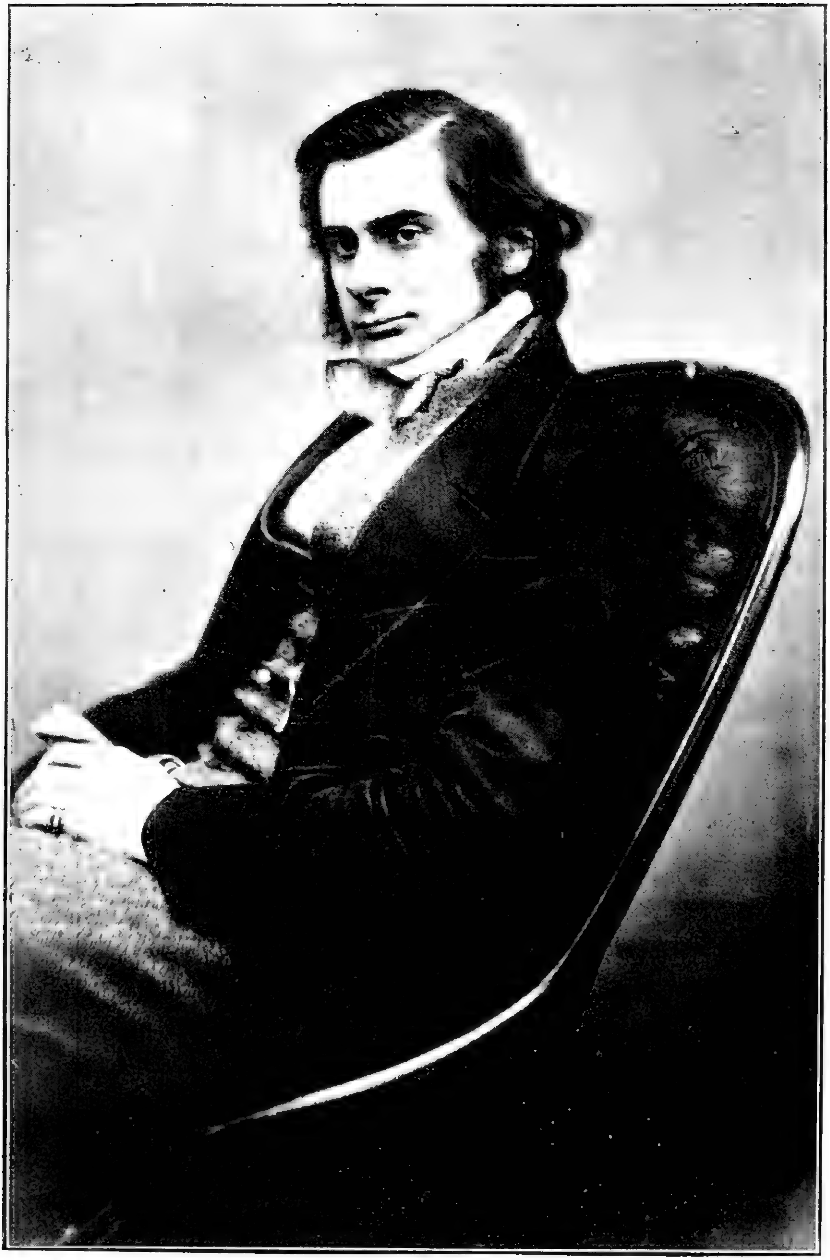
Fig. 2. Manganese nodule with two tunicates (*Styela squamosa* and *Styela bythia*) and a brachiopod attached Southern Indian Ocean, 2,600 fms.

Fig. 3. *Bathypterois longipes*, Günth.

Fig. 4. *Echiostoma micripnus*, Günth.; 2,150 fms.



Entrance to a Club-house, with carved and painted door-posts,
Wild Island, Admiralty Islands.
From a sketch by Dr. J. J. Wild, Artist to the "Challenger" Expedition.

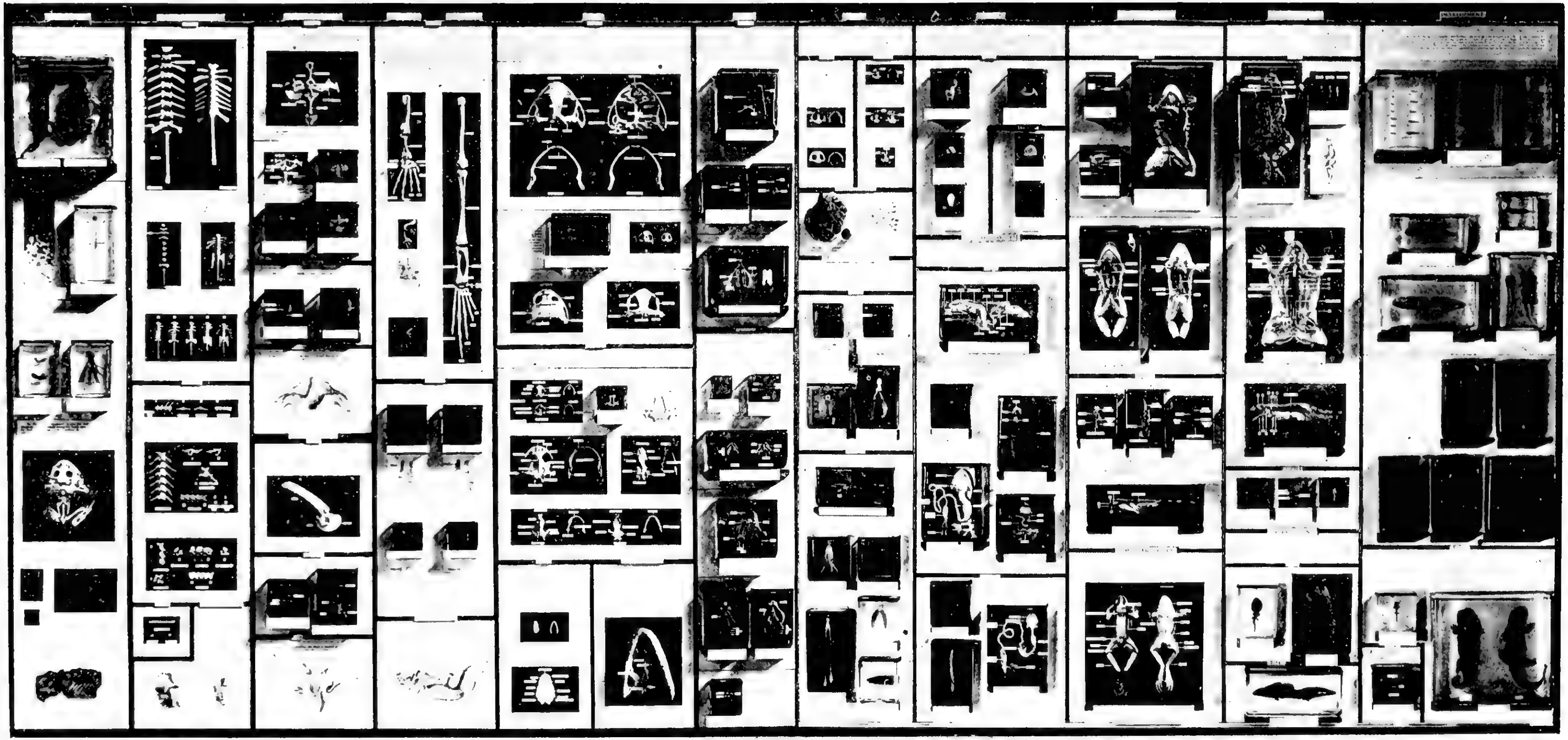


B. Dellagana, Sc.] *[Photo. by Maull & Polyblank.*

THOMAS HENRY HUXLEY.

—

1857.



CASE IN THE INDEX COLLECTION AT THE NATURAL HISTORY MUSEUM, ILLUSTRATING THE MORPHOLOGY OF THE AMPHIBIA.
By kind permission of Sir William Flower, K.C.B.

B. Dellagana, Sc.] [*A. Gepp, Photo.*

Ljustr. Gen. Stab. Lit. Anst. Stockh.

The Swedish Marine Biological Station
from the land

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July 22, 1895

Vol. VII. No. 41.

NATURAL SCIENCE:

12,911

A Monthly Review of Scientific Progress.

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