maintenance of secondary and technical (including agricultural) schools and colleges.

V. Public libraries and museums:

(*a*) That ratepayers have power, by vote, to sanction the increase of the expenditure, under the Public Libraries Acts, beyond its present limit, and that the restriction of the Acts to localities having 5,000 inhabitants and upwards be repealed.

(*b*) That museums of art and science and technological collections be opened to the public on Sundays.

VI. Special recommendations in regard to Ireland:

(*a*) That steps be taken at the earliest possible moment for the gradual introduction of compulsory attendance at elementary schools in Ireland.

(*b*) That payments be made by the National Board, under proper regulations, on the results of the teaching of home industries to children, young persons, and adults; as well as in aid of the salaries of industrial teachers.

(*c*) That systematic instruction be given to primary school teachers, qualifying them to teach the use of tools for working in wood and iron, in the primary schools.

(*d*) That steps be taken by the Commissioners of National Education in Ireland for the provision of books calculated to assist the teachers of primary schools in giving graduated lessons in rudimentary science.

(*e*) That grants-in-aid be sanctioned by the Treasury to approved agricultural schools, and to approved schools for instruction in local industries.

(*f*) That practical evening science classes for artisans form part of the instruction in the Royal College of Science of Ireland, in Dublin.

(*g*) That the Board of Intermediate Education take steps to insure the provision of adequate means for the practical teaching of science in the schools under their direction.

In addition to the preceding recommendations which necessitate action on the part of the Legislature or of the public authorities, or of both, your Commissioners make the following recommendations, requiring no such action, by way of suggestions for the consideration of those in whose power it is to comply with them:—

I. That it be made a condition by employers of young persons, and by the trade organisations, in the case of industries for which an acquaintance with science or art is desirable, that such young persons requiring it receive instruction therein either in schools attached to works or groups of works, or in such classes as may be available, the employers and trade organisations in the latter case contributing to the maintenance of such classes.

II. That the managers and promoters of science and technical classes should (*a*) so arrange the emoluments of teachers as to encourage them to retain their students for the advanced stages of subjects in which they have passed the elementary stage, and (*b*) that they should endeavour to group the teaching of cognate science subjects, as recommended by the Royal Commission on the Advancement of Science, and as provided for by the regulations of the Science and Art Department.

III. That scholarships be more liberally founded, especially for pupils of higher elementary schools, enabling them to proceed to higher technical schools and colleges.

IV. That the great national agricultural societies give aid to the establishment in counties of secondary schools or classes for teaching agriculture.

V. That those responsible for the management of primary schools in Ireland, in the districts where farming is defective, attach small example farms to such schools wherever it is possible; and that Boards of Guardians employ the plots of land attached to workhouses for the agricultural instruction of the children therein.

VI. That the subscriptions given by the liberality of the City of London and of the different Guilds, to the City and Guilds Institute, be made adequate to the fulfilment of the work which that Institute has undertaken, including the equipment and maintenance of its Central Institution.

In closing our Report we think it right to recall the fact that the first impulse to an inquiry into the subject of technical instruction was given by the important letter of Dr., now Sir Lyon, Playfair, K.C.B., of May 15, 1867, to the Chairman of the Schools' Inquiry Commission, in which he called attention to the great progress in engineering and manufactures abroad, shown at the Paris Exhibition of that year. In the course of our inquiry we have received much guidance from the letter on the subject by Mr. B. Samuelson, M.P., to the Vice-President of the Committee of Council on Education, dated November 16, 1867; from the Report of the Select Committee of the House of Commons on Scientific Instruction, 1868; the Report of the Royal Commission on the same subject; the papers by Mr. H. M. Felkin on Chemnitz, by Messrs. McLaren and Beaumont, and various other publications.

We desire also to express our thanks to the public authorities, to the owners and managers of industrial works, and to the numerous other persons, both at home and abroad, to whom we had occasion to apply for information, for the frank and courteous manner in which it was given to us; and also to acknowledge the prompt and valuable assistance which we received from the members of our Diplomatic and Consular services in the prosecution of our inquiry. All of which we humbly beg leave to submit for Your Majesty's gracious consideration.

(Signed) B. SAMUELSON
H. E. ROSCOE
PHILIP MAGNUS
JOHN SLAGG
SWIRE SMITH
WM. WOODALL

GILBERT R. REDGRAVE,
Secretary,
April 4, 1884

## *ON THE NOMENCLATURE, ORIGIN, AND DISTRIBUTION OF DEEP-SEA DEPOSITS*[1]

II.

*Globigerina Ooze.*—We designate by this name all those truly pelagic deposits containing over 40 per cent. of carbonate of lime, which consists principally of the dead shells of pelagic Foraminifera—*Globigerina*, *Orbulina*, *Pulvinulina*, *Pullenia*, *Sphæroidina*, &c. In some localities this deposit contains 95 per cent. of carbonate of lime. The colour is milky white, yellow, brown, or rose, the varieties of colour depending principally on the relative abundance in the deposit of the oxides of iron and manganese. This ooze is fine grained; in the tropics some of the Foraminifera shells are macroscopic. When dried it is pulverulent. Analyses show that the sediment contains, in addition to carbonate of lime, phosphate and sulphate of lime, carbonate of magnesia, oxides of iron and manganese, and argillaceous matters. The *residue* is of a reddish brown tinge. Lapilli, pumice, and glassy fragments, often altered into palagonite, seem always to be present, and are frequently very abundant. The mineral particles are generally angular, and rarely exceed 0·08 mm. in diameter; monoclinic and triclinic feldspars, augite, olivine, hornblende, and magnetite are the most frequent. When quartz is present, it is in the form of minute, rounded, probably wind-borne grains, often partially covered with oxide of iron. More rarely we have white and black mica, bronzite, actinolite, chromite, glauconite, and cosmic dust. Silliceous organisms are probably never absent, sometimes forming 20 per cent. of the deposit, at other times only recognisable after careful microscopic examination. In some regions the frustules of Diatoms predominate, in others the skeletons of Radiolarians.

The *fine washings*, viewed with the microscope, are not homogeneous. The greater part consists of argillaceous matter coloured by the oxides of iron and manganese. Mixed with this, we distinguish fragments of minerals with a diameter less than 0·05 mm., and minute particles of pumice can nearly always be detected. Fragments of Radiolarians, Diatoms, and siliceous spicules can always be recognised, and are sometimes very abundant.

*Pteropod Ooze.*—This deposit differs in no way from a Globigerina ooze except in the presence of a greater number and variety of pelagic organisms, and especially in the presence of Pteropod and Heteropod shells, such as *Diacria*, *Atlanta*, *Styliola*, *Carinaria*, &c. The shells of the more delicate species of pelagic Foraminifera and young shells are also more abundant in these deposits than in a Globigerina ooze. It must be remembered that the name "Pteropod ooze" is not intended to indicate that the deposit is chiefly composed of the shells of these mollusks, but, as their presence in a deposit is characteristic and has an important bearing on geographical and bathymetrical distribution, we think it desirable to emphasise the presence of these shells in any great abundance. It may here be pointed out that there is a very considerable difference between a Globigerina

[1] A Paper read before the Royal Society of Edinburgh by John Murray and A. Renard. Communicated by John Murray. Continued from p. 88.

ooze or a Pteropod ooze situated near continental shores and deposits bearing the same names situated towards the centres of oceanic areas, both with respect to mineral particles and remains of organisms.

*Diatom Ooze.*—This ooze is of a pale straw colour, and is composed principally of the frustules of Diatoms. When dry it is a dirty white siliceous flour, soft to the touch, taking the impression of the fingers, and contains gritty particles which can be recognised by the touch. It contains on an average about 25 per cent. of carbonate of lime, which exists in the deposit in the form of small *Globigerina* shells, fragments of Echinoderms and other organisms. The *residue* is pale white and slightly plastic; minerals and fragments of rocks are in some cases abundant; these are volcanic, or, more frequently, fragments and minerals coming from continental rocks and transported by glaciers. The *fine washings* consist essentially of particles of Diatoms along with argillaceous and other amorphous matter. We estimate that the frustules of Diatoms and skeletons of siliceous organisms make up more than 50 per cent. of this deposit.

*Radiolarian Ooze.*—It was stated, when describing a Globigerina ooze, that Radiolarians were seldom, if ever, completely absent from marine deposits. In some regions they make up a considerable portion of a Globigerina ooze, and are also found in Diatom ooze and in the terrigenous deposits of the deeper water surrounding the land. In some regions of the Pacific, however, the skeletons of these organisms make up the principal part of the deposits, and to these we have given the name "Radiolarian ooze." The colour is reddish or deep brown, due to the presence of the oxides of iron and manganese. The *mineral particles* consist of fragments of pumice, lapilli, and volcanic minerals, rarely exceeding 0·07 mm. in diameter. There is not a trace of carbonate of lime in the form of shells in some samples of Radiolarian ooze, but other specimens contain 20 per cent. of carbonate of lime derived from the shells of pelagic Foraminifera. The clayey matter and mineral particles in this ooze are the same as those found in the red clays, which we will now proceed to describe.

*Red Clay.*—Of all the deep-sea deposits this is the one which is distributed over the largest areas in the modern oceans. It might be said that it exists everywhere in the abysmal regions of the ocean basins, for the *residue* in the organic deposits which has been described under the names Globigerina, Pteropod, and Radiolarian ooze, is nothing else than the red clay. However, this deposit only appears in its characteristic form in those areas where the terrigenous minerals and calcareous and siliceous organisms disappear to a greater or less extent from the bottom. It is in the central regions of the Pacific that we meet with the typical examples. Like other marine deposits, this one passes laterally, according to position and depth, into the adjacent kind of deep-sea ooze or mud.

The argillaceous matters are of a more or less deep brown tint from the presence of the oxides of iron and manganese. In the typical examples no mineralogical species can be distinguished by the naked eye, for the grains are exceedingly fine and of nearly uniform dimensions, rarely exceeding 0·05 mm. in diameter. It is plastic and greasy to the touch; when dried it coagulates into lumps so coherent that considerable force must be employed to break them. It gives the brilliant streak of clay, and breaks down in water. The pyrognostic properties show that we are not dealing with a pure clay, for it fuses easily before the blowpipe into a magnetic bead.

Under the term red clay are comprised those deposits in which the characters of clay are not well pronounced, but which are mainly composed of minute particles of pumice and other volcanic material which, owing to their relatively recent deposition, have not undergone great alteration. If we calculate the analyses of red clay, it will be seen, moreover, that the silicate of alumina present as clay ($2SiO_2,Al_2O_3 + 2H_2O$) comprises only a relatively small portion of the sediment; the calculation shows always an excess of free silica, which is attributed chiefly to the presence of siliceous organisms.

Microscopic examination shows that a red clay consists of argillaceous matter, minute mineral particles, and fragments of siliceous organisms; in a word, it is in all respects identical with the *residue* of the organic oozes. The mineral particles are for the greater part of volcanic origin, except in those cases where continental matters are transported by floating ice, or where the sand of deserts has been carried to great distances by winds. These volcanic minerals are the same constituent minerals of modern eruptive rocks, enumerated in the description of volcanic muds and sands; in the great majority of cases they are accompanied by fragments of lapilli and of pumice more or less altered. Vitreous volcanic matters belonging to the acid and basic series of rocks predominate in the regions where the red clay has its greatest development, and it will be seen presently that the most characteristic decompositions which there take place are associated with pyroxenic lavas.

Associated with the red clay are almost always found concretions and microscopic particles of the oxides of iron and manganese, to which the deposit owes its colour. Again, in the typical examples of the deposit, zeolites in the form of crystals and crystalline spherules are present, along with metallic globules and silicates which are regarded as of cosmic origin. Calcareous organisms are so generally absent in the red clay that they cannot be regarded as characteristic; when present, they are chiefly the shells of pelagic Foraminifera, and are usually met with in greater numbers in the surface layers of the deposit, to which they give a lighter colour. On the other hand, the remains of Diatoms, Radiolarians, and Sponge-spicules are generally present, and are sometimes very abundant. The ear-bones of various Cetaceans, as well as the remnants of other Cetacean bones, and the teeth of sharks, are, in some of the typical samples far removed from the continents, exceedingly abundant, and are often deeply impregnated with, or embedded in thick coatings of, oxides of iron and manganese. The remains of these Vertebrates have seldom been dredged in the organic oozes, and still more rarely in the terrigenous deposits.

The *fine washings*, as examined with a power of 450 diameters, are composed of an amorphous matter, fragments of minerals, the remains of siliceous organisms, and colouring substances. What we call amorphous matter may be considered as properly the argillaceous matter, and presents characters essentially vague. It appears as a gelatinous substance, without definite contours, generally colourless, perfectly isotropic, and forms the base which agglutinates the other particles of the washings. As these physical properties are very indefinite, it is difficult to estimate even approximately the quantity present in a deposit. However, it augments in proportion as the deposit becomes more clayey, but we think that only a small quantity of this substance is necessary to give a clayey character to a deposit. Irregular fragments of minerals, small pieces of vitreous rocks, and remains of siliceous organisms predominate in this fundamental base. These particles probably make up about 50 per cent. of the whole mass of the *fine washings*, and this large percentage of foreign substances must necessarily mask the character of the clayey matter in which they are embedded. The mineral particles are seldom larger than 0·01 mm. in diameter, but descend from this size to the merest points. It is impossible, on account of their minuteness, to say to what mineral species they belong: their optical reactions are insensible, their outlines too irregular, and all special coloration has disappeared. All that can be reasonably said is that these minute mineral particles probably belong to the same species as the larger particles in the same deposit, such as feldspar, hornblende, magnetite, &c. In the case of pumice and siliceous organisms the fragments can, owing to their structure, be recognised when of a much less size than in the case of the above minerals.

It can be made out by means of the microscope that the colouring substances are hydrated oxides of iron and manganese. The former is scattered through the mass in a state of very fine division; in some points, however, it is more localised, the argillaceous matter here appearing with a browner tinge, but these spots are noticed gradually to disappear in the surrounding mass. The coloration given by the manganese is much more distinct; there are small, rounded, brownish spots with a diameter of less than 0·01 mm., which disappear under the action of hydrochloric acid with disengagement of chlorine. These small round concretions, which are probably a mixture of the oxides of iron and manganese, will be described with more detail in the *Challenger* Report.

The following table shows the nomenclature we have adopted:—

| | | |
|---|---|---|
| Terrigenous deposits. | Shore formations,<br>Blue mud,<br>Green mud and sand,<br>Red mud, | Found in inland seas and along the shores of continents. |
| | Coral mud and sand,<br>Coralline mud and sand,<br>Volcanic mud and sand, | Found about oceanic islands and along the shores of continents. |

| | | |
|---|---|---|
| Pelagic deposits. | Red clay, Globigerina ooze, Pteropod ooze, Diatom ooze, Radiolarian ooze, | Found in the abysmal regions of the ocean basins. |

*Geographical and Bathymetrical Distribution.*—In the preceding pages we have confined our remarks essentially to the lithological nature of the deep-sea deposits, including in this term the dead shells and skeletons of organisms. From this point of view it has been possible to define the sediments and to give them distinctive names. We now proceed to consider their geographical and bathymetrical distribution, and the relations which exist between the mineralogical and organic composition and the different areas of the ocean in which they are formed.

A cursory glance at the geographical distribution shows that the deposits which we have designated MUDS and SANDS are situated at various depths at no great distance from the land, while the ORGANIC OOZES and RED CLAYS occupy the abysmal regions of the ocean basins far from land. Leaving out of view the coral and volcanic muds and sands which are found principally around oceanic islands, we notice that our blue muds, green muds and sands, red muds, together with all the coast and shore formations, are situated along the margins of the continents and in inclosed and partially inclosed seas. The chief characteristic of these deposits is the presence in them of continental debris. The blue muds are found in all the deeper parts of the regions just indicated, and especially near the embouchures of rivers. Red muds do not differ much from blue muds except in colour, due to the presence of ferruginous matter in great abundance, and we find them under the same conditions as the blue muds. The green muds and sands occupy, as a rule, portions of the coast where detrital matter from rivers is not, apparently, accumulating at a rapid rate, viz. on such places as the Agulhas Bank, off the east coast of Australia, off the coast of Spain, and at various points along the coast of America.

Let us cast a glance at the region occupied by terrigenous deposits, in which we include all truly littoral formations. This region extends from high-water mark down, it may be, to a depth of over four miles, and in a horizontal direction from 60 to perhaps 300 miles seawards, and includes, in the view we take, all inland seas, such as the North Sea, Norwegian Sea, Mediterranean Sea, Red Sea, China Sea, Japan Sea, Caribbean Sea, and many others. It is the region of change and of variety with respect to light, temperature, motion, and biological conditions. In the surface waters the temperature ranges from 80° F. in the tropics, to 28° F. in the polar regions. Below the surface down to the nearly ice-cold water found at the lower limits of the region in the deep sea, there is in the tropics an equally great range of temperature. Plants and animals are abundant near the shore, and animals extend in relatively great abundance down to the lower limits of this region which is now covered by these terrigenous deposits. The specific gravity of the water varies much, owing to mixture with river water or great local evaporation, and this variation in its turn affects the fauna and flora. In the terrigenous region tides and currents produce their maximum effect, and these influences can in some instances be traced to a depth of 300 fathoms, or nearly 2000 feet. The upper or continental margin of the region is clearly defined by the high-water mark of the coast-line, which is constantly changing through breaker action, elevation, and subsidence. The lower or abysmal margin is less clearly marked out. It passes in most cases insensibly into the abysmal region, but may be regarded as ending when the mineral particles from the neighbouring continents begin to disappear from the deposits, which then pass into an organic ooze or a red clay.

Contrast with these, those conditions which prevail in the abysmal region in which occur the organic oozes and red clay, the distribution of which will presently be considered. This area comprises vast undulating plains from two to five miles beneath the surface of the sea, the average being about three miles, here and there interrupted by huge volcanic cones (the oceanic islands). No sunlight ever reaches these deep cold tracts. The range of temperature over them is not more than 7°, viz. from 31° to 38° F., and is apparently constant throughout the whole year in each locality. Plant life is absent, and although animals belonging to all the great types are present, there is no great variety of form or abundance of individuals. Change of any kind is exceedingly slow.

What is the distribution of deposits in this abysmal region of the earth's surface? In the tropical and temperate zones of the great oceans, which occupy about 110° of latitude between the two polar zones, at depths where the action of the waves is not felt, and at points to which the terrigenous materials do not extend, there are now forming vast accumulations of *Globigerina* and other pelagic Foraminifera, coccoliths, rhabdoliths, shells of pelagic Mollusks, and remains of other organisms. These deposits may perhaps be called the sediments of median depths and of warmer zones, because they diminish in great depths and tend to disappear towards the poles. This fact is evidently in relation with the surface temperature of the ocean, and shows that pelagic Foraminifera and Mollusks live in the superficial waters of the sea, whence their dead shells fall to the bottom. Globigerina ooze is not found in inclosed seas nor in polar latitudes. In the Southern Hemisphere it has not been met with beyond the 50th parallel. In the Atlantic it is deposited upon the bottom at a very high latitude below the warm waters of the Gulf Stream, and is not observed under the cold descending polar current which runs south in the same latitude. These facts are readily explained, if we admit that this ooze is formed chiefly by the shells of surface organisms, which require an elevated temperature and a wide expanse of sea. But as long as the conditions of the surface are the same, we would expect the deposits at the bottom also to remain the same. In showing that such is not the case, we are led to take into account an agent which is in direct correlation with the depth. We may regard it as established that the majority of the calcareous organisms which make up the Globigerina and Pteropod oozes live in the surface waters, and we may also take for granted that there is always a specific identity between the calcareous organisms which live at the surface and the shells of these pelagic creatures found at the bottom. This observation will permit us to place in relation the organic deposits and those which are directly or indirectly the result of the chemical activity of the ocean. Globigerina ooze is found in the tropical zone at depths which do not exceed 2400 fathoms, but when depths of 3000 fathoms are explored in this zone of the Atlantic and Pacific, there is found an argillaceous deposit without, in many instances, any trace of calcareous organisms. When we descend from the "submarine plateaus" to depths which exceed 2250 fathoms, the Globigerina ooze gradually disappears, passing into a grayish marl, and finally is wholly replaced by an argillaceous material which covers the bottom at all depths greater than 2900 fathoms.

The transition between the calcareous formations and the argillaceous ones takes place by almost insensible degrees. The thinner and more delicate shells disappear first. The thicker and larger shells lose little by little the sharpness of their contour and appear to undergo a profound alteration. They assume a brownish colour, and break up in proportion as the calcareous constituent disappears. The red clay predominates more and more as the calcareous element diminishes in the deposit.

If we now recollect that the most important elements of the organic deposits have descended from the superficial waters, and that the variations in contour of the bottom of the sea cannot of themselves prevent the debris of animals and plants from accumulating upon the bottom, their absence in the red clay areas can only be explained by a decomposition under the action of a cause which we must seek to discover.

*Pteropod ooze*, it will be remembered, is a calcareous organic deposit, in which the remains of Pteropods and other pelagic Mollusca are present, though they do not always form a preponderating constituent, and it has been found that their presence is in correlation with the bathymetrical distribution.

In studying the nature of the calcareous elements which are deposited in the pelagic areas, it has been noticed that, like the shells of the Foraminifera, those of the Thecosomatous Pteropoda, which live everywhere in the superficial waters, especially in the tropics, become fewer in number as the depth from which the sediments are derived increases. We have just observed that the shells of Foraminifera disappear gradually as we descend along a series of soundings from a point where the Globigerina ooze has abundance of carbonate of lime, towards deeper regions; but we notice also that when the sounding-rod brings up a graduated series of sediments from a declivity descending into deep water, among the calcareous shells those of the Pteropods and Heteropods disappear first in proportion as the depth increases. At depths less than 1400 fathoms in the tropics a Pteropod ooze is found with abundant remains of Heteropods and Pteropods; deeper soundings then give a Globigerina ooze without these molluscan remains; and in still greater depths, as before mentioned, there is a red clay in which calcareous organisms are nearly, if not quite, absent.

In this manner, then, it is shown that the remains of calcareous organisms are completely eliminated in the greatest depths of the ocean. For if such be not the case, why do we find all these shells at the bottom in the shallower depths, and not at all in the greater depths, although they are equally abundant on the surface at both places? There is reason to think that this solution of calcareous shells is due to the presence of carbonic acid throughout all depths of ocean water. It is well known that this substance, dissolved in water, is an energetic solvent of calcareous matter. The investigations of Buchanan and Dittmar have shown that carbonic acid exists in a free state in sea water, and in the second place, Dittmar's analyses show that deep-sea water contains more lime than surface water. This is a confirmation of the theory which regards carbonic acid as the agent concerned in the total or partial solution of the surface shells before or immediately after they reach the bottom of the ocean, and is likewise in relation with the fact that in high latitudes where fewer calcareous organisms are found at the surface, their remains are removed at lesser depths than where these organisms are in greater abundance. It is not improbable that sea water itself may have some effect in the solution of carbonate of lime, and further, that the immense pressure to which water is subjected in great depths may have an influence on its chemical activity. We await the result of further researches on this point, which have been undertaken in connection with the *Challenger* Reports. We are aware that objections have been raised to the explanation here advanced, on account of the alkalinity of sea water, but we may remark that alkalinity presents no difficulty which need be here considered (Dittmar, "Phys. Chem. *Chall.* Exp.," part i. 1884).

This interpretation permits us to explain how the remains of Diatoms and Radiolarians (surface organisms like the Foraminifera) are found in greater abundance in the red clay than in a Globigerina ooze. The action which suffices to dissolve the calcareous matter has little or no effect upon the silica, and so the siliceous shells accumulate. Nor is this view of the case opposed to the distribution of the Pteropod ooze. At first we should expect that the Foraminifera shells, being smaller, would disappear from a deposit before the Pteropod shells; but if we remember that the latter are very thin and delicate, and, for the quantity of carbonate of lime present, offer a larger surface to the action of the solvent than the thicker, though smaller, Globigerina shells, we shall see the explanation of this apparent anomaly.

(*To be continued.*)

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Special Board for Mathematics has reported in favour of an interval of one year being allowed between the second and the third parts of the Mathematical Tripos, instead of seven months as at present. It is also suggested that the work done in the first two parts of the Tripos has deteriorated in consequence of being held in the latter part of the Easter Term, when men are subject to many distractions.

The new buildings for the Department of Practical Botany are to be proceeded with forthwith, and thus Dr. Vines will gain the much-needed accommodation he has so long waited for.

The thanks of the University have been voted to Sir A. Gordon and to Mr. A. P. Maudslay for their presents of valuable ethnological collections, made by them in Fiji, to the new Museum of Archæology.

The eighteenth annual report of the Museums and Lecture-Rooms Syndicate draws attention to the pressing need of additional accommodation for Human and Comparative Anatomy and for Physiology. Nothing can be done to enlarge the provision of Human Anatomy till the new Chemical Laboratory is completed. A further report as to the accommodation for Physiology and Comparative Anatomy will be made shortly.

Profs. Liveing and Dewar report that additional special courses for medical students have been established. Lord Rayleigh reports that the elementary demonstrations on Physics in the Cavendish Laboratory are attended by forty students, the advanced by twenty, and the professorial lectures by from twenty to thirty students. Numerous additions of physical apparatus have been made during the year.

Prof. Lewis records a continued improvement in the Mineralogical Museum. Prof. J. P. Cooke of Harvard has presented a large and fine series of American specimens. Mr. G. Seligman of Coblentz has sent specimens far exceeding in value those for which they were exchanged. Mr. Solly brought back many excellent specimens from a tour in Norway; and the late Mr. Tawney's polariscope and optic sections have been presented by his brother.

Prof. Stuart has added some large machines to the Mechanical Department. There were sixty-one pupils in the Lent Term, and their work continues to improve. He states that Mr. Lyon's services are of extreme value as superintendent of the workshops, for he combines practical experience and theoretical knowledge in a manner rarely to be met with.

The additions to the Woodwardian Museum include twelve or fourteen thousand specimens, the collection of the late Mr. Montagu Smith, B.A., of Trinity College, a promising young student of geology, given by his parents in fulfilment of his expressed wish. They include several thousand specimens from all the crags of Norfolk and Suffolk, a rich collection of Chalk mollusca from Berkshire, mollusca from the Gault of Folkestone, the Farringdon sponge-bed, and specimens from many Jurassic localities. Mammalian remains from the Hamstead Beds, Isle of Wight, and Vertebrates from the Gault of Folkestone have been purchased. A number of interesting specimens from the Welsh Palæozoic strata, from Lower Llandoveny down to Harlech, have been added by Mr. T. Roberts. The Library continues to increase largely.

Mr. J. W. Clark reports that the collection acquired from Dr. Dohrn, exhibited at the Fisheries Exhibition, turns out much more valuable than was anticipated, there being 283 species of Invertebrates, and 38 of fishes in it, each being usually represented by several specimens. All are in first-rate order, and exceptionally good specimens. Mr. H. B. Brady has announced his intention of presenting all his valuable collections of Rhizopoda, chiefly Foraminifera, to be forwarded as the monographs relating to them are completed. Large instalments have already arrived, including the collection of British brackish-water and estuarine forms described in *Ann. and Mag. Nat. Hist.*, 1870, the North Polar Foraminifera from the Nares Expedition, the Carboniferous and Permian Foraminifera ("Pal. Soc. Monograph"), a large series of the genus Fusulina, a collection of the genera Nummulites and Orbiloides, numerous specimens of Loftusia and Parkeria, Nummulites from Egypt, and microzoic rocks illustrating the extent to which Forominifera are concerned in the building of geological strata.

Mr. Cooke, Curator in Zoology, has catalogued and arranged the specimens of Murex, Purpura, Triton, Fasciolaria, Buccinum, Nassa, Fusus, Voluta, and Mitra, and related genera.

Mr. Hans Gadow, Strickland Curator, has been occupied in arranging the collection of birds' skins in a systematic way, and preparing to exhibit the groups in a complete manner, skins, skeletons, viscera, nests, and eggs, in juxtaposition, but want of space, cases and drawers, is a great hindrance. Valuable donations of birds' skins have been received from Major H. W. Feilden (Natal), Lady Barkly (Penang), and Mr. C. E. Lister (St. Vincent, Antilles), and in exchange from the Australian Museum, Sydney (New Guinea species).

The Morphological Department records good progress; many diagrams and models have been added owing to the liberality of Trinity College, and much valuable material has been brought by students who have visited foreign countries for purposes of morphological research. The Balfour Library is of great value, and Mr. A. J. Balfour, M.P., is defraying the cost of continuing the periodicals. Twelve students have been engaged in research; seventeen have worked in the advanced class; forty-four worked at embryology last year, while nearly fifty have worked at Elementary Morphology during the past winter. Overwhelming pressure has been put upon the department owing to the new arrangements for Elementary Biology in the M.B. examinations; 201 students entered it last term, belonging to more than one year, and no lecture-room or work-room has proved adequate for them all. The work of research, storage of material, and administration of classes are much interfered with by want of suitable rooms, and new rooms are urgently needed. A bust of Prof. Balfour, executed in bronze by Hildebrandt of Florence, has been presented to the Laboratory by Prof. Darwin and Mr. J. W. Clark.

Prof. Michael Foster reports that the teaching of Physiology has been still further developed, but has suffered somewhat from the necessary use of the Laboratory by the class of Elementary