The *Discovery* Expedition.

By Dr. STANLEY KEMP, Director of Research

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THE R.R.S. *Discovery* left Falmouth on October 5, 1925, and, after touching at Las Palmas and Ascension Island, arrived at Cape Town on December 20. On this passage apparatus and nets were tested, and certain defects which were found were made good. Later passages, until our return to Cape Town in June of the present year, are shown in the accompanying track-chart (Fig. 1).

We left Cape Town on January 17, delivered mails and stores at Tristan d'Acunha on January 30, and sailed for South Georgia on February 1. During the first few days very heavy weather was experienced and we were driven far out of our course by gales of almost hurricane force from the west and south-east. On the passage five deep-water stations were taken. We sighted our first iceberg on February 16, and arrived at Grytviken, in Cumberland Bay, on February 20. For about two months from this date we were engaged in observations on the whaling grounds, sailing for the Falkland Islands on April 17 and arriving in Port Stanley on April 25. A short cruise was made to Falkland Sound (northern end), where whales had been reported, and on May 20 we left on the return passage, laying a course to the north-east in order to pass the reported position of two shoals. On the passage nine full stations were taken and large plankton nets were towed at intervening points. Strong westerly winds and high seas prevented us from making as many observations as we had hoped. We reached Cape Town on June 29.

An account of the *Discovery* expedition and its objects has already been published in this journal (vol. 115, 1925, p. 950), and our principal aim during the recent cruise was to carry out a biological and hydrographic survey of the South Georgian whaling grounds. In this we were largely frustrated by the bad weather which prevailed. Data of considerable interest were, however, obtained and experience acquired which will be of great value in our next attempt.

During the 1925–1926 season the whaling grounds at South Georgia were situated on the shelf on the north-east side of the island in soundings of 200 to 250 metres.

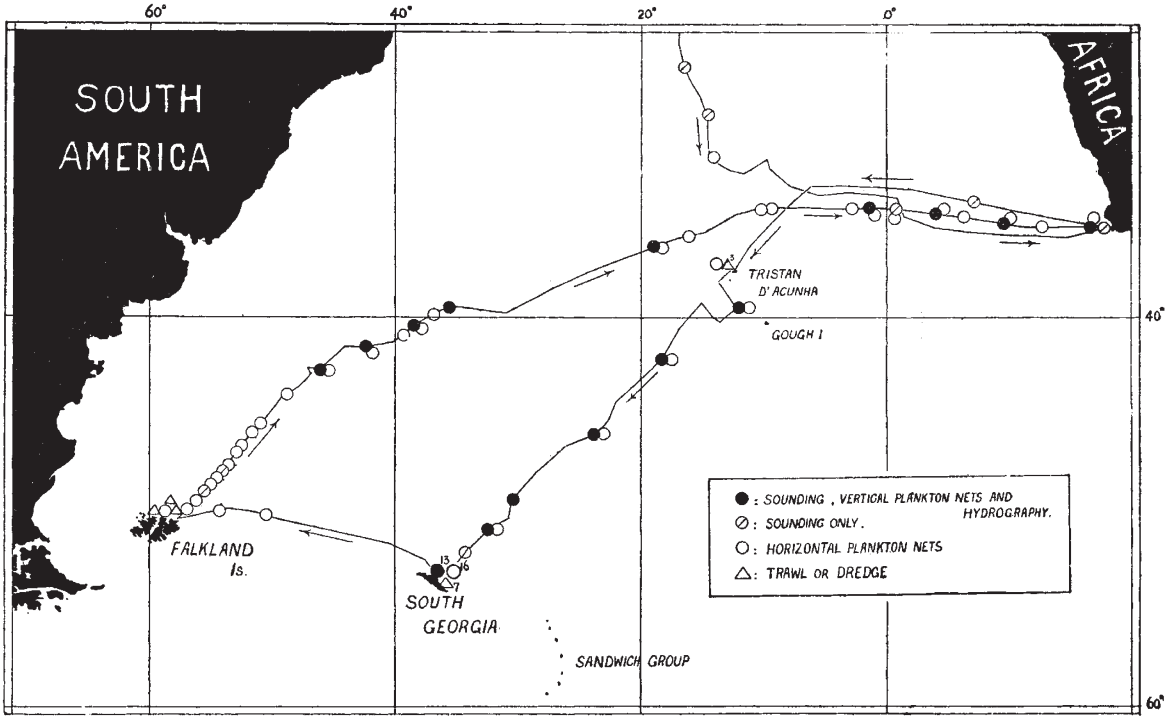

FIG. 1.—Track-chart of the R.R.S. *Discovery*, November 1925–June 1926.

In this area, at the time of our visit, Euphausian Crustacea were plentiful and *Euphausia superba*, which in our experience forms the only food of fin and blue whales, was often extremely abundant. *E. superba* is a comparatively large species, too active to be caught in vertical nets; to obtain adequate samples it is necessary to use nets towed horizontally. We have not yet sufficient material for a study of the life-history of this species. On the whaling grounds we obtained a few very early post-larval forms, while the great majority were in stages just short of sexual maturity. An Amphipod of the genus Euthemisto occurs in prodigious numbers in the same area and appears to feed almost exclusively on young Euphausians.

As regards hydrographic conditions on the whaling grounds, the most striking feature was the existence of a cold middle layer, with temperatures of about 0° C. at a depth of some 150 metres. This layer was

found to within about ten miles of the shore and, as shown by observations taken on our passage from Tristan d'Acunha, extends seaward to 50° 26′ S. The salinity increased regularly from about 33·7 per thousand at the surface to 34·3 per thousand at the bottom. As might be expected, at the end of the season Diatoms were almost absent on the whaling grounds, but a dense patch of *Thalassothrix longissima* was found in 51° 55′ S. and another of *Rhizosolenia polydactyla* between South Georgia and the Falkland Islands. Phosphates showed very high values in the whaling area, the readings, expressed in mgm. per m.^{3}, varying from 102 to 108 at the surface to 183 at the bottom. Hydrogen-ion concentration varied from 8·26 at the surface to 7·96 in the lower layers.

During a short cruise to the northern end of Falkland Sound, quantities of *Grimothea gregaria* were taken. This decapod Crustacean, which is the pelagic post-larval stage of the rock-lobster, *Munida gregaria*, no doubt forms the food of the rorqual whales which periodically visit the islands.

Large midwater nets have been hauled on numerous occasions, more particularly on the passage from the Falklands to the Cape, yielding collections which should add greatly to our knowledge of the plankton of this region. Among the more interesting forms are great numbers of Diphyids, including a species with scarlet zooids, several pelagic Nemertines—one 13 cm. in length—Decapods with luminous organs belonging to the genera Sergestes, Systellaspis, Hoplophorus, and Stylopandalus, the Pteropod Schizobrachium, Thaumatolampas, and other peculiar Cephalopods, and, among the fish, Chiasmodon, Cynomacrurus, and *Stylophthalmus paradoxus*.

The Continuous Plankton Recorder has been employed on numerous occasions and has given successful records on runs which exceed 1300 miles in total length. Mr. A. C. Hardy, to whom the invention of this instrument is due, contributes an account of the apparatus and of the results so far obtained (see App. II.).

The 40-feet otter trawl was used on a few occasions in shallow water at South Georgia and off the Falkland Islands. The bottom fauna is very rich and varied, and, particularly in the former locality, quantities of Nototheniiform fish were taken. Among large collections of invertebrates special mention may perhaps be made of the ten-legged Pycnogonid *Decolopoda antarctica*, of which six individuals were obtained. Dredgings off Tristan d'Acunha resulted in large hauls of Alcyonaria and Antipatharia, and it was found that some colonies of the latter were being invaded by a small brilliantly luminous Actinian, apparently allied to the genus Girardia.

Between the equator and Ascension Island, over a distance of some 600 miles, vast quantities of Pyrosoma were seen every night at the surface, giving a most wonderful display of luminescence, and, at a later date, not far from Cape Town, a colony of another species of this Tunicate was caught which must have been fully 8 ft. in length when intact. Patches of discoloration in the water were on one occasion found to be due to the alga Trichodesmium, on others to swarms of Salpa, in which numbers of semi-parasitic Copepods of the genus Sapphirina were obtained.

During the course of the work, 48 deep-sea soundings have been taken and an examination made in the vicinity of a reported shoal lying to the north-east of the Falkland Islands. Latterly, tests have been made with a modified form of the Nansen tube, designed to bring up cores of ooze enclosed in glass tubes. With this apparatus a core of red clay 47 cm. in length, and one of Globigerina ooze 30 cm. in length, have been secured. It is anticipated that still better results will be obtained in the future. At two points between Tristan d'Acunha and South Georgia, in 46° 35′ S. and 50° 26′ S., the bottom was found to consist of a pure radiolarian ooze, a deposit apparently hitherto reported only from the Pacific. The deep-water echo-sounding apparatus unfortunately developed defects which rendered it unserviceable, but repairs have been put in hand and it is hoped that good results will be obtained with it during the latter half of the voyage.

While at South Georgia, the coasts of which are very poorly charted, as much survey work as possible was undertaken by Lieut.-Comm. J. M. Chaplin. He made a special visit in a sailing vessel to Undine Harbour in order to fix positions at the north-west end of the island.

To shoot and haul large nets and to carry out all the operations necessary for modern oceanographic research in a barque-rigged vessel such as the *Discovery* has naturally proved to be a formidable undertaking. The results we have obtained are due in no small measure to the interest and enthusiasm shown by Commander J. R. Stenhouse, who has invariably done his utmost to render the work successful.

A second ship belonging to the expedition, the R.S.S. *William Scoresby*, has recently arrived in Cape Town. She is of the whale-catcher type, and has been designed especially for whale-marking and trawling. According to the provisional programme which has been drawn up, both vessels will be employed on the south-west coast of Africa until the middle of October, the *Discovery* in plankton investigations on the whaling grounds off Saldanha Bay and the *William Scoresby* in whale-marking. Towards the end of October the passage to South Georgia will be made, the *Discovery* taking a southerly route and skirting the pack-ice. At the end of the year the two vessels will co-operate in a survey of the South Georgia whaling grounds, the *Discovery* afterwards proceeding to the South Shetlands, while the *William Scoresby* undertakes trawling in the vicinity of the Falkland Islands. The Marine Station at Grytviken, South Georgia, will be open throughout the season. I append an account of the work at Grytviken.

APPENDIX I.

WORK OF THE MARINE STATION AT GRYTVIKEN.

By N. A. MACKINTOSH.

The Marine Station was established chiefly for investigations on whales brought to the whaling station, and work has now been in progress since February 1925.

The main problems with which the whale work is concerned fall under the following headings: (1) the specific and subspecific identity of southern whales in comparison with their northern representatives; (2) the investigation of various problems connected with the reproduction, growth, and general breeding habits

of whales; and (3) the interrelations of breeding, migration, nourishment, age, adolescence, etc. Data have been obtained from 738 whales examined at South Georgia.

The routine work included under the first heading consists in the collection, by a series of measurements, of statistical records of the bodily proportions of a large number of whales and notes on a variety of external characters taken with the view of determining what characters are constant and to what extent variation may occur. In this way a large body of material has been collected for subsequent analysis. Attention has been paid to such parasites as occur, since the study of the species of external and internal parasites might be found to have a bearing on the distribution of species or communities of whales.

In regard to breeding and the subjects with which it is related, it should be pointed out that whaling at South Georgia is carried on almost exclusively during the southern summer. The indications point to the winter as the period of maximum pairing and calving, and the material so far obtained cannot therefore be regarded as complete until observations have been made which extend over the whole year. In order that these observations can be made, work is now being started in South Africa at Saldanha Bay, where whaling is carried on during the southern winter. In the meantime, some provisional conclusions can be drawn from the results obtained at South Georgia.

The type of information required relates to such problems as the time occupied by the different stages in the reproductive cycle, and the seasons at which they take place, the time required to reach sexual and full maturity, etc., and to the general reproductive potentiality of the stock of whalebone whales in southern waters. A certain amount of evidence has been obtained on a number of these points, and some indication can be given of the lines on which the investigations are developing. A study of the monthly increment in the average length of fœtal fin whales at South Georgia corroborates the theory that both pairing and parturition occur most frequently during the winter months, while the diversity of lengths of the fœtuses taken at any one time shows that the pairing and consequently the calving seasons are relatively extensive. There is evidence that parturition occurs when the fœtus has reached a length of about 6·0 metres, and the monthly average fœtal lengths suggest that this length would in general be reached about the middle of the southern winter. It does not in any case seem possible that the period of gestation can be much more or much less than a year. With regard to the frequency of the recurrence of pregnancy, the most that can be said at present is that whales probably do not become pregnant every year.

The study of the ovaries has revealed no sign of œstrus occurring between October and May, which is in keeping with the supposition that impregnation mostly takes place during the southern winter. The testes also appear to be in a quiescent condition. The inspection of the ovaries of whales taken in South African waters should be of special value in defining the pairing season more exactly.

An important point to be considered is the proportion of sexually immature whales which are killed. In the case of fin whales, about 26 per cent. are estimated to be immature, while in the case of blue whales, the ratio is so high as 58 per cent., a fact to which attention must be paid in considering the effect of the whaling industry on the general stock of whales.

A point of special interest arises from a study of the numbers of blue whales taken at different sizes. There are indications that the majority of these whales approximate to one of three different lengths, two of which represent a stage of growth at which the animal is still sexually immature. This suggests that young blue whales are inclined to visit South Georgian waters at two successive stages in their development towards maturity, living elsewhere between the stages until they grow to the next size. If they make regular annual migrations, the suggestion at once arises that the difference between the first and second sizes represents a year's growth. Then, assuming that the young are born in the warmer waters during winter and travel towards South Georgia during their first spring, it would follow that sexual maturity is reached just three years after birth. This, however, is a point which will need confirmation from a larger body of material, and it is noteworthy that no indications of the same nature have been detected in the fin whale statistics.

In regard to the estimation of the age of whales, there is some indication that the number of corpora lutea, including the traces of very old ones left in the ovaries, may be to some extent correlated with the age of the whale. The evidence is arrived at from a comparison of the length of the whale with the number of corpora lutea, and partly from the fact that blue whales, which appear to be taken in general at an earlier age than fin whales, usually have fewer old corpora lutea in the ovaries.

Several other points of interest have arisen, amongst which are the observation of a curious structure, found only in some immature female fin whales, which consists of a fleshy band bridging the entrance to the vagina, and the finding of a 24-mm. fin whale fœtus. Twin fœtuses have been found on two occasions.

Other work done at the Marine Station includes the chemical analysis of water-samples collected by the *Discovery* and investigations on elephant seals and on the bird life of the island. With the help of a motor-boat, with which the station is now provided, observations have been begun on the rich fauna of Cumberland Bay.

APPENDIX II.

A NEW METHOD OF PLANKTON RESEARCH.

By A. C. HARDY.

Hitherto our knowledge of the density and distribution of the plankton has been gained from samples taken at a number of stations within the area concerned. When, as on long cruises, the stations have to be twenty, fifty, or even a hundred or more miles apart, it may be doubted whether such samples are giving a true idea of the planktonic content of the water traversed: at one point one may strike a swarm of Copepods, or between two others miss an important zone of Diatoms. For a long time I have felt the need of an instrument which, by giving a continuous record

mile by mile to scale, would enable one to study and compare the uniformity or irregularity of planktonic life in different areas, to measure the size, varying internal density, and frequency of patches, and to indicate more exactly than can be done with comparable tow-nettings whether any correlation exists between different species.

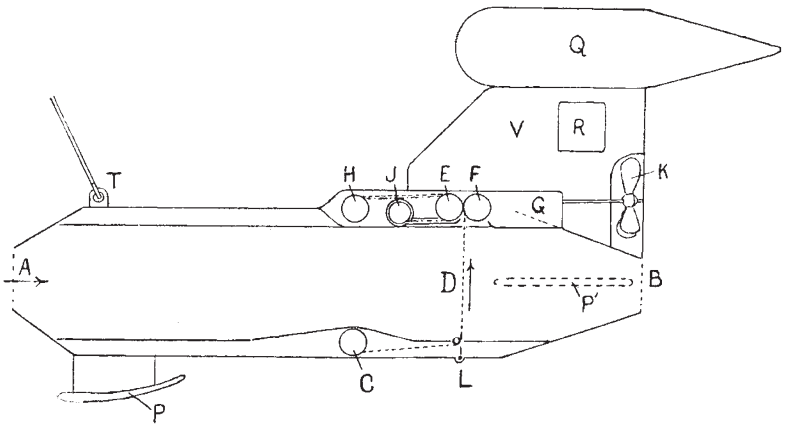

FIG. 2.—Diagrammatic section of the continuous plankton recorder.

Whilst on the *Discovery* expedition I have been experimenting with such an instrument, which I am calling the Continuous Plankton Recorder. Numerous little defects and difficulties have had to be overcome; but now that, taken together, more than 1300 miles of plankton have been recorded, it may be of interest to publish a brief description of the instrument and a note of some of the results obtained by its use. It is a development of the simple Plankton Indicator which I used in the North Sea (*Min. of Agric. and Fisheries Fishery Investigations* II, vol. 8, No. 7, 1926), but in place of the silk netting discs, which had to be reloaded for each sample, I have substituted a long continuously moving roll operated by a propeller turned by the water through which it is towed. Like the Indicator, it is used at full speed without stopping the ship.

Fig. 2 is a diagram of the instrument. It has a hollow cylindrical body tapered at each end, is weighted in front and furnished with planes P and P', a vertical fin V with adjustable rudder R, and buoyancy chamber Q, so that when it is towed at the point T it 'flies' like a paravane in a horizontal position in the water at the required depth. I am greatly indebted to H.M.S. *Vernon*, Portsmouth, which carried out stability tests up to a speed of 16 knots and fitted the present planes and fin in place of those of my own design which proved unsatisfactory.

As the apparatus is towed, water enters through the circular opening A, passes through the cylinder and out at B. A length of silk netting, 9 inches wide and with 60 meshes to the inch, is arranged to wind off the braked roller C across the stream of water at D, where, supported behind by a gridwork of fine rollers, it catches the organisms in the water, then between the driving rollers E and F, which are of soft rubber but with hard ends gripping the edges of the silk, and so on to the storage roller H. The openings A and B, of 4 inches diameter, are smaller than that of D and approximately equal to the filtration area of the netting; a steady flow of water is thus assured, which by its pressure causes the organisms to adhere to the silk. The rollers E and F are driven through the gear-box G by the propeller K, and the storage roller H from E by a chain and friction drive, which prevents acceleration in winding due to its increasing diameter. At J, in a box, is a roll immersed in 5 per cent. formalin; this winds in with the catching roll between E and F, so preserving and separating the layers of organisms on the storage roller H. The instrument is hinged at L and made to open so that the rollers C, J, and H can be quickly taken out and replaced by others. It will be noted that the opening A is not masked by any towing bridle and cuts the water cleanly. The drawings of the instrument were prepared by Mr. M. T. Denne of

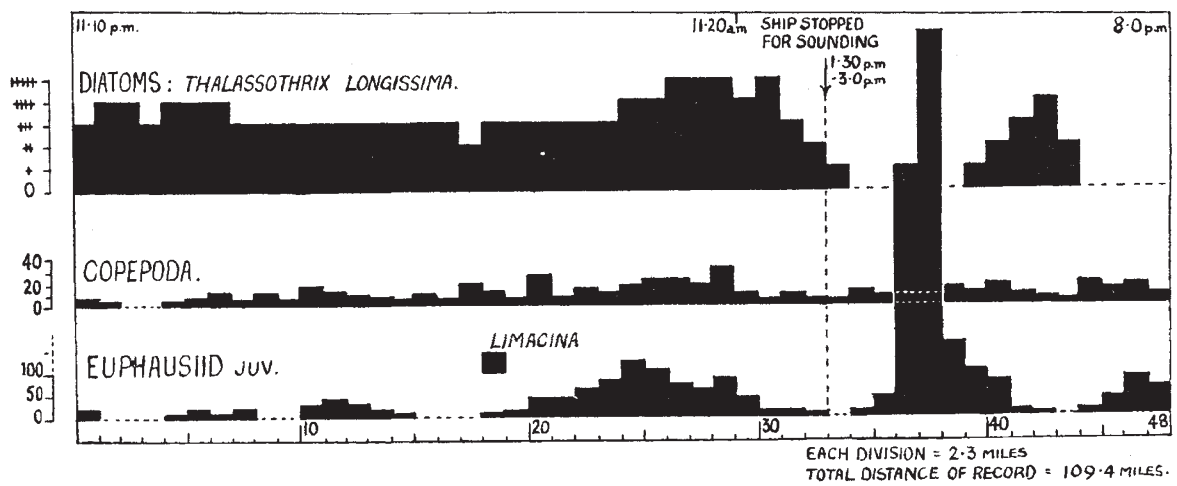

FIG. 3.—Graphic representation of continuous plankton record approaching South Georgia, February 18-19, 1926.

310 Regent Street, W., to whom I am indebted for a number of valuable suggestions.

Each silk-catching roll is ruled with transverse numbered lines at 6-inch intervals. Rolls up to 75 sections in length may be used. The blades of the propeller are adjustable so that each section may represent an equal distance of one or more miles as required; the distance actually travelled by the instrument is measured by the ship's log.

At the end of the record the completed roll is unwound across a glass stage with mirror below and examined section by section with a microscope; occasionally an organism may have been removed from the netting for identification. As detailed an analysis is made as may be desired or time permits, from an exact quantitative estimation of all the species to a rough estimation of the general density in different places. The specimens are sometimes damaged in the process of winding, but in nearly all cases they can be identified; in areas where the plankton is well known determination is conspicuously easy. The instrument is not intended for collecting purposes, and, having different functions, is a supplement to, rather than a substitute for, the plankton net.

Fig. 3 shows one of the records obtained; it indicates the distribution of the Diatom *Thalassothrix longissima*, the Pteropod Limacina, the Copepoda, and young Euphausians on a run of 109·4 miles, each section representing approximately 2·3 miles. In the twenty-two records so far made there is evidence of a marked variation in the density and regularity of the plankton in different oceanic regions, and various methods of comparison may be adopted. Discontinuity is expected more in coastal waters, but in mid-ocean sharply defined patches of small Salps, *S. democratica* and *S. longicauda*, Pteropods of the genus Limacina, young Ianthina, Ostracods, Copepods such as *Candacia ethiopica* and *Calanus robustior*, and young Euphausians have been demonstrated. On the other hand, Diphyids and Chætognaths, where they occur, have tended to be constant in numbers. On one occasion, by their occurrence in patches on the roll together, a relation was suspected between small Salps and the Copepod *Sapphirina angusta*; this was afterwards confirmed by living material, the latter being found to enter the former and feed upon the food collected on the endostyle.

Operations with the instrument were temporarily suspended owing to a mechanical defect; this has, however, been remedied, and I hope in the coming season that many more results may be obtained.

City and Guilds (Engineering) College.

THE Duke of York, on October 21, opened the extension of the City and Guilds (Engineering) College at South Kensington, which has been provided by the munificence of the Goldsmiths' Company at a capital cost for building of 87,000*l*. Soon after the Royal Charter was granted in 1907 to the Imperial College of Science and Technology, of which the City and Guilds College forms the engineering department, it was decided that a large extension was necessary to provide adequate equipment for engineering education and research. A site was granted for the purpose by the Commissioners of the 1851 Exhibition to the north of the old college in Exhibition Road, and Prof. Dalby, the Dean of the College, drew up a scheme for three new laboratories: (1) hydraulics, (2) structural engineering, motive power engineering and strength of materials, and (3) railway engineering. Building was commenced in 1911 and completed in 1914, the architect being Sir Aston Webb. The laboratories, one of which is top-lighted, cover an area of 32,900 square feet. Apart from the cost of the building, defrayed by the Goldsmiths' Company, Mr. Hawksley contributed 4000*l*. towards the equipment of the hydraulics laboratory, the governing body of the Imperial College expended 20,000*l*. on equipment, and the Clothworkers' Company has provided 4000*l*. per annum for a number of years towards the cost of research. During the War, the buildings were occupied by the Government for war purposes, the structural laboratories, in particular, being used by the Admiralty as research laboratories.

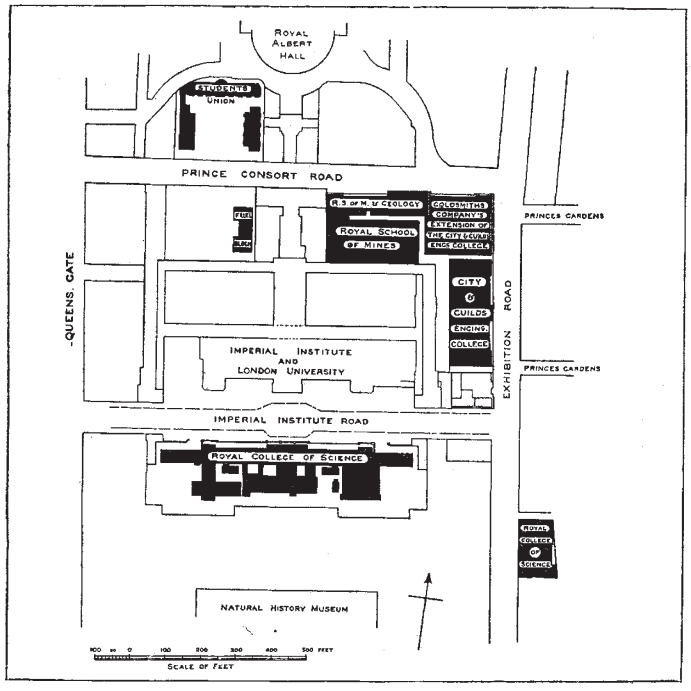

FIG. 1.—General plan of the associated buildings which have been erected on the site of the 1851 Exhibition. The areas coloured black indicate the buildings of the Imperial College of Science and Technology.

The main building of the extension is in the shape of a letter L, the short arm facing Exhibition Road and the long arm Prince Consort Road, the space in the angle being filled by the top-lighted laboratory. The façades are pleasing and well-designed, and the building forms a worthy addition to the great group of educational and public buildings for which South Kensington is famous. Equipment has been provided