## The *Discovery* Expedition.

By Dr. STANLEY KEMP.

IN a previous issue of NATURE (Oct. 30, 1926, p. 628) an account was given of the work of the *Discovery* Expedition up to the end of June 1926: the investigations since that date, to the conclusion of the commission on Sept. 29, 1927, form the subject of the present article.

The work at whaling stations during this period has been continued mainly under the direction of Mr. N. A. Mackintosh, and a note by him on this side of the investigations is given below. This shore work has now been in progress for two and a half seasons at South Georgia and for one season in South Africa, and the whales examined, nearly all Blue and Fin, have reached a total of 1685: never before has so large a number been the subject of scientific investigation. The task of working up the data has only just begun, but already there are indications that results of great economic importance will be gained.

Among other work at the South Georgia station reference may be made to investigations on the elephant seal and on birds by Mr. L. H. Matthews: it is hoped that papers embodying his results will be published at an early date.

As noted previously, the *Discovery* reached Cape Town after her first season's work on June 29, 1926, and she proceeded almost immediately to the Admiralty Dockyard at Simonstown for refit. Hitherto the excessive rolling of the ship had been a serious hindrance to the work, and to minimise this defect sister-keels were fitted. The keels proved very effective in reducing the extent of the roll, but they unfortunately interfered with reception from the echo-sounding apparatus, and in consequence the deep water gear could not be used. On completion of the refit, the *Discovery* left for a short cruise on the south-west coast of Africa before returning to South Georgia for the next season's

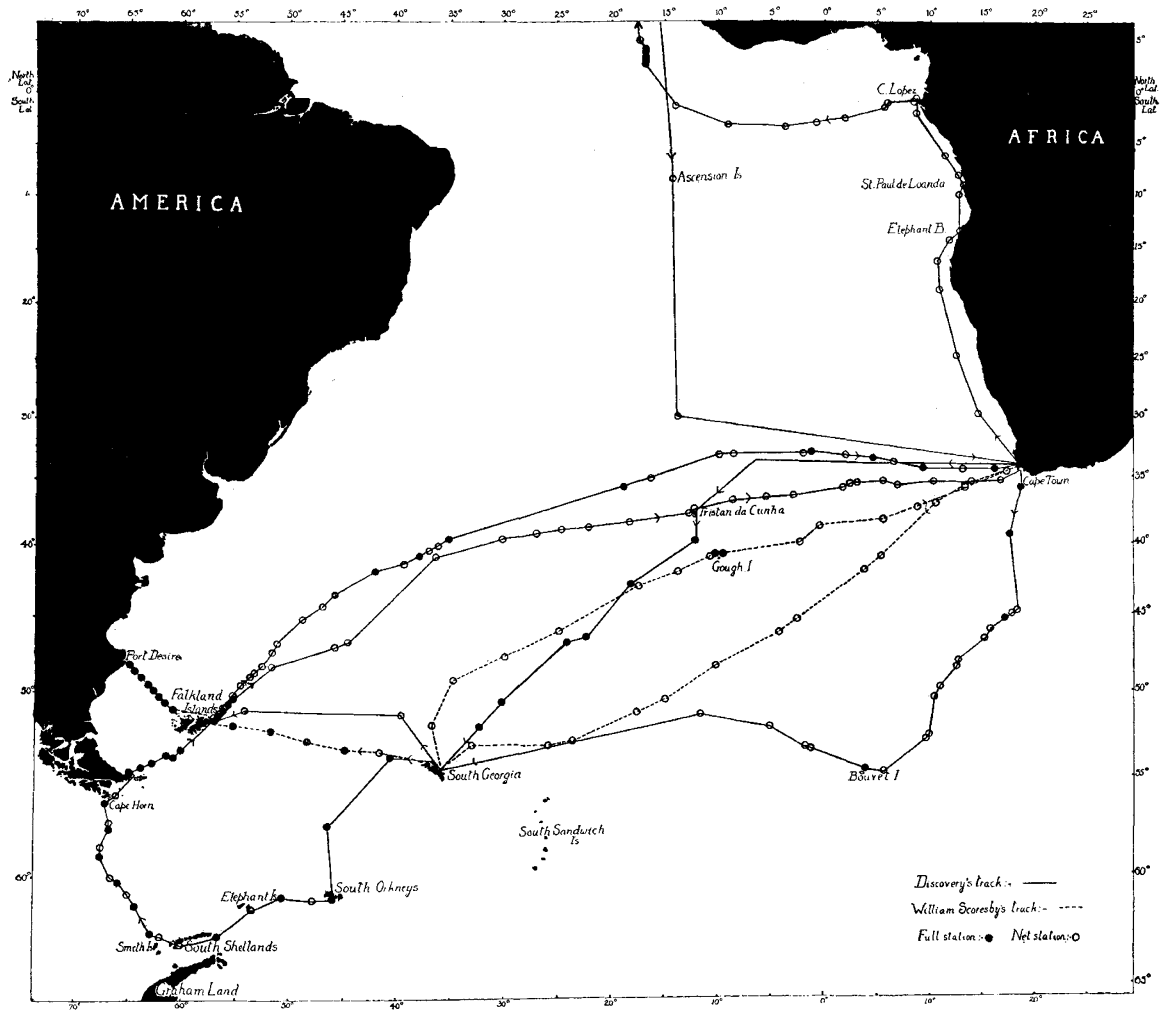


FIG. 1.—Chart of the South Atlantic, showing the tracks of the *Discovery* and *William Scoresby*.

work. Off Saldanha Bay, where two whaling stations are located, a line of planktonic and hydrographic stations was taken and a series of hauls with large closing nets was made in deep water. In order if possible to obtain some knowledge of the diurnal movements of the plankton on the whaling grounds, hauls with closing nets, towed horizontally, were made every four hours during a 24-hour period.

In the meantime the second vessel of the expedition, the *William Scoresby*, had arrived from England, and in October both ships left for South Georgia. The tracks of the two ships are shown in Fig. 1. The *William Scoresby*, with Mr. J. E. Hamilton in charge of the scientific work and Capt. G. M. Mercer in command of the ship, took a direct course, making a series of observations on the plankton during the passage. The *Discovery* attempted a more southerly route with the object of testing the theory that the entire fringe of the Antarctic continent is potential feeding ground for whales. It was our aim to proceed due south past Bouvet Island and to work to the west in high latitudes where easterly winds might be expected to prevail; but abnormal ice conditions frustrated this hope. Near Bouvet Island, which we approached within a short distance, dense pack-ice was encountered, through which it was impossible to make headway, and we were obliged to turn west while still in the track of the westerly winds. With shortage of coal the passage proved one of exceptional difficulty, and we counted ourselves fortunate when we reached Cumberland Bay on Dec. 5.

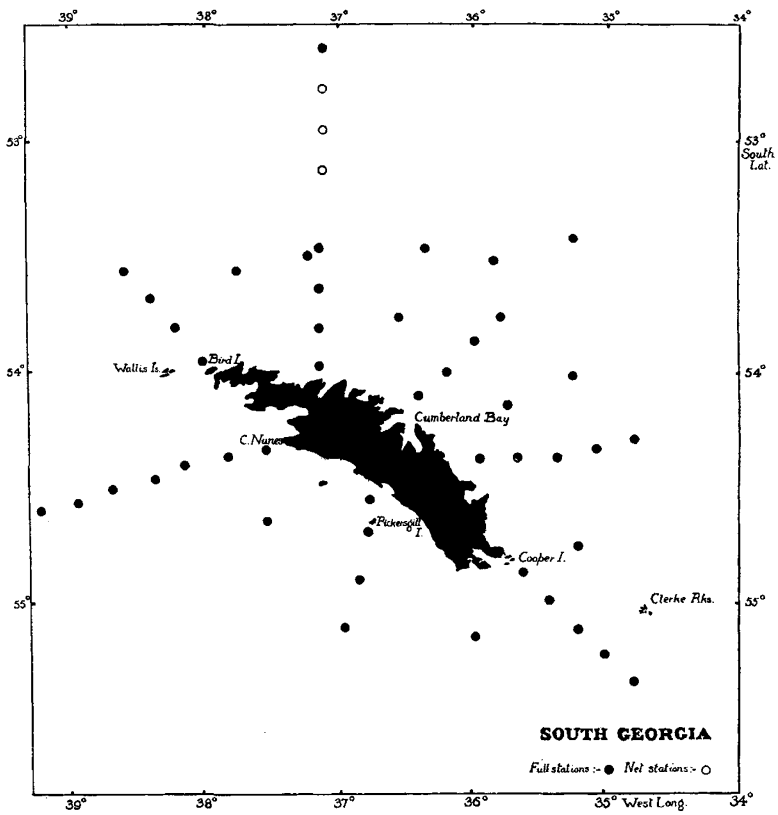


FIG. 2.—Chart illustrating work carried out off South Georgia during December 1926 and January 1927.

The *William Scoresby* had arrived earlier, and before long the two ships set about an intensive study of the conditions on the South Georgian whaling grounds. Mr. A. C. Hardy, in charge of the work on the *William Scoresby*, was in wireless touch with me throughout, and, thanks largely to the great enthusiasm of everyone concerned, the full programme, as illustrated in Fig. 2, was completed. At each of the stations a series of vertical hauls was made with closing plankton nets, covering in standardised sections a column of water from bottom to surface, and two flights of nets towed horizontally, one of coarser and one of finer mesh, were taken in the upper layers between the surface and a depth of about 150 m. The hydrographic observations include full serial readings of temperature, salinity, and phosphate at each of the stations, oxygen determinations at every alternate station, and hydrogen ion concentration values over a considerable area on the north-east side of the island. As a result of this work, we possess material and data from which a precise picture can be drawn of the organic and physical conditions on the whaling grounds at this period. Much can be learnt from a study of these data, and if the observations can be repeated in subsequent years the conditions in different seasons can be compared.

At the conclusion of this survey the *William Scoresby*, with Mr. N. A. Mackintosh in charge, left for Port Stanley, taking a line of hydrographic and plankton stations on the passage, and then began a trawling survey of the continental shelf between the Falkland Islands and South America. The trawl was used at thirty separate positions, and a line of hydrographic stations taken between West Falkland Island and Port Desire in Patagonia. The trawling survey is being continued during the present season, and an account of the results obtained cannot usefully be given until it is completed.

The *Discovery*, after dredging and trawling for a short time on the South Georgian coast, left for the South Orkneys, arriving after a slow and very rough passage, during which only two stations could be taken. At the South Orkneys great numbers of icebergs were encountered, and on the further passage to the South Shetlands one was found which was 35 miles long; another, reported by the whaling community, was said to have exceeded 100 miles in length. All these bergs appear to have come from the Weddell Sea.

We reached Deception Island, the centre of the South Shetland whaling industry, on Feb. 26, and after a few days steamed south to Melchior Harbour in Schollært Channel and to Port Lockroy in Wiencke Island—both in the Palmer Archipelago. We passed through Bismarck Strait and made plankton observations at a station situated in latitude 64° 58′ S., but were unable owing to bad weather to undertake any hydrographic work. Some trawling and dredging was done in the sheltered channels among the islands, where the fauna was found to be one of very great richness. A large species of *Umbellula* was abundant, together with another remarkable alcyonarian probably belonging to the family Xeniidæ. Elasipod and other peculiar holothurians were plentiful, and, among cephalopods, a very large purple *Cirroteuthis* was taken: amphipods and pycnogons occurred in great quantity. Several species of *Cephalodiscus* were found, and with them what appear to be some early developmental stages. On the return passage to Deception Island a line of stations was taken in Gerlache Strait. Work in this area ended with two lines of full plankton and hydrographic stations across Bransfield Strait (not shown in Fig. 1), in the course of which we took immense numbers of larvæ of *Euphausia superba*, the euphausian which in these waters and on the evidence obtained constitutes the sole food of Blue and Fin whales.

The return passage to the Falkland Islands was taken by way of Cape Horn, and owing in no small degree to a spell of particularly favourable weather, good series of observations were made across Drake Strait. Results of considerable interest were obtained in both plankton and hydrography, the most significant feature being the presence of a warm mid-water layer of water on the southern side of the Strait. After a few days at St. Martin's Cove in Hermite Island, close to Cape Horn, the passage to the Falklands was continued, a series of further observations being made on the way. We arrived at Port Stanley on May 6 and found the *William Scoresby* awaiting us after completion of her trawling programme.

Shortly afterwards both vessels left for Cape Town. The *William Scoresby*, with Mr. A. C. Hardy in scientific command, first went to South Georgia, where, with the view of ascertaining the conditions at the close of the whaling season, she repeated a line of stations on the north-east side of the island. Her subsequent course to Cape Town was made via Gough Island, where a party landed, and throughout the passage systematic observations were made on the plankton. The *Discovery* took a direct course via Tristan da Cunha —a second visit to the islanders proving impossible by reason of weather conditions—and made a similar series of plankton investigations on the way.

Soon after her arrival in Cape Town, the *William Scoresby* sailed for England, while the *Discovery*, after a brief period in dock, cruised up the west coast of Africa. The line of stations off Saldanha Bay was repeated, and throughout the passage until arrival at St. Vincent plankton observations were continued. The plankton throughout this passage was of very considerable interest. Among cœlenterates, siphonophores of great beauty were taken, some belonging to the genus *Crystallodes*, and a mysterious form, which defied the zoological knowledge on board but has since been identified as 'Semper's larva.' At some positions cymbuliid pteropods were found in astonishing numbers, and a small fresh-water prawn (*Atya*) was caught in the open sea many miles off the mouth of the Congo river. Fish and crustaceans, often provided with great numbers of luminous organs, were abundant. One night a remarkable luminescent effect was observed, due to a ctenophore of the genus *Deiopea*. Most surface forms which are capable of producing light luminesce only when some mechanical stimulus is provided, such as contact with the ship, the movement of the propeller, or a rough sea. The *Deiopea*, however, on a perfectly calm night, and over an area which extended as far as could be seen in every direction, were emitting momentary but most vivid flashes. Owing to the numbers present in the water, the effect produced was one of the most remarkable seen during the voyage.

We touched at Elephant Bay and St. Paul de Loanda in Angola, and at Port Gentil in French Congo, with the object of visiting whaling stations, and also landed on Annobon Island in Spanish Guinea. Whaling has unfortunately proved unprofitable on this part of the coast, and the stations visited were found to have ceased operations. The *William Scoresby* reached England on Aug. 14 and the *Discovery* on Sept. 29.

One or two points remain to be noticed. It may be remembered that when the *William Scoresby* was commissioned, it was hoped that she would be able to undertake the marking of whales with the view of tracing their migrations. In this work we have so far had little success, for it was found in practice that owing to certain structural defects in the vessel, the operation of marking was unexpectedly difficult. The necessary alterations were made, however, while the ship was in England, and we hope for better results in the future. The experience we have had indicates that the marking of whales is a practicable method of research.

In the brief outline of the work of the two ships it will be noticed that plankton observations have been made at a great number of points covering a very considerable part of the South Atlantic. This work has been done to a carefully standardised programme and in working up results the hauls may be regarded as strictly comparable if the assumption is made that the plankton is uniform over comparatively large areas. To ascertain the truth of this theory was one of the objects for which the 'continuous plankton recorder' was invented by Mr. Hardy (see NATURE, Oct. 30, 1926), and with this instrument records of plankton extending over nearly 2400 miles of our course have been taken. We have also on several occasions made continuous hauls over long distances with surface nets. Both methods show an almost startling lack of uniformity in the plankton, and teach us that it

is only by working on broad lines that results of real value can be obtained.

Opportunities for survey work were limited, but Lieut.-Commdr. J. M. Chaplin made the utmost use of all that came his way. Harbours in South Georgia and the South Shetlands were surveyed, and numerous corrections made in our charts of these little-known regions.

It will be seen that in the second season's work we have been more successful than in the first—a result due in no small measure to the efficient help given by the *William Scoresby*. We have made a detailed survey of the conditions on the whaling grounds of South Georgia, with some work on the same lines in Bransfield Strait and off Saldanha Bay in South Africa. We also have a considerable number of observations on plankton and hydrography in the region bounded by Cape Horn, the Falkland Islands, South Georgia, and the South Shetlands, and plankton material obtained on a system of comparable hauls over a much more extensive area.

My thanks are due to Commdr. J. R. Stenhouse, Capt. Mercer, and to all officers and men for their continuous efforts to carry on the work, often in the face of very considerable difficulty, and to the scientific staff, both on the ships and at the shore station, for their enthusiastic support in every programme that was attempted.

In the course of the work a great number of hydrographic observations have been made, and very large zoological collections obtained, and this material is being studied, with particular reference to its economic value, by those of the scientific staff who are now in England. The systematic treatment of some of the zoological collections is being undertaken by specialists, and the publication of results will shortly begin.

The *William Scoresby*, with Mr. D. D. John and Capt. H. de G. Lamotte respectively in scientific and executive command, is again at work in South Georgia, and the shore station, with Mr. F. C. Fraser in charge, has been reopened. It is expected that most of the scientific staff at present in England will leave for further work in the south towards the end of this year.

## Work at the Whaling Stations.

By N. A. Mackintosh.

The previous description of the work of the marine station at Grytviken (included in the article in NATURE, Oct. 30, 1926) dealt mainly with the observations made there at the whaling station from February 1925 until March 1926. Since that period a further 455 whales were examined at Saldanha Bay, Cape Colony, from June to October 1926, after which work was resumed at South Georgia, where 490 whales were examined between November 1926 and April 1927. The material and data obtained are now being studied in England.

As was previously explained, it was desirable that work should be continued in South Africa during the southern winter in order that observations should extend over the whole year. Records of the lengths of fœtuses obtained at South Georgia clearly indicate that both pairing and parturition take place for the most part during the southern winter, and it was therefore hoped that the work at Saldanha Bay would lead to a more accurate knowledge of the breeding of whales. Observations on the adult females taken there were very instructive, but it was not possible to examine nearly as many as was desirable, since the vast majority of whales taken in this locality are immature. Evidence of œstrus taking place at this time of year was, however, found, and several very small fœtuses were collected. Three of these measured 20 mm. to 30 mm., and one, a Sei whale embryo, measured 2 mm. to 3 mm.

As at South Georgia, the catches at Saldanha Bay consisted almost entirely of Blue and Fin whales, other species being practically negligible. Between 80 and 90 per cent of the Blue and Fin whales we examined were, however, immature, and both the abundance of whales and the proportion of adults remained roughly constant during the period we were there. During the final season's work at South Georgia, whales were caught throughout in large numbers, Blue whales being specially abundant.

An interesting comparison can now be made between the whale 'populations' of South Georgia and the south-west African coast. At the latter locality we have two classes of whales—the small immature whales which are abundant, and the large and fully mature whales which are comparatively scarce. The number of intermediate sized whales is very small. At South Georgia the whale community is quite different and much more complex. The population is more representative, but undergoes important changes during the season through the arrival and departure of different 'sets' or herds of whales which may differ in respect of sex, age, condition, etc. The constitution of the whale community may also differ from season to season. In view of these fluctuations, it is necessary to exercise caution in drawing conclusions from such estimations as the percentage of immature whales caught, the ratios of pregnant and lactating females, etc., as one cannot assume that the catches are representative samples of the whole stock.

A further study of the lengths of fœtuses which have been examined indicates that the period of gestation is about 10 months. The uncertainty regarding the rate of growth in the earliest stages of gestation, however, is the principal difficulty in making a precise estimation of the length of this period.

It appears that birth mostly takes place early in the southern winter, and a study of the lengths of young calves occurring in different months suggests that the nursing period lasts for five or six months, mostly in the winter. The young Blue whale appears to be weaned at a length of about 15 or 16 metres, and the young Fin whale at a somewhat shorter length. Growth is thus very rapid during the nursing period, but there are indica-

tions that it slows down very considerably after weaning.

It may be mentioned that external parasites which are rare on Blue and Fin whales at South Georgia, are abundant on those taken at the Cape, *Pennella* being particularly plentiful. Many of the whales examined at Saldanha Bay were also notable for the numerous and peculiar scars which are found on the body, mostly towards the tail. These are in the form of clean, cup-shaped holes in the blubber, and in the majority of whales they are found in all stages of healing. Old scars are quite common in this position on whales at South Georgia, but the unhealed pits are very rare.

## The Problem of Artificial Production of Diamonds.

THE relations between the allotropic forms of carbon constitute one of the most baffling problems in chemistry. The hardness and incompressibility of the diamond point to its structure as being an exceedingly stable one, and the examination by X-rays proves it to have the tetrahedral lattice which accords with the known chemical properties of the carbon atom. On the other hand, graphite has its atoms arranged in sheets made up of hexagons, the carbon atoms in that plane being actually closer than in the diamond (1·42 instead of 1·53 Angstrom units), but the sheets are widely separated, their distance being 3·41 A., so that the structure is a loose one, corresponding with the easy cleavage. Graphite is readily produced from diamond at high temperatures, but the converse change has presented the greatest difficulties, graphite having shown itself under all conditions to be the more stable modification. It has been supposed that the atoms of carbon in the two substances differ in their electronic structure, the atom in diamond having four $2_1$ orbits, and that in graphite only three $2_1$ orbits and one of the $2_2$ form, an arrangement which is consistent with the two space lattices and also with the great difference in electrical conductivity between the two modifications. It is doubtful whether specimens of graphite have ever been obtained quite free from other elements, and Prof. H. E. Armstrong has maintained that it always contains hydrogen, which is the cause of its open structure.

The diamond is found in Nature under conditions which afford little clue as to its genesis, but as it is converted into graphite by heat in the laboratory, it has seemed probable that it has been formed under a high pressure, and most attempts at its artificial production have started from this assumption. Of these, the most famous were those of Prof. Henri Moissan. Moissan's most successful experiments were made by melting pure iron with sugar charcoal in an arc furnace, and plunging the crucible containing the molten mass into cold water. The pressure produced by the rapid chilling of the outer crust was relied on to bring about the conversion of the carbon, so that it would crystallise from its solution in iron as diamond, and not, as usual, as graphite. The iron was successively treated with nitric and hydrochloric acids, with oxidising mixtures, and with fused potassium hydrogen fluoride to remove all minerals except diamond, and after the operation minute crystals were found, some of which had the optical properties of diamond and yielded carbon dioxide on combustion. Molten silver was also used as a solvent, with similar results. Sir William Crookes, working with the residues found in a bomb in which cordite had been exploded, the pressure being calculated to reach 8000 atmospheres, obtained similar crystals after the same chemical treatment. Crookes arrived at the conclusion that carbon, if sufficiently heated under a pressure of 2350 atmospheres, would be liquefied, behaving in this respect like arsenic, and should then crystallise on cooling.

Sir Charles Parsons carried out extensive experiments on this subject, the results of which were communicated in his Bakerian Lecture of the Royal Society for 1918. The main conclusions were:

1. That carbon, if melted or vapourised under a pressure of 15,000 atmospheres does not crystallise, as predicted by Moissan and Crookes.
2. That Moissan's supposition that great pressure was produced by quenching molten cast iron is erroneous.
3. That if the crucible, instead of being quenched, were subjected to a pressure of 100 tons per in.$^2$ in a steel die under a press, less crystal residue was obtained.
4. That impurities in the iron, such as silicon, aluminium, magnesium, and chromium, greatly increase the amount of crystalline residue, whilst commercially pure iron melted and carburised with graphite yielded practically no residue.

All attempts to produce diamond by the rapid compression and adiabatic heating of acetylene and other substances (as by firing rifle bullets into cavities which they fitted closely), without the use of iron as a solvent, failed to give a crystalline residue.

The method of analysis adopted was that used by Prof. Moissan. Great uncertainties are involved, as there are no chemical reagents which can be relied on to dissolve every crystalline substance formed at such high temperatures other than diamond. Some of the minerals are extremely resistant to acids, even after prolonged boiling, whilst fusion with alkalies cannot be used, as it destroys diamond. The only certain test is that of combustion, microscopical examination being uncertain in view of the hardness and transparency of some of the spinels and carbides. When the crystals are very minute, all that can be done is to place them in a silica boat and heat in a current