



DISCOVERY INVESTIGATIONS
SECOND
ANNUAL REPORT

January, 1927—May, 1928.

LONDON:

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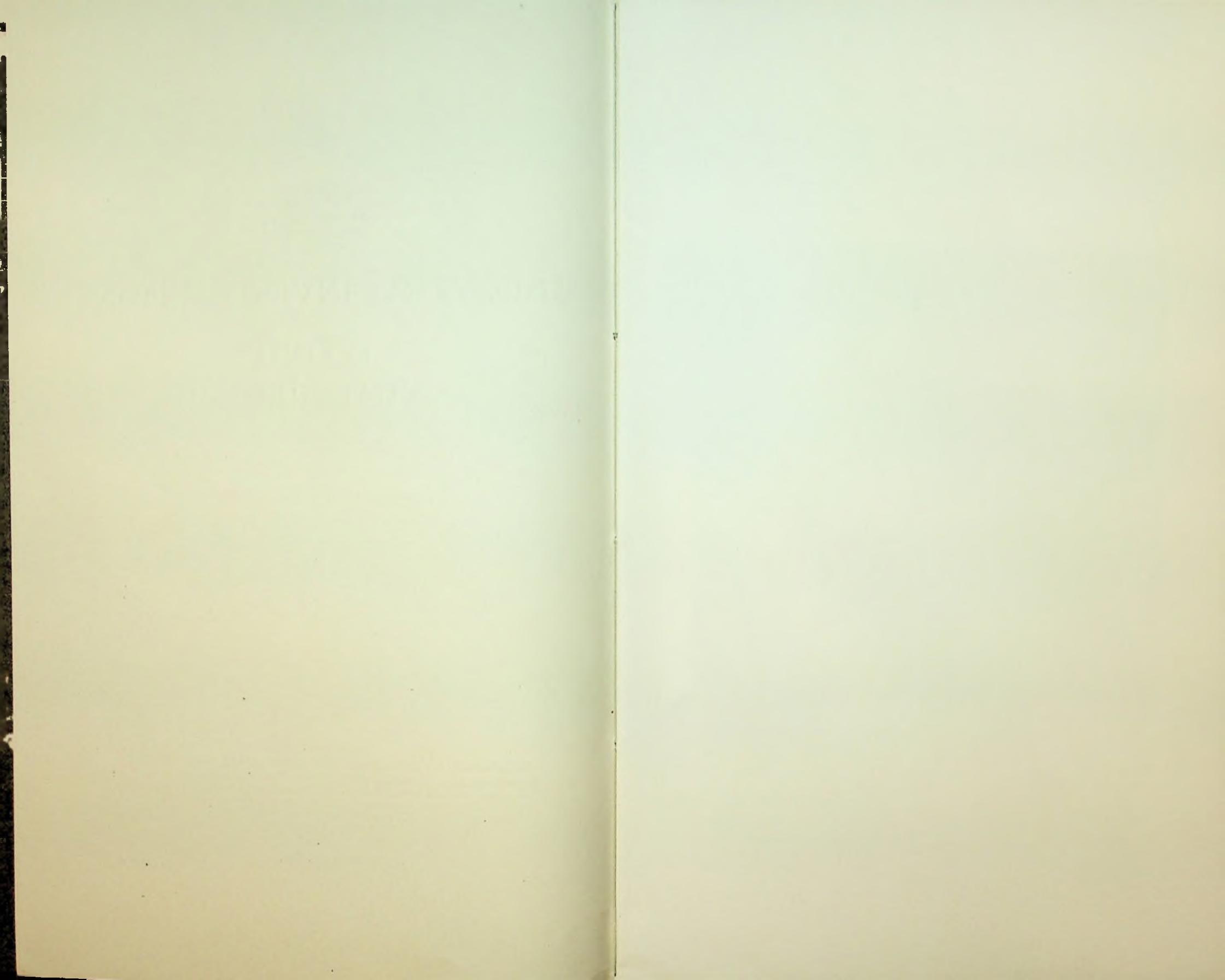
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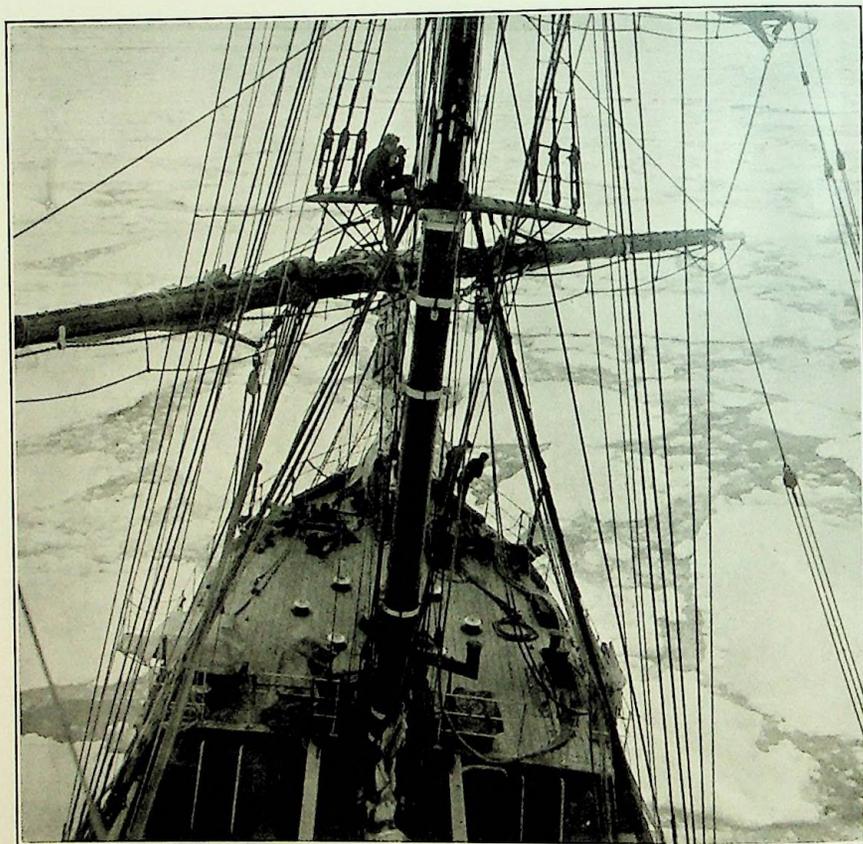
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R.R.S. 'Discovery' in the ice.

[Frontispiece.

CONTENTS.

	PAGE.
I.—INTRODUCTION	5
II.—AIMS OF THE COMMITTEE	5
III.—GENERAL NARRATIVE OF THE INVESTIGATIONS	10
Marine Biological Station	10
R.R.S. 'Discovery'	11
R.S. 'William Scoresby'	13
Other Cruises	14
IV.—PROGRESS MADE	14
Coastal surveying	14
Biological and Hydrological work	16
Whales	16
Plankton	18
Hydrological work	22
Fisheries	22
V.—FINANCIAL	26
VI.—CONCLUSION	27

ILLUSTRATIONS.

	PAGE.
FRONTISPIECE—R.R.S. 'Discovery' in the ice.	
FIG. 1.—Track chart of R.R.S. 'Discovery' and R.S. 'William Scoresby' in the South Atlantic and Antarctic Oceans.	12
FIG. 2.—Biological Laboratory, R.R.S. 'Discovery'	16
FIG. 3.—Whale on flensing plane, South Georgia <i>(Facing)</i>	16
FIG. 4.— <i>Euphausia Superba</i> , the food of Blue and Fin whales in the Falkland Islands Dependencies	18
FIG. 5.—Stations investigated in the survey of the waters about South Georgia	19
FIG. 6.—Hauling a plankton net <i>(Facing)</i>	22
FIG. 7.—Working a water bottle <i>(Facing)</i>	22
FIG. 8.—Stations investigated in the trawling survey of the Falkland Islands region	24

I.—INTRODUCTION.

The circumstances which led to the institution of the Discovery Investigations and the setting up of the Discovery Committee to which their prosecution is entrusted have been outlined in the First Annual Report of that Committee for the year 1926. The period covered by the present report was extended from a year to seventeen months, from 1st January, 1927, to 31st May, 1928, in order to avoid a termination within the southern whaling season. It is intended that future reports shall deal with twelve-monthly periods commencing with the month of June.

The whaling season 1927-28 proved a momentous one for whaling in the Antarctic. Whaling off the South Shetland Islands was more successful than in any previous year. Five thousand five hundred whales were taken, and the yield of oil was over 66,000 tons, an increase in output of 47 per cent. on the previous season, itself a season only once surpassed for output in the history of South Shetlands whaling: and the whales were taken by catchers working neither from shore stations nor from mother-ships anchored in the shelter of land, but from factory ships operating along the edge of the ice. It is true that the success attending the operations very probably may have been due to climatic conditions which occur only from time to time, but its magnitude, coupled with the particular character of the whaling, resulted in an enormous expansion of whaling enterprise. The accompanying increase of catching power must inevitably modify profoundly the future of whaling and the problems attending its regulation, and some attention is given to it later in this report. It is fortunate that the Discovery Investigations have not only made considerable progress in the study of the whale stock and the conditions affecting the distribution and abundance of whales, but that they have incidentally secured records of these conditions before and during the season which has proved the occasion of such remarkable changes in the magnitude of the industry and in the methods it adopts.

II.—AIMS OF THE COMMITTEE.

Since the objects of the Committee were mentioned but very briefly in their first annual report it may be desirable to state them now more fully. The main purpose of the Committee is to make a serious attempt to place the whaling industry on a scientific basis. Other objects are to render service to navigation by conducting a hydrographic survey of the whaling areas, to enquire into the resources of the region from the point of view of fisheries, and to add to scientific knowledge of the sea.

The Committee consider it their chief duty to carry out researches of immediate practical utility, and the three lines of work of this character mentioned above require separate treatment. In waters as little surveyed as those of the Falkland Islands Dependencies, and as beset with difficulties to the navigator, the utility and indeed the urgency of this work is obvious. During the season 1927-28 twelve licensed factory ships and 62 whale catchers were employed in whaling in the area, and to these, their supply ships and reserve whale catchers, the importance of trustworthy charts can hardly be over-estimated. For this work the Admiralty seconded to the 'Discovery' an experienced marine surveyor, Lieut.-Commander Chaplin, R.N. Lieut.-Commander Chaplin acted as Chief Officer of the R.R.S. 'Discovery,' but in addition to survey work from that ship he was from time to time detached for separate observations. Subsequent to the period of this report he has been enabled to devote his whole time to survey, a motor boat being placed at his service with the necessary assistance. The Research Ship 'William Scoresby' is fully equipped for trawling with the gear ordinarily employed in commercial fishing, and has made trawling surveys in several localities that seemed to offer prospects of success.

The most important investigations undertaken are however, without question, those directed to finding a rational basis for the regulation of whaling. Whaling is the most important, almost the only industry of the Falkland Islands Dependencies. These territories furnish usually about 60 per cent. of the world's supply of whale oil (for which there is a firm demand in soap making, margarine and other industries), as well as yielding a valuable export of whale meal and fertiliser. During the season 1927-28 their output of oil was over 134,000 tons, and as the price of the oil is from £28 to £30 per ton, the value was obviously considerable. The industry is thus of real importance, and it is clearly desirable to determine the intensity with which it can be prosecuted without detriment to future supply. Unfortunately the past history of whaling gives every reason to fear that unrestricted whaling would lead not merely to a decline but to a complete collapse of the operations. The policy of the Government accordingly has been the conservative one of restricting whaling approximately to its present dimensions, while energetically searching for a basis for a definite conclusion as to the maximum intensity of whaling desirable. This policy was carried out by the limitation of whaling licences and the institution of the 'Discovery' investigations.

It is necessary to outline the chief lines of research which it was necessary to undertake. In various ways and from various directions all these lines bear on one central and final problem; namely, what is the number of whales of each species that can be taken annually, without so depleting the stock that a progressive decline in abundance is caused which ultimately must make whaling commercially impracticable.

One of the first necessities is to determine with what whales the operations in the Dependencies deal. The effect of a given intensity of destruction in that area will evidently depend on whether the stock attacked is, for instance, the same as that pursued on the African coast and other whaling grounds, or is part of a great stock that is but little attacked elsewhere. Systematic enquiry into the structure of the whales taken, and comparison of these animals with similar whales taken elsewhere are therefore necessary. Equally important is the determination of growth rate, of age and size at maturity, and of the birth rate, since from these studies light is cast on the rate of recuperation of the species. Work on all these lines has been pressed forward at the Marine Biological Station, and comparison with the whales taken in other areas has been made possible by similar investigations at the whaling stations of Saldanha Bay and Durban, and in whaling vessels on the South Sandwich and Deception Island grounds. The Committee is indebted to several whaling companies and to their managers for hospitality and for facilities for the work.

The importance of the study of the distribution and migration of the whales also lies in its bearing on the same question, namely that of the stock affected by whaling.

It should be borne in mind that two views as to whale stock in the South have been advanced, one being that there is one vast circumpolar stock, which, except in the course of northerly migrations, occupies the whole Southern Ocean with an abundance which if not uniform is at least everywhere considerable, the other that the distribution is extremely irregular, whales being abundant in certain areas only. The cruises of the 'Discovery,' extending from South Africa to Cape Horn, and from Tristan da Cunha to the ice edge, have contributed to the solution of this question directly, and still more indirectly by a study of whale food. The whales when in the South are feeding, and their distribution is necessarily governed largely by that of the small creatures on which they feed; it follows that if large tracts are found in which these creatures are absent or scarce, no accumulation of whales can be expected. Investigations have been made, therefore, both at the whaling stations as to the exact species eaten by the whales and at sea as to the distribution of these creatures. Direct evidence as to migration is sought by marking whales with numbered darts, which when returned from whaling stations (a small reward is offered) will show the course travelled. These darts, shot from a shoulder gun, are used from the Research Ship 'William Scoresby,' whose design, mainly that of a whale catcher, enables her to make the necessary approach to within striking distance of the whale. Other duties prevented the 'William Scoresby' from carrying out intensive operations in the period covered, but a start was made.

Other attempts to determine whether depletion is occurring to a dangerous extent are more beset with difficulty. A decline in the number or size of the individuals of any species taken in a given area, even when catching power remains constant, can be taken as conclusive

evidence only when continued progressively over a term of years. A decline in catch has in certain years been followed, without any artificial rest from persecution, by a rise. In other words, apart from any effect of the operations of man, abundance fluctuates owing to natural causes. If, as seems probable, observations on the conditions prevailing over the whaling area repeated over a term of years can lead to the understanding of the causes of these fluctuations, the nature and extent of the fluctuations can be ascertained. When this has been done, it should be possible to evaluate approximately the effects of nature and those of the operations of man; and in this way conclusions as to the real extent of depletion should be reached which would be far more reliable than any deductions from the rise and fall of output alone, and would be available at an earlier date. It is for this reason that year by year the Committee's vessels are carrying out systematic surveys, over and beyond some of the chief southern whaling grounds, to study conditions, biological and hydrological, both in the waters in which whales congregate and also in the adjacent waters in which they are scarce or absent.

Such are the main lines of enquiry concerning whales on which the scientific staff have been engaged. They are numerous and demand prolonged and intensive work. Yet the Committee feel that the omission of any one of them from the scheme of investigations would dangerously imperil the aim sought, the laying down of a rational basis for the regulation of whaling. To have contributed so materially to their progress as has been done is, the Committee feel, an achievement which redounds greatly to the credit of the staff, both scientific and marine.

It remains to add a word on the possible bearing on the 'Discovery' investigations of the introduction of new whaling methods. It has been said that the most successful whaling of 1927-28 was carried out by floating factories working, not in coves or harbours, but along the edge of the Antarctic ice. Probably South Shetlands whaling would in any case have enjoyed a good season. In South Georgia the season was poor, and whaling in that Dependency and in the South Shetlands not infrequently show a complementary rise and fall. This success of whaling away from a shore base led immediately to an enormous expansion of pelagic whaling, an expansion which is moreover not yet spent, and which having taken up a large volume of invested money in Norway, shows signs of absorbing increasing amounts of capital from other countries. Pelagic whaling consists in the working up as well as the capture of the whale in the open sea. The modern pelagic whaler is a large floating factory equipped with a slipway in stern or bow by which the whale can be taken bodily on board for dismemberment and "trying down." As long as she works outside territorial limits she is subject to no regulation except those imposed by the Government of her own country, and at present, while there is hope that certain steps may be taken to prohibit her from destroying cow whales with calves, it is difficult, if not impossible, for her

to work up whale meal or guano, and there is reason to suppose that the extraction of oil from the carcass is less complete and therefore less economic than at a shore factory. There is at present no means of restricting the number of pelagic whalers or of the catchers they employ. Pelagic whaling thus is not merely a less economic method, but it permits of indefinite extension of the grounds worked and indefinite increase in the intensity of whaling.

Whether and how far this development should affect the future activities of the Committee is a subject to which close attention will be given. Yet some remarks upon it seem permissible in this report.

Firstly, all the enquiries in progress remain necessary. Rate of growth and reproduction, distribution and migration, the causes determining natural good and bad seasons, are of the essence of any problem of whaling regulation. Secondly the great increase which will occur in the destruction of whales—a destruction sufficient to alarm experienced whalers, whose immediate interest is in an expanded industry—greatly increases the need for a speedy attainment of definitive results in the researches. The facts have to be faced that the industry may be irreparably damaged before the greatest diligence in research can furnish complete solutions of all the problems with which they deal, and that measures of a tentative and temporary character may have to be decided upon by the Governments interested in order to avoid a possible collapse. Even so, the greater the fund of relevant information available the greater would be the prospect of devising successful measures and securing their ready acceptance, and the less the danger of any unnecessary interference with enterprise; moreover, such temporary measures could be developed into a more satisfactory and permanent form only by modification in the light of increasing knowledge of the life of the whales. Thirdly, regions other than the Falkland Islands Dependencies will be directly concerned to a far greater extent than has been the case in the past, and this is particularly true of the regions about the Antarctic. All experience of marine research is against the extension of work over so wide an area that no certainty can attach to the indications of the results, which become more suggestions than conclusions; and thus, while some changes or additions may be made in the Committee's work, it is clear that this cannot cover, with sufficient speed, the whole of the ground it will be necessary to traverse. Two points at least therefore seem to emerge from the new increase of unlicensed whaling. The first is the need of increased activity—possibly even of a greater scale of operations—to give results in time to be of value. The second is the desirability of a series of investigations connected with whaling, particularly in other parts of the Antarctic, which in co-operation with the 'Discovery' work should form an adequate and co-ordinated whole.

It should be added that while the Committee is primarily engaged in researches for definite economic ends, they consider it a duty to facilitate other scientific enquiries where this can be done without detriment to their main purpose. As is well known, experience has shown that

frequently most valuable results have ensued from researches undertaken with no other aim than the acquisition of knowledge. The scientific staff has been employed on work of practically immediate economic utility; but the Committee have been fortunate in enlisting the voluntary help of a number of recognised authorities in general science, and propose to publish the results of the work of these specialists in their series of scientific reports.

III.—GENERAL NARRATIVE OF THE INVESTIGATIONS.

Before outlining the general course of the operations the Committee desire again to express their indebtedness for the sympathy and the continuous and valuable help afforded to their investigations by the whaling community. While they cannot make acknowledgment to all those who have assisted, they would instance Captain Esbensen, who has rendered valuable general assistance throughout, particularly to the Marine Biological Station at Grytviken; Captain Ore, who extended to members of the staff facilities for work at Deception Island; Captain Sørle, who assisted the 'William Scoresby' when her propeller became entangled in a trawl-warp, who has navigated this vessel while she was carrying out a whale marking cruise, and has devised a new whale mark; Mr. Hansen, who rendered valuable aid both to the biological and survey work at Leith Harbour, and who at considerable expense prepared skeletons of whales for transmission to England. It should be added that in 1926 Mr. Garden did much to facilitate the work at Saldanha Bay. To these and to many others the thanks of the Committee are due.

Marine Biological Station.

The Station was at work at the opening of 1927, work having been resumed in the previous December. In January Blue whales proved unusually abundant; and during the remainder of the season Sei and Sperm whales were brought in for the first time since the opening of the station. Before the season closed detailed observations had been made on 490 whales, bringing the total number examined during the course of the investigations to 1680. While the staff were occupied mainly in this work and in the chemical examination of water samples collected by the research ships and taken off the coast of the island, it was possible for them to study the Elephant Seal, the marine fauna and certain birds found on the island. In May the staff of the Station sailed for England. The Director of Research had placed Mr. Mackintosh in charge of the Station until February 5th, 1928, and Mr. Hamilton for the next two months.

When a staff sailed on November 30th to re-open the Station Mr. Fraser was placed in charge. After observations in Deception Island, when the facilities that might be afforded by the whaling ships for biological survey were explored, the staff reached Grytviken early in

February, when the station was re-opened. Mr. Barlas, acting Magistrate, had at Mr. Hamilton's request arranged to keep the heating apparatus in working order during the southern winter, and Mr. Fraser found the structure in good condition. The Station was kept open throughout the following winter. During February His Excellency the Governor of the Falkland Islands paid a visit to Grytviken, South Georgia, and spent some days at the Station.

R. R. S. 'Discovery.'

During January, 1927, the 'Discovery' was occupied in observations on hydrology, plankton and fish about South Georgia; the work was frequently interrupted by the bad weather so frequently met with in this region. On February 4th she sailed for the South Orkneys, and carried out observations in this archipelago, in the South Shetlands, the Palmer Archipelago and Bismarck and Gerlache Straits. In the course of this work she reached her most southerly point in her present commission, and a station was taken at 64°58' S. Latitude. In the passage between the South Orkneys and South Shetlands great numbers of icebergs were encountered, and one was found which was 35 miles long; whalers reported yet larger bergs, described as being as large as South Georgia. In Whaler's Bay, Deception Island, volcanic activity was much in evidence, clouds of steam arising frequently at the sea's edge. During her cruises in the southern islands, hydrographic surveys were effected by Commander Chaplin.

After a return from the south to Deception Island, the ship proceeded to Cape Horn, carrying out a valuable series of observations across Drake Strait, and after a short stay in St. Martin's Cove, Hermite Island, an anchorage visited by Darwin in H.M.S. 'Beagle' a course was set for Port Stanley, which was reached on May 6th. The 'Discovery' sailed shortly afterwards for Cape Town, accompanied by the 'William Scoresby.'

Three weeks were spent at Cape Town, the ship being docked and the staff employed in various ways on shore and afloat. The ship then sailed for England, calling at several whaling stations on the African coast, where operations were found to have ceased, the season having been a bad one. Whales were scarce throughout this voyage, and indeed were only sighted on five occasions.

The conditions under which cruising is carried out in high southern latitudes are too well known to need description. On her return to England the 'Discovery' had traversed 37,000 miles, and 299 stations had been made from her decks. It may be added that a station implies sounding, taking water samples, and the use of both vertical and horizontal series of nets, the former from the bottom to the surface, the latter at various depths in the upper 200 metres. In deep water the work of taking a station cannot be accomplished in less than four hours. She arrived on September 29th in a condition which, in the opinion of the naval and other members of the Committee best qualified to judge, reflected the greatest credit on her Com-

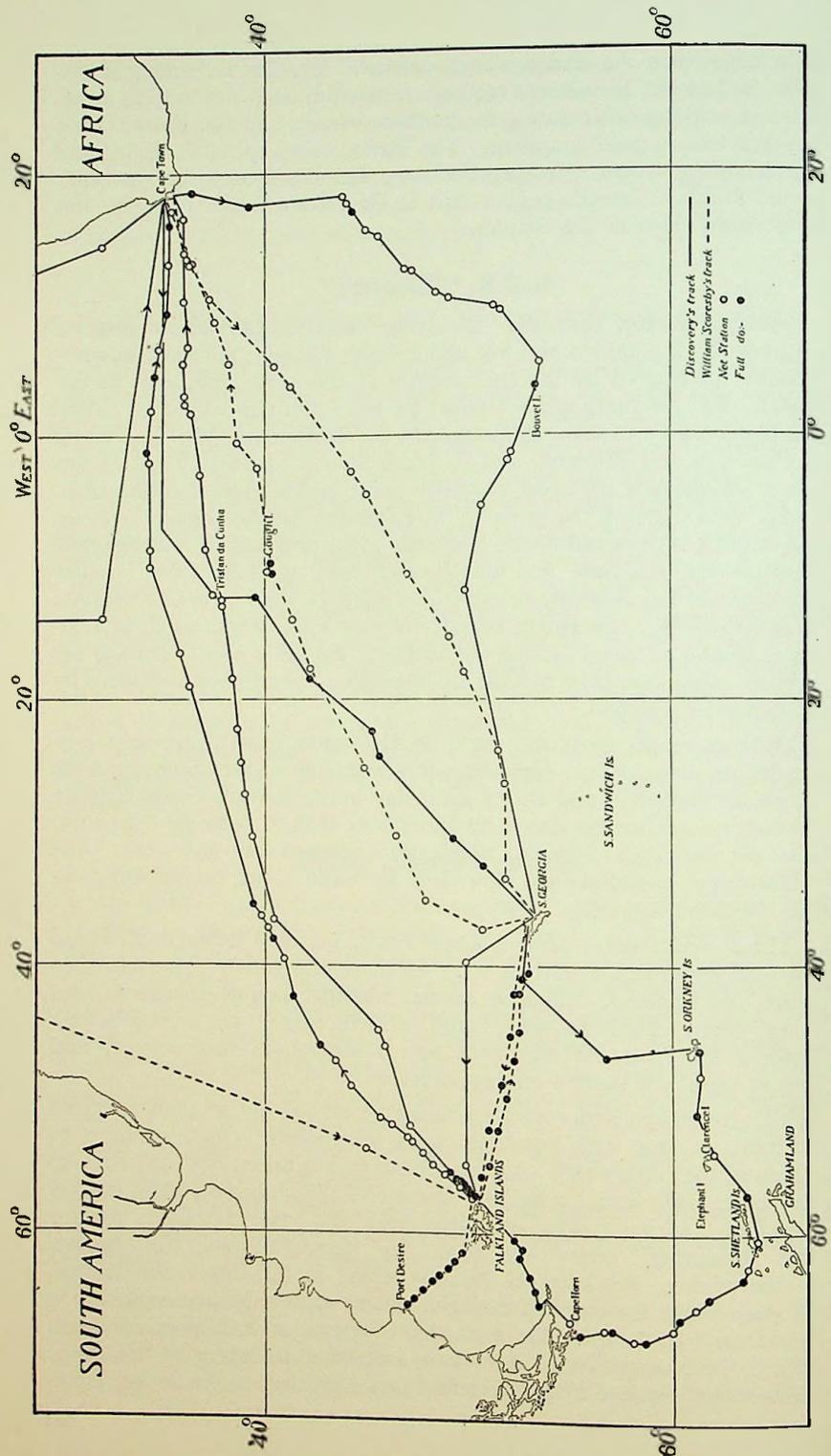


FIG. 1. Track chart of the R.R.S. 'Discovery' and R.S. 'William Scoresby' in the South Atlantic and Antarctic Oceans. Many stations near shore omitted.

mander, Captain Stenhouse; and in this opinion the Committee as a whole entirely concur. The main track of both the 'Discovery' and the 'William Scoresby' can be seen in the accompanying sketch chart (Fig. 1).

R. S. 'William Scoresby.'

On January 6th, 1927, the Research Ship 'William Scoresby' renewed her operations off the West and South-West of South Georgia, Mr. A. C. Hardy being in charge of the work, and after landing a survey party at Larsen Harbour, carried out observations on plankton, which however, were interrupted by the necessity of returning to port for repair of certain auxiliary machinery. Despite unfavourable weather, she then completed her programme and sailed for Port Stanley, making four stations on her way. March and April were spent, under Mr. Mackintosh's direction, on a trawling survey of the continental shelf between the Falklands and South America, a full-sized commercial trawl being employed; hydrological observations were made also.

In the latter part of May she repeated certain lines of stations North-East of South Georgia for purposes of comparison, and then worked her way to the Cape by way of Gough Island, where a party was landed. She sailed for England after a short stay at the Cape, arriving in good condition in August. Certain alterations were effected during the autumn, notably the fitting of a raised fore-castle which gave protection from heavy seas for those engaged in whale-marking, a modification which had been found essential.

She sailed again for the south in the last days of 1927, proceeding *via* St. Vincent and Rio, with Mr. John in charge of her scientific work. The Committee record with the most profound regret the loss of Leading Seaman and Netman S. Cook, who was washed overboard in a gale in the Bay of Biscay. Mr. Cook was devoted to his work and to the Expedition, and had given valuable service throughout the first commission. His death—he was a skilled fisherman—was a serious loss to the ship.

The ship reached South Georgia in February, working stations from Port Stanley on the way, and until early in May was employed in a successful repetition of the biological surveys of waters about South Georgia. She then proceeded towards the South Orkneys (again repeating stations of a previous season) until ice was met. The ice was skirted for some distance, and one station worked in an open lane in the pack; but conditions becoming rapidly worse the ice was cleared and a course set for Port Stanley, observations being made across Burdwood Bank on the way. The remainder of the month was occupied in trawling survey.

The 'William Scoresby' left England for the second time later than had been expected, and the spring of 1928 was one of unusually severe ice conditions. That she accomplished so much in the time remaining after her arrival was due to the marked diligence and energy of those on board.

Other Cruises.

In addition to certain voyages in whale catchers, taken for experience or other purposes, members of the staff carried out observations on commercial vessels on several occasions.

Mr. Gunther sailed in Cape trawlers and collected valuable notes and records as to the fishing in June, 1927.

Mr. Hamilton, in June, 1927, by courtesy of the Anglo Norse Company, proceeded in the ship of that name to the South Sandwich Islands. All the operations, which were spread over some 28,000 square miles, were carried out in the shelter of pack ice, the islands themselves being sighted twice only in the course of the work. Observations were made from both the 'Anglo Norse' and her attendant catchers. Six species of whales were seen, and 405 Blue whales and 64 Fin whales were taken. The cruise furnished useful information as to the possibilities of conducting scientific work on whaling vessels.

Deception Island was visited by Mr. Fraser and others in January, 1928, and facilities for work were kindly afforded them by Captain Ore of the Factory ship 'Ronald,' the only factory which had not left the Island for the ice-edge. Observations were made on 26 Fin whales and 2 Blue whales. The work was carried out during a delay on the way to South Georgia, and ceased shortly before the end of the month.

IV.—PROGRESS MADE.

The material and observations, whenever collected, were examined at once in a provisional way. As will be realised, full consideration of the material demands uninterrupted attention. With this end in view the staff has been so distributed as to provide for each member periods (mostly in this country) for study and for reporting on the data. Such study is a work of time, and though some papers are already in the press, it is as yet incomplete. Even were the whole available it would be as impracticable as it would be inappropriate to set out in this place all the results obtained. Some of the more important may be outlined, however, as illustrative of the work.

Coastal Surveying.

Lieut.-Commander Chaplin from the first carried out survey work as and when his executive duties permitted. As this work in 1926 is not mentioned in the previous report, it is included with that of 1927.

South Georgia.—Shortly after reaching the island, Lieut.-Commander Chaplin drew up a list of harbours used by sealers and available except in certain winds, and which were not mentioned in Sailing Directions. Of these Undine Harbour was first examined. Regular surveys were made of Undine, Larsen and Leith Harbours, the approaches to Undine were sketched in and work was done on the coast-line. A triangulation and some soundings were made in East Cumberland and Stromness Bays

and the approaches to Leith and Stromness Harbours, and to Husvik. Astronomical observations for the purpose of fixing positions were taken at all these places.

South Orkneys.—Observations for position were made and a sextant triangulation effected, together with some soundings.

South Shetlands.—The position of Clarence Island was determined by Astronomical observations off the land, these being then connected with the island by land bearings.

At Deception Island, observations were made to check the position of Island and Lighthouse, and some soundings added.

At King George I Island the position of Bransfield Rocks was fixed by land bearings; a rough running survey made of the coast from Deception Island to Admiralty Bay; and some soundings secured at North Anchorage, Admiralty Bay.

Palmer Archipelago.—Rough sketch surveys were made of the Melchior Group, Schollaert Channel, N.E. Anvers Island, and Neumayer and Peltier Channel. Port Lockroy (Wiencke Island) was sounded out with the aid of temporarily fixed marks and of Charcot's Survey. On the way back from Lockroy to Deception Island the positions of the Austin Rocks and of some adjacent islands were corrected.

It should be added that throughout the work observations of magnetic variation were taken from time to time.

Even in the time available for the work, the surveyor was hampered by the need of adequate boat facilities—a difficulty which, as has been said, has since been met.

Lieut.-Commander Chaplin's reports have been communicated to the Admiralty, who have accepted them and will publish the charts he has based upon them. These charts will appear also, with the full reports, in the series of 'Discovery' Reports.

While the above paragraphs summarise the chief detailed survey operations carried out, it may be said that on several occasions observations were made in addition. Thus in Wilson and Undine Harbours, South Georgia, numerous photographs were made of distinctive features of the coast, with careful bearings in each case.

Before passing to the Biological work, it may be well to mention two points of interest to navigators. The *Ice conditions* were carefully logged and reported by Captain Stenhouse in the R.R.S. 'Discovery' and Captain Mercer in the 'William Scoresby.' No purpose would be served by summarising these reports. It is hoped, however, that when the information of this kind, from all sources, has accumulated, it may be of both navigational and biological interest. Lastly, a report was prepared as to the reception of *wireless time signals* by the 'Discovery' when in the Southern Ocean. The distribution of the areas in which reception from certain transmitting stations was good presented some features of interest, and the report was communicated to the Admiralty and the Air Ministry.

Biological and Hydrological Work.

The whole of this work is under the immediate supervision of the Director of Research, Dr. Stanley Kemp. The staff has not been divided into Marine Biological Station and Research Vessel sections, but has been interchanged between those bases so that experience is shared. The same community of interest is observed in the sections of the work itself. It is, however, convenient to mention separately the work on whales, which is carried out mainly at the Station.



FIG. 2.

Biological Laboratory. R.R.S. 'Discovery.'

Whales.

The whales examined by the end of the season 1925-6 in South Georgia, chiefly by Mr. Macintosh and Mr. Wheeler, numbered 738. In the period covered by this report 549 were added, making the total 1,287, or, with those dealt with at Saldanha Bay and Durban in 1926 and at Deception Island in 1928, 1,792 in all. The examination of each whale was as detailed as circumstances permitted. The total mass of material is thus great. From first to last the South Georgia whales examined include 642 Blue and 904 Fin whales.

The external features noted included colour, baleen or whalebone, both as to the number and length of plates, number of the grooves

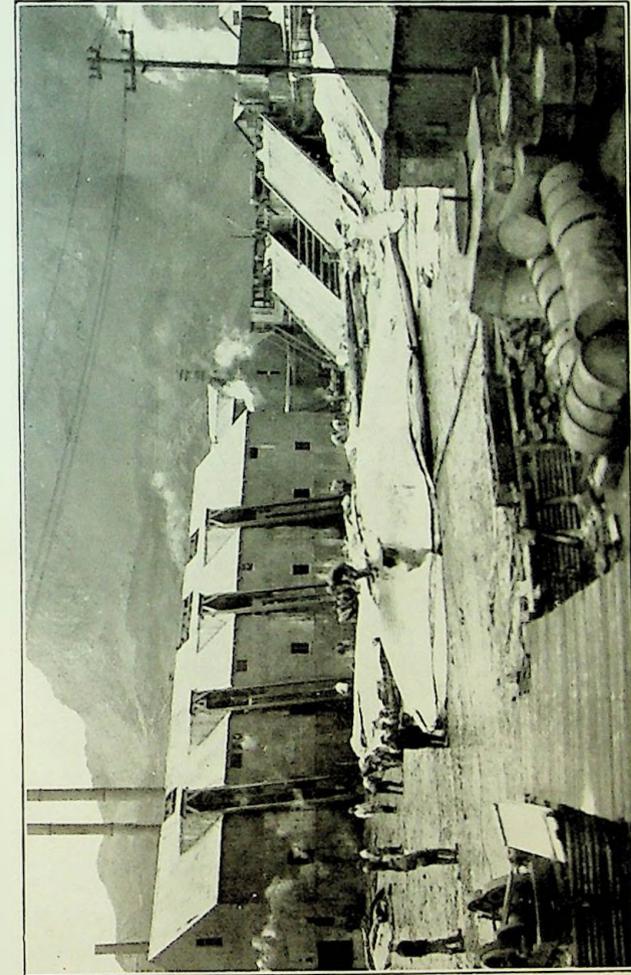


FIG. 3 — Whale on flensing plane.

[To face page 16.

below the head and body which distinguish the Rorquals, and 25 measurements of various parts, the results of which were in all cases reduced to percentages of the total body-length. The object of all these observations, which it would be tedious to detail, was to ascertain whether they afforded any indication of difference between the northern and southern whales recognised by whalers as of the same species. No such indication of difference has been detected. The observations furnish what is probably the most complete investigation of southern whales yet made. One interesting observation made on the Fin whales is that, as in the northern hemisphere, the head is coloured white in many parts of the right side where the corresponding left side is dark: a character which has given rise to the suggestion that this whale may swim much on its side.

Continuous attention was paid to the maturity and breeding of the whales, both in the Dependencies and in South Africa. Sexual maturity can be reckoned with far more certainty in the females than in the males. Of 129 Blue whales examined in South Georgia in the season 1925-26, 58 per cent. were immature, the corresponding percentage among 214 Fin whales being 26 per cent. The proportion in the following season appears to have been lower among Blue whales.

It is obvious that a very high percentage of captured immature individuals among a slow breeding stock is a dangerous feature in regard to the future. It is, however, difficult to apply the proportions found to the whole stock, even when these shall be based on adequate numbers, since there is reason to suppose that whales do not always move in herds composed of individuals of mixed sexes, sizes and ages. Thus in the South Georgia season 1925-26, while the majority of Blue whales taken were small, large specimens were caught early in the season, disappearing in November: in the following season, however, which was characterised by exceptional prevalence of ice near the island, these large whales appear to have remained. They were not abundant in the South Shetlands. It is at least probable, therefore, that the herds of large whales moved as a whole. Again, in the Saldanha Bay catch examined in 1926, only 25 out of 127 female Blue whales were mature, the schools being composed almost entirely of young and small individuals. The high percentage of immature specimens among the Blue whales must thus be considered with caution as an index to the condition of the main stock; but it does not help to justify unlimited destruction.

The same warning is sounded more emphatically by the conclusions reached as to the rate of reproduction. Study of the length of foetuses of Blue and Fin whales found in whales in successive months indicates a period of about a year from pairing to birth (which in both Blue and Fin whales occurs at rather over 6 metres, or about 20 feet) and consideration of this period, the proportion of whales pregnant and other relevant facts suggests that the young are brought forth once in two years at most, a conclusion which has already been reached in regard to northern whales. As a rule but one calf is born, though

twins occur occasionally, and yet more rarely higher numbers of foetuses are found. The rate of recuperation of stock thus appears to be slow. It may be added that the investigations have contributed materially to the knowledge of the breeding seasons of the Blue and Fin whale. Attempts which show some promise are being made to cast further light on the rate of recuperation of supply by determining the rate of growth after birth.

The distribution of whales and their migrations have been studied in various ways apart from the statistics of the whole catch. Whales seen from the research ships have been logged consistently, and the records obtained do nothing to support the hypothesis that they are abundant throughout the southern seas. Observations from two ships are naturally inconclusive, however, and the help of the whaling companies has been obtained in preparing charts of positions at which whales have been taken or seen by the whaling fleets. A valuable contribution to the study of whale migration is being made by Mr. A. G. Bennett, Naturalist to the Falklands Islands Government. Mr. Bennett is analysing the records made by whalers of the directions in which whales were seen to be moving.

The extensive examination of the food of the whales had shown, as stated in the last Annual Report, that the Blue and Fin whales of this area were eating one species only, the shrimp-like *Euphausia superba*. In the observations at Saldanha Bay, although fish were found in one Fin whale, the food was found to consist almost entirely of Euphausians. These, however, were rarely present in large quantities; and it is to be remarked that in one season at least the Blue whales taken at South Georgia early in January were nearly empty of food and later were full. It would seem established, therefore, that over very great areas of the Southern Ocean one species is taken by these whales, even at the cost of a scanty diet in their absence. One other species of crustacean, *Munida gregaria*, appears to be taken off Patagonia; but the Euphausian alone is used as food elsewhere by the whales in the waters for long distances about South Georgia, and their prevalence east of the Island appears to account for the importance of that locality as a whaling ground.

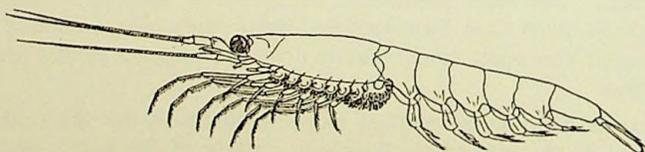


FIG. 4.—*Euphausia superba*, the food of Blue and Fin whales in the Falkland Islands Dependencies. Actual size.

Plankton.

The distribution of the food of the Blue and Fin whales—the Krill of the Norwegians—is one of the most important and obvious factors affecting their distribution in waters in which they feed. Great

importance, therefore, attaches to the investigation of plankton, the assemblage of floating organisms in great number and variety, of which Krill and the food of Krill are constituents. It is possible here to mention only some of the chief results obtained in reference to the Krill, which, as has been said, is in these waters *Euphausia superba*.

Earlier work of the 'Discovery' had shown that this crustacean occurred in some abundance some 15 miles east of South Georgia, where whales were numerous and whale catchers were at work. At the opening of the period here discussed, both ships were engaged in a survey of waters about South Georgia which had commenced in the previous month. This survey may be described briefly as an example of the work undertaken by the research ships.

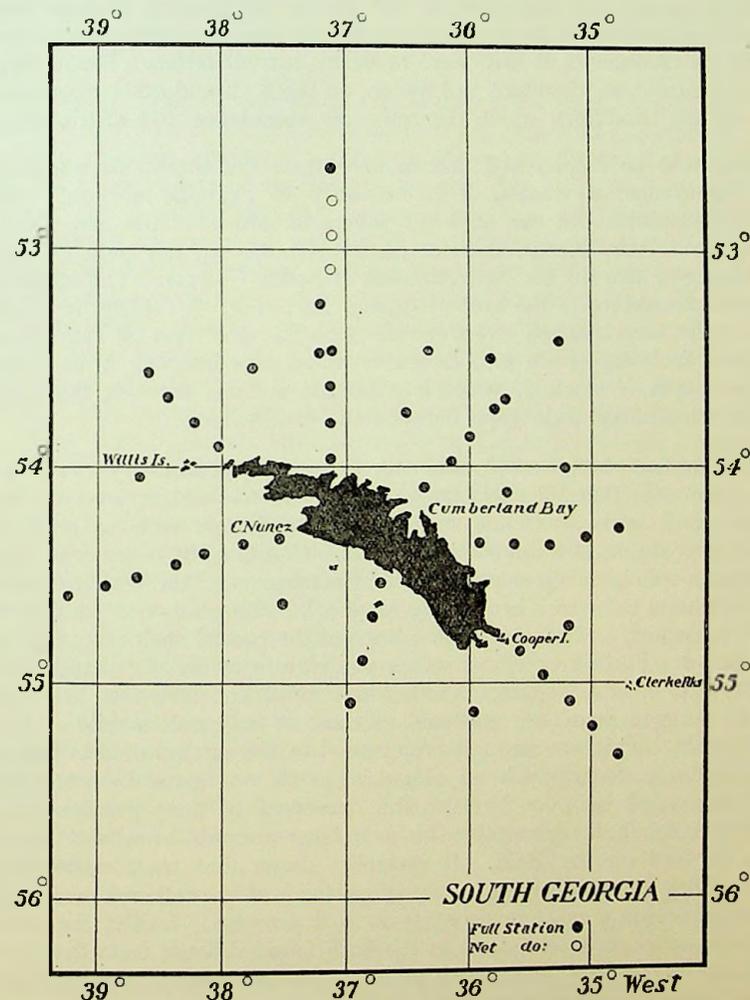


FIG. 5.—Stations investigated in the survey of the waters about South Georgia.

The operations included hydrological as well as plankton observations, and in addition trawling and faunistic work. At each station soundings were made, samples of the bottom secured, tow nettings taken vertically through numerous ranges of depth down to 1,000 metres, and water samples collected from numerous depths down to 1,500 metres, while after each station tow nets were hauled for a mile at various depths down to 100 metres. In all 592 tow nettings were made, 589 water samples taken for salinity and temperature observations, and determinations of phosphate content of the water carried out on 577 occasions, of oxygen on 333 and alkalinity on 231. It is difficult to consider these separately, as all are in reality parts of a co-ordinated whole. As will be seen later, the hydrological work casts light not merely on the ultimate sources of nutriment of the marine life present, but on the important matter of the prevalent drift. It may be added that some direct measurements of drift were made by current meter. The survey gave information, therefore, not merely on the Krill and other plankton, but on the conditions which determine its abundance and distribution.

It should be emphasised that to investigate the conditions affecting the occurrence of whales, it is necessary to examine not only the whaling grounds but the adjacent waters in which whales are scarce or absent. Dr. Kemp, therefore, surveyed the sea not only off the eastern, but also off the western coast of South Georgia. The stations selected are shown in the accompanying chart (Fig. 5). They lie along lines stretching radially from South Georgia, the first at 10 miles distance from the coast, and thereafter at 10 mile intervals until 1,000 metres depth is reached, while intermediate stations between the lines avoid undesirably wide gaps between the observations.

The most important result obtained, as far as a preliminary examination shows, is that the Krill was absent from the waters west of the island, and fairly abundant to the east, being met with in greatest abundance 20 or 30 miles from the coast. Charts of its occurrence and of whales seen or taken show the area of occurrence of the Krill and that of the whales to be in a broad way identical. The position of abundant Krill is, in fact, just off the sudden slope of the coastal shelf surrounding the island. Further observations on this feature of the distribution are made later in this report. Another important conclusion is that the Krill occurs in dense but scattered patches, of only half a mile or less in breadth. This was strongly emphasised in the catches of nets towed consecutively, from which an abundant catch was generally preceded and succeeded by poor hauls. The denseness of these patches may help to explain the possibility of such large animals as whales being able to feed on the Krill. It certainly shows that most misleading results may be obtained by observations too widely scattered, and that thoroughness is a positive necessity in such surveys. Lastly, the most common stage of development of the Krill found differed from that met with in the previous year, which points to the inadequacy of one or two years' observations as a basis for final conclusions.

Discussion of the details of other plankton species found is beyond the scope of this report. It is interesting, however, to note that the diatoms form a belt about the island which is most dense on the west, and that this may be due to the welling up against the west coast of water rich in phosphates from the depths; and that such current measurements as have been attempted at the end of the island are consistent with a drift eastward such as this welling up would imply. The plankton of the east side differs from that of the west in its constituent species, including several forms such as in northern waters form the food of the herring.

Some of the stations of this survey were repeated in May, 1927, and the chief of them—a merely abridged edition of the detailed survey—in February and March, 1928. There are thus available for comparison observations made during the end of the seasons 1925-26 and 1927-28, and part of the latter.

Space will not permit more than a mention of the work carried out in the more southern Dependencies, and between these and Cape Horn. It included working numerous stations in Bransfield Straits, Gerlache Straits and other waters of the extreme south. The work was carried out under considerable difficulty, nets and the taps of water bottles freezing almost immediately on emerging from the water, and the exhaust of the Lucas sounding machine needed to be thawed out. A series of stations were taken also across Drake Straits to Cape Horn. Two results emerge at once from the examination of the plankton taken. The first is the immense abundance of diatoms near the coast in the extreme south and their gradually increasing scarcity as the ship made northing. This feature, it may be added, was noticed in the collections made along high southern latitudes between Cape Town and South Georgia in the concluding months of 1926, enormous masses being met near Bouvet Island, the abundance being very much less in the open ocean even in the same latitude, and still less in the direction of Cape Town. Another feature of the collection is the similar diminution in the abundance of *Euphausia superba*, or Krill, as the south was left. This confirms the results of earlier 'Discovery' work in indicating that the species is to be found in any abundance only comparatively near land. The importance of this result on the question whether whales are to be expected in considerable numbers throughout the Southern Ocean is obvious. In this connection it may be remarked that soundings gave some indication of a ridge connecting Wallis Island and the Shag Rocks; such ridges might well form a bridge for the Krill between two areas of abundance. For the study of Krill it is of value that stages of development, of the species not previously met with, were taken in these operations.

Operations between South Georgia and the southern archipelagoes were to have been repeated by the 'William Scoresby' in March or April, 1928. On March 20th, however, the ship struck a rock in entering Stromness Bay and fractured her stern frame. With the assistance of the Tønsberg Whaling Company's catchers she was taken

in and repaired, but the start southward was delayed sufficiently to prevent the execution of the whole of this programme. It was, however, completed as far as ice and weather permitted, some stations being made in the close vicinity of the ice and in lanes in the pack.

Observations on oceanic conditions were made also in June, 1927, when the 'William Scoresby' made the passage from South Georgia to Cape Town by way of Gough Island. No Krill was taken off Gough Island, and no whales were seen there.

Hydrological Work.

The collection of temperature observations and samples of sea water for analysis has been a normal procedure throughout the work of the ships. The material so collected is very large, and its examination, involving routine chemical operations repeated on almost innumerable samples has needed much devotion on the part of the staff. Much of this work was carried out at the Marine Biological Station by Mr. Clowes or under his supervision, but when this laboratory was closed, excessive accumulation was avoided by Mr. Herdman undertaking additional work in the ship. The data obtained have not yet been worked up completely, and are, moreover, of a character not lending themselves to simply stated conclusions. As has been said already, the presence of certain substances in sea water, of which phosphates are instances, determines the possibility of existence of the minute plants such as diatoms which are the ultimate source of nutriment in the open ocean. It was found at South Georgia that abundance of diatoms followed a rise in the amount of phosphates present, and there are already indications that the study of the composition of the water will cast light on the occurrence of organisms such as Krill. The physical conditions of the sea similarly can but have an important effect on the distribution of the animals living in it. In March 1926, off the eastern coast of South Georgia, there were indications of a layer of water with a temperature about 0° C. between 100 and 200 metres depths, with warmer water above and below it. In May 1927 the cold layer, of almost uniform temperature, reached from the surface to 100-150 metres. Such changes, it is reasonable to suppose, materially affect the plankton of the area. Of at least equal value is the information afforded by the salinity as to drift, a factor in the life of the region which it is hard to overestimate. The salinity of a great mass of water changes very slowly, and accordingly enables the movements of such a mass to be traced among others more or less salt: and as has been said, it is possible from the salinity and temperature at stations sufficiently closely spaced to compute the rate and direction of drift in progress.

Fisheries.

Although the investigation of fish and particularly the exploration of the economic possibilities of fisheries in the waters near the Falkland Islands and their Dependencies is only a secondary object of the



FIG. 6.—Hauling a plankton net.

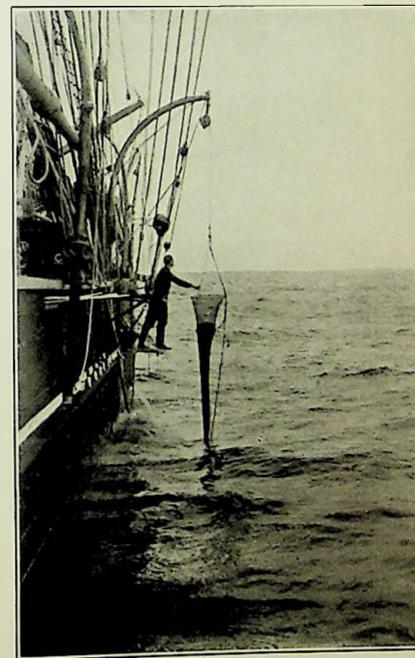


FIG. 7.—Working a water bottle.

[To face page 22.

DISCOVERY INVESTIGATIONS.
SECOND ANNUAL REPORT.

CORRECTION.

The descriptions under Figs. 6 and 7
should be transposed.

Committee, it has been carried out as occasion served during the general work of the ships, and has been the object of three special cruises.

During the South Georgia survey of December 1926 to January 1927, a good deal of attention was paid to trawling. The best ground on the north-east side of the island was found to be in the fjords, in some 250 metres, on a bottom of fine mud: outside this for 10 or 15 miles the sea bed is smooth, and so far suitable for trawling. It has, however, a very rich fauna of sponges and other rooted forms which are not welcome to the fisherman, and as far as has been ascertained, no great stock of fish. This ground lies under 150-200 metres of water. From its margin to that of the coastal shelf the depth is about 200 metres, and the ground very rough and rocky, and unsuitable, therefore, for the trawl at least. The most useful species of fish found are of no great size, though some reach a length of 60 centimetres. The most abundant are various members of the group *Nototheniidae*, which somewhat resemble cod. These are taken at a small size in the borders of the kelp, and some 30 miles offshore larger specimens are taken in quantity while feeding on patches of Krill. There is evidently a small constant demand for fish in South Georgia, as several of the whaling stations keep a fisherman constantly employed. When the abundance of small crustaceans similar to those eaten by Herring and Mackerel were found on the western side of the island an attempt to find such fish was made by the use of buoyed drift nets: unfortunately the rough sea caused the nets to foul, so that the experiment failed. A similar failure attended the use of a large fish trap, the warp by which it was buoyed, capable of withstanding a strain of $2\frac{1}{4}$ tons, was broken, probably by a drifting iceberg, and the trap lost. Taking the work as a whole there is little indication of the probability of very valuable fisheries being carried on round South Georgia; but, as will be seen, the enquiries are not yet thorough, and for drift net fishing not commenced.

During February, March and April, 1927, a definite investigation was made by the 'William Scoresby,' using a commercial otter trawl, of the areas about the Falkland Islands and between these islands and the mainland of South America. At all stations soundings were taken before and after the haul, a bottom sample collected by the conical dredge, and water samples secured from surface and bottom. The stations all lay within the 100 fathom line: and as far as was previously known, the continental plateau between the Falkland Islands and South America was in bottom as in depth suitable for trawling.

In this survey over 40 species of fish were taken, and more than a dozen can be said to be common. The Hake is the most important species caught. Hake was fairly evenly distributed over the area north of the latitude of the Falkland Islands: apparently the spawning season was over at the time of the survey, a circumstance which would affect the distribution of the fish. *Notothenia ramsayi* and *N. wiltoni* were taken in practically every haul, but

are of small size. Two other important species are *Macruronus*, which the ship's company found one of the best for the table, and a species of *Stromateus* somewhat resembling John Dory. *Macruronus* is very slender, and escapes in quantity through the meshes of the ordinary trawl. About the Falklands themselves fish was not abundant, but invertebrates of many groups were

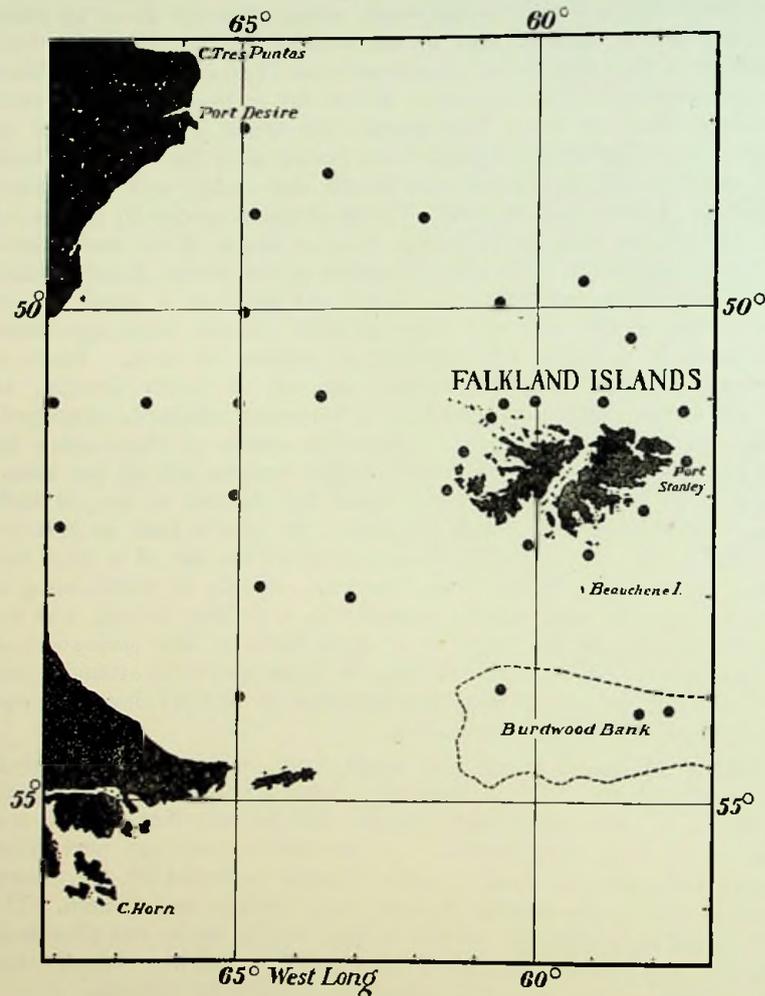


FIG. 8.—Stations investigated in the trawling survey of the Falkland Islands region.

abundant—the crab *Lithodes antarcticus* possibly possessing economic value: Burdwood Bank, according to the three hauls made, is similar in character. The whole area visited may therefore be considered to be divided into two, the continental plateau north and west of the Falkland Islands and the ground about and to the south and east of that group. The plateau has a bottom mainly

of clean dark sand, coarse to fine in texture, and with occasional patches of gravel: with this ground the Hake appears to be correlated, and the trawl can be used. The ground round the south-east, south and west sides of the Falklands and on the Burwood Bank on the other hand has a very rich invertebrate fauna, but appears to be definitely unsuitable for trawling with the ordinary otter trawl. The quantity of fish taken was half a ton an hour as a maximum and included 2 to 4 cwt. of Hake. The catch of marketable fish may be put at about 2 cwt. per hour on the average.

A comparison with the area surveyed was made in July 1927, when by courtesy of Messrs. Irvin and Johnson a cruise was made in the steam trawler 'Richard Bennett,' working ground off Cape Town.

The ground worked was on the continental slope in 200 fathoms. The bottom was green mud. The currents were far less violent than near Cape Horn. About thirty species were taken, of which three (including Hake) are common to these and the Falkland Plateau grounds and many are nearly related. The two most important fish caught, from the commercial standpoint, are Cape Hake and King Klip (*Genypterus*), and both were of larger size and (in the hauls made) more numerous than at the Falkland grounds. Most species were larger at the Cape than were their representatives or allied forms off the Falklands. The catch was very heavy, about 13 cwt. of marketed fish per hour, with an equal quantity of other fish and invertebrates. The fish rejected include such kinds as John Dory, and even certain sizes of Hake, which doubtless would be marketed were the supply of fish less in excess of the local demand. The richness of the ground is shown further by the trawlers working only during the day.

While this comparison of the grounds is extremely useful, it is far from enabling a really reliable conclusion to be reached as to their respective fishing values. The data are, it will be seen, too scanty adequately to represent such large areas, and the season was not the same. Again, taking first the Hake, it will be noticed that in the Falkland areas the hauls were made in less than 100 fathoms, in the Cape grounds in 200 fathoms. The northern Hake fisheries of the present day are in deep water, reaching even 300 fathoms. Moreover larger specimens would quite probably be met with on the Falkland Plateau in the warmer waters rather farther north, as is the case on the African coast. Apart from these and similar considerations it must be remembered that the Cape observations were made in the course of the operation of an established fishery. The best grounds would be known by the fishermen, and if any modification of standard gear or customary method of trawling such as length of warp, rate of towing, or size of mesh were necessary it would probably have been made. The Falkland work was a first general survey, and commercial fishing might increase the yield.

Even putting this aside, the catch was far from poor. During 1926 and 1927 English steam trawlers, working their principal grounds, landed 2.61 and 2.45 cwt. of fish respectively per hour's trawling, and

from the best Hake grounds, off the Scottish and Irish coasts, from 1.4 to 2.5 cwt. of that fish: with these catches the Falkland yield does not compare badly as to quantity. There is moreover in the South American republics a great and growing market for fish. Argentina in 1927 imported 17,000 tons of fish which with the Uruguayan import of 1925 and that of Brazil for 1926 (the last year's returns available) totalled over 57,000 tons. Since 1914 the Argentine import has increased by about two thirds. Nearly half the fish imported by this State is brought from Norway. It is possible that a South African supply may contribute shortly to the amount. The possibility of developing trawl and possibly other fisheries off the South American coast is therefore one that should be seriously explored.

Intensive fisheries work by the two research ships is likely to be postponed for some time, in view of the urgency of the need for whaling research, but it will be resumed as soon as circumstances permit.

V.—FINANCIAL.

The expenses of the investigations, as explained in the previous annual report, are met from the revenues of the Dependencies of the Falkland Islands. Expenditure is incurred within the limits of estimates sanctioned by the Secretary of State for the Colonies, subject to his general directions and in accordance with a code of regulations and instructions which he has approved. The accounts of the Committee are for calendar years, and the following statement shows the actual expenditure to December 31st, 1927.

<i>Service.</i>	<i>Actual Expenditure to 31/12/26. £ s. d.</i>	<i>Actual Expenditure, 1927. £ s. d.</i>
RECURRENT EXPENDITURE:		
'Discovery' Committee ..	5,510 17 3	2,042 0 7
Scientific Staff *		9,244 6 8
R.R.S. 'Discovery' ..	58,635 0 5	15,011 6 0
Marine Station	8,910 3 7	867 13 3
R.S. 'William Scoresby' ..	12,782 1 10	13,688 9 1
Pension Contributions ..	1,329 11 10	270 0 0
	<hr/>	<hr/>
	87,167 14 11	41,123 15 7
DEDUCT:		
Miscellaneous Receipts ..	632 16 9	2,112 16 8
	<hr/>	<hr/>
Net Recurrent Expenditure..	£86,534 18 2	39,010 18 11

* The expenditure under this head up to 31st December, 1926, is included under the heads 'Discovery,' 'Marine Station' and 'William Scoresby.'

<i>Service</i>	<i>Actual Expenditure to 31/12/26. £ s. d.</i>	<i>Actual Expenditure 1927. £ s. d.</i>
CAPITAL EXPENDITURE:		
R.R.S. 'Discovery'	131,550 6 3	—
Marine Station	10,478 17 2	168 12 4
R.S. 'William Scoresby' ..	40,473 11 5	115 0 3
	<hr/>	<hr/>
	£182,502 14 10	283 12 7

VI.—CONCLUSION.

The outline of work accomplished which is given above deals only with such broad conclusions as have emerged from the study of the data collected as far as this has proceeded at present. It makes no attempt even to mention the whole of the researches carried out, and inevitably omits accounts of technical and general scientific matters which nevertheless may prove of great importance to the objects of the investigations. Full consideration of the material to hand is proceeding, and the first volume of full reports will appear in 1929.

The Committee wish to express their continued satisfaction with the broad spirit of enquiry in which Dr. Kemp is executing the work, and with the uniform and praiseworthy energy which he and every member of the staff have shown in carrying it out under conditions of difficulty and frequently of hardship.

It remains to record certain changes in the staff. Mr. L. H. Matthews resigned on the return of the R.R.S. 'Discovery.' Before doing so he had completed reports on the Elephant Seal and on the birds of South Georgia, the first of which is in the press. Later Mr. A. C. Hardy also resigned on accepting the chair of Zoology at Hull University. Before leaving London he had written in joint authorship with the Director of Research a report on the Equipment, Gear and Methods employed in the investigations, which has already appeared. He will also complete a report on the Plankton work of the ships, a section of investigations which owes much to his initiative. Additions to the staff during the period covered by this report were made by the appointment of Mr. J. W. S. Marr and Mr. G. W. Rayner as assistants in Zoology and Mr. G. E. R. Deacon in Hydrology.

