'DISCOVERY' EXPEDITION.

Note on the scientific work to be undertaken by the 'Discovery.'

In this note on the research work to be undertaken by the 'Discovery,' I have endeavoured to give, in sufficient detail to form the basis of criticism, an outline of the various operations which should be conducted on the ship.

In Appendices VIII and XVI of the Report of the Inter-Departmental Committee on Research and Development of the Falkland Islands (Cmd. 657, 1920), and in memoranda subsequently written for the 'Discovery' Committee, Sir Sidney Harmer and Mr. J. O. Borley have indicated the lines on which the work should proceed. They have drawn attention to the value of general oceanographic research in the elucidation of the problems with which the expedition is primarily concerned, and, in particular, have emphasized the importance of observations on the plankton and hydrography[1] of southern waters. It is thus not necessary for me to restate the principles and theoretical considerations which underlie the work.

It is suggested that this outline of the research to be undertaken by the ship, after discussion and amendment at the hands of the Committee, may conveniently be adopted as a working programme issued for my guidance. The programme should not in my opinion be defined any more rigidly than I have done in this note; our procedure must obviously be open to modification as circumstances may dictate, and some of the work, more particularly the intensive hydrographic and planktonic survey of the southern whaling grounds, is so dependent on local conditions that it is impossible to foretell what is the precise method that should be employed.

As the Committee is aware, the amount of direct work on whales that the 'Discovery' will be able to accomplish is limited. Her time will be mainly occupied in investigations planned to yield as much information as possible on the environment of whales—on their food and the causes which influence it, and on the general conditions in the oceans which they frequent.

Much of this work will be done at stations or fixed points, at each of which a definite series of observations is made. In the South Atlantic and Antarctic, whenever the ship is at sea, stations will be taken at varying intervals. When making a run from one point to another, across the open ocean or in regions where only a general knowledge of the oceanographical conditions is required, the stations may be comparatively wide apart—100 to 120 miles; but where currents are likely to cause abrupt changes in conditions, on the whaling grounds and in all areas where exact information is necessary, they must be much closer together and should be taken at intervals of 10 miles or even less.

[1] Throughout this note the term "hydrography" is employed in the sense understood by biologists, *viz.*, as the science of the physical and chemical constitution of the sea.

164,200. 4/25.

In this note I have first considered the work to be done on the stations and have followed this with an account of the observations to be made between stations. I have added some remarks on working up results, and at the end have suggested a programme to be followed during the first year.

Work at Stations.

The series of observations to be made at all principal stations may be summarized as follows :—

As the ship is losing way a surface water-sample will be taken and the temperature recorded, while the direction and velocity of the wind, the air temperature, the barometric pressure, the weather, percentage of cloud and state of the sea, will be noted. When stopped a sounding will be taken, water-bottles will be lowered to various depths to bring up water-samples and record the temperature, and a succession of vertical hauls will be made with fine-meshed nets. When this is completed the ship will move slowly ahead towing series of plankton nets varying from 1 to 4½ metres in diameter. Before leaving the station the observations made at the beginning may be repeated.

This programme may be examined in detail.

The position of the ship, except at stations which are close inshore, will be recorded in latitude and longitude. Frequently it will not be possible to determine it on the spot ; conditions may be unfavourable for the necessary observations, and, owing to currents and to the drift of the ship while working at stations, dead reckoning alone cannot be relied upon. The position can be worked out later, at the end of the run, from all available data.

Observations on the force of the wind, the weather and the state of the sea will be made according to Beaufort's scales. It is understood that the Meteorological Office will supply a small anemometer which will provide a useful check on the estimates of wind velocity.

When the ship is hove to for the stationary observations she should be laid with head to wind or with the wind a point or so on the port bow. It is important that drift should be reduced as much as possible in order to avoid " stray " on the sounding wire and on the lines carrying the instruments and nets. With much " stray " the sounding will be in excess of the real depth, while the water-bottles and nets will not reach their indicated positions. Not infrequently it will be necessary to use the propeller to keep the ship up to her position. A useful way of checking drift is to shoot a beam trawl on arrival at a station and lead the warp up to the bow, the trawl thus forming a sort of sea-anchor. I have used this method with success on the Irish coast, and Dr. Schmidt speaks well of it in his account of his expedition to the Mediterranean. The trawl travels very slowly along the ground, and, while reducing drift, frequently brings up a good sample of the bottom fauna. On the ' Discovery ' the opportunities of employing this procedure will be limited, for deep-water trawling is not a regular part of our work ; even in shallow water the method cannot often be adopted, since time, which it may not be possible to spare, must necessarily be occupied in shooting and hauling the trawl.

Hydrographic Work.

In taking the sounding, it is important that a sample of the bottom should be secured. In shallow water a snapper lead, or " Sondeur Leger " can be used for the purpose. If a larger sample is required the conical dredge can be employed, but this is not properly a sounding operation, since the dredge cannot be attached to the sounding wire. In deep

water snapper leads may be used, or " drivers," in the form of long tubes driven deeply into the ooze. These are preferably lined with glass tubing, and, when successfully operated, bring up a long core of ooze in which evidence of stratification of the sea-bottom may be sought. Detachable cast-iron weights must be used in deep water. As a rule a single strand of piano wire is employed in sounding; but it is very stiff and if it kinks is certain to part. A very light seven-stranded wire is preferable, and with this it is possible to attach a light Richard water-bottle above the lead. By this method a water-sample and temperature can be taken at the same time that the sounding is being made, and at a deep-water station this will mean a considerable saving of time. Soundings will be taken in metres.

While the sounding is in progress operations with the water-bottles and vertical nets can be begun. Water-samples and temperatures should be taken at depths of 5, 10, 20, 30, 40, 50, 75, 100, 150, 200, 300, 500, 1,000, 1,500 and 2,000 metres, and thence at every 1,000 metres to the bottom. At most stations inspection of the temperature gradient will show that it is not uniform, and that at a particular point there is an abrupt change. It may be expected that sharp differences in salinity will also occur in this critical stratum, in which further observations will probably be necessary in order to plot the temperatures and salinities with accuracy. With experience of a particular area it may be found that some of the other observations may safely be omitted.

Three types of water-bottle will be used. The Nansen-Pettersson will be employed for depths down to 200 metres. In this model the water-sample is insulated and the thermometer is taking up the temperature while the instrument is being hauled to the surface. It can thus be shot and hauled with rapidity, but it is not possible to use more than one bottle at a time. For deeper water the Knudsen-Ekman pattern will be used. This is a reversing bottle which must be left at the proper depth until the thermometer has registered the temperature. A number of instruments can, however, be sent down on the one line. The third type is the Richard bottle, a light reversing instrument suitable for attachment to the sounding line.

The samples obtained by these bottles are required for the chemical estimation of some of the more important constituents of sea-water. From each of the depths mentioned above a sample will be required for determination of salinity, while other less numerous samples must be taken for estimating the degree of hydrogen-ion concentration, the amount of dissolved oxygen, and the phosphate content.

It is hoped to arrange for the collection of water-samples by lines of steamships traversing the South Atlantic. Such samples, though they will necessarily be from the surface only, should prove of value in providing contemporaneous data from a number of widely distant points.

The transparency of the water can, in my opinion, be observed with sufficient accuracy by means of a white disc lowered until it has just reached the limit of visibility. With due precautions it seems likely that this will furnish sufficiently accurate indications; it is not proposed to use a photometer to determine the greatest depth to which light rays can penetrate.

Plankton Work.

It will be understood that it is impossible to collect all the organisms which constitute the plankton by the use of a single kind of net. Small and very fine-meshed silk nets, hauled slowly, will provide a sample of most of the microscopic organisms; but larger animals usually occur in less abundance and are sufficiently active to avoid a small net moving at a slow speed. For these a larger frame must be employed, with coarser mesh and towed more rapidly.

On the ' Discovery ' it is proposed to use four standard types of net for general work, all with graded meshing to facilitate rapid filtration :—

	Diameter of mouth.	Mesh at middle.	Mesh at end.	Hauled.	Speed.
1.	70 cm.	Coarse silk.	Medium silk.	Vertically.	1 m. per sec.
2.	1 m.	4·5 mm.	Coarse silk.	Horizontally.	$1\frac{1}{2}$—2 knots.
3.	2 m.	7 mm.	4·5 mm.	,,	3—4 ,,
4.	$4\frac{1}{2}$ m.	15 mm.	7 mm.	,,	,, ,,

With these four nets the greater part of the plankton can be caught, but extremely small organisms will pass through the finest nets, and some large animals will probably be sufficiently active to escape even the $4\frac{1}{2}$ metre nets. For these other methods will be necessary, but it will only be possible to employ them occasionally.

The 70 cm. vertical nets will be hauled while the hydrographic observations are in progress, each being closed at the end of the haul on the Nansen principle. The series should be so arranged that all the strata down to a depth of 750 or 1,000 metres are fished, with three or four additional hauls in the lower layers at deep-water stations.

When all these observations are completed a series of 1 metre nets will be shot and towed slowly for half an hour, after which two series of 2 and $4\frac{1}{2}$ nets will be towed simultaneously at a faster speed for two hours. It is hoped to provide an apparatus by which these towed nets will be opened and closed mechanically, and to attach to each a gauge which will indicate the depth at which they are working.

It will not be possible to carry out plankton observations in deep water and with the large 2 and $4\frac{1}{2}$ metre nets at every station, owing to the length of time which the operations involve. These nets will, in ordinary circumstances, be employed only at alternate stations or at wider intervals. Hauls with the vertical nets and with the 1 metre horizontal nets should, however, always be made down to depths of 500 metres.

In putting forward for the consideration of the Committee this brief outline of work on stations, it is not necessary for me to urge the importance of either the hydrographic or the planktonic observations. These are matters which have been fully dealt with by Mr. Borley. In preparing the scheme I have been guided by the need for obtaining as much information as possible, while bearing in mind the value of time, for it will be understood that an extra half-hour spent at each station will amount to a very long period in the course of a two years' cruise. It is impossible to foresee what hydrographic factors and what organisms in the plankton will be found to have a direct bearing on our enquiries, and it is thus of great importance that our observations should be in sufficiently full detail. The deck equipment of the ' Discovery ' is being planned so that as many operations as possible may take place simultaneously, and each member of the staff will have a specific part of the work allotted to him, so that the whole programme can be carried out in the minimum of time.

With series of stations run on suitable lines it will be possible to plot the hydrographic data in sufficient detail to form a valuable record of the conditions prevailing at the time in a particular area, and if the stations can be repeated at a later date information of great importance as to seasonal or annual changes may result. The plankton observations—if

we are successful in putting our theories into practice—should enable us to determine the geographical distribution of the more important organisms within the area explored by the 'Discovery,' their bathymetric range, diurnal movements, and relative abundance. As with the hydrographic data annual or seasonal changes may be detected if the stations are repeated at suitable intervals.

The method used in the plankton work will be that of comparable hauls. It will be found that any particular organism is caught most efficiently by one of the four kinds of net specified above. In estimating its distribution and abundance only the hauls with this type of net need be considered and by the application of a factor, based on the duration of the haul and the speed of the ship, all the samples obtained with this type of net can be brought into comparison with one another.

Intensive Work.

The procedure outlined above will need some modification in the intensive work which will be necessary on the southern whaling grounds. Stations with the full series of observations, as outlined above, may be taken at the usual intervals in order to obtain comparable results over the whole area investigated; but some additional operations will be required and numerous subsidiary stations, with a shorter programme of special work, will be needed. This work will be mainly directed towards obtaining a full knowledge of the distribution, movements and abundance of the Euphausians which constitute the food of southern rorquals, and of the diatoms or other organisms on which the Euphausians feed. The best method will probably be to run lines in all directions across the whaling areas, taking stations at frequent intervals and pushing the lines beyond the regions in which whales are observed in order to investigate the conditions which determine their presence or absence. Full series of hydrographic observations will be necessary in order that an attempt may be made to correlate the physical conditions with the data yielded by the plankton. The Euphausians will probably be best obtained in large nets hauled vertically—the 2-metre nets can be arranged for this work or a large-sized Fowler net may be used. The diatoms and other small organisms will perhaps be obtained best by centrifuging the contents of water-bottles. Observations will be necessary on the stomach-contents of Euphausians, in comparison with the associated microplankton, to discover whether the Euphausians exercise any selection in feeding.

In my opinion no useful purpose is likely to be served by an attempt to work out a full programme of observations at subsidiary stations. We must necessarily be guided by the conditions as we find them, and have at present no data on which a reliable programme can be based.

Other work at Stations.

So far only the routine hydrographic and plankton work at stations has been dealt with; trawling remains to be considered, and mention must be made of other apparatus which will be carried for occasional use as opportunity offers.

I understand that the Committee wish trawling to be undertaken in shallow water, whenever it can be done without undue interruption of the work on hydrography and plankton, in order to find out whether fish exist in marketable quantity. For this purpose the larger areas which should be explored are the submarine plateau between the Falkland Islands and the mainland, the Burdwood Bank and the coastal banks of South Georgia. The first of these areas is of great size, and it does not seem probable that the 'Discovery'

will have many opportunities of examining it ; but she will often be in the vicinity of the other two, and it is hoped there will be many occasions when trawling can be undertaken without detriment to other work. It is proposed to carry two kinds of bottom trawl, an otter-trawl with headline 40—50 ft. in length, and a 30 ft. beam trawl. The latter, as already explained, can sometimes be fished while work at stations is in progress.

It was originally intended that the ' Discovery ' should be provided with a full-size otter-trawl ; but on account of the rigging and other difficulties this has been found impracticable and the trawl carried will only be about half-size. Trawling on a commercial scale will, however, form part of the work of the auxiliary vessel which is now being built.

Two kinds of current-meter will be provided ; but inasmuch as these instruments must be operated from an anchored ship or buoy they will under ordinary circumstances be used infrequently, and only in shallow water. Current-meter observations occupy a considerable amount of time, but may furnish data of very great value. During the Atlantic cruise of the ' Michael Sars,' the trawl on one occasion hitched in deep water, and advantage was taken of this misadventure to take a series of current-meter observations—the first ever made in the open ocean. It is possible that some such circumstance as this may permit us to use current-meters to advantage.

The Equipment Sub-committee has recently considered the question of employing floats of various patterns, set free from the ship, as a means of determining the direction and velocity of surface drift. Bottles of suitable specific gravity have been used with success for this purpose in European waters, but it is felt that the chances of their being found again, if liberated in Antarctic waters, are too remote to justify the experiment. Wooden floats of large size which might be sighted by passing vessels were also thought useless, but it was decided to recommend the provision of a small number, since they might prove useful as temporary marks for swarms of plankton.

I have already remarked that special methods will be necessary to obtain very small and very large planktonic organisms which cannot be secured by any of our four standard types of tow-net. For obtaining microplankton, very fine silk nets, with mouths 50 cm. in diameter, will be employed. These nets are of the same pattern as those used by Professor Gran in Norway, and it is possible that we shall need them frequently in our intensive work on the whaling grounds. Still smaller organisms can be obtained if required by centrifuging the contents of water-bottles. For very large organisms it is proposed occasionally to employ a mid-water trawl, kept extended by three otter boards, with net 250 ft. in length, and with a mouth area of about 1,500 sq. ft. This trawl is for work at the surface and at moderate depths ; but it will be awkward to handle and can only be used occasionally.

The Petersen young-fish trawl will probably not be used in routine plankton investigations, owing to the fact that it cannot be opened and shut at the required depth ; often, however, it yields most valuable results when fished very near the bottom. A Petersen Grab will be taken for occasional use, but it will not be possible to operate it with sufficient frequency to obtain the accurate data on the sedentary bottom fauna for which it is designed. Drift nets can rarely be used, but some should be taken in view of the probable occurrence in certain localities of shoals of the southern herring.

Fish-traps of various sizes will be taken, the largest some 10 ft. long and 4 ft. broad. They are instruments that are not often employed in scientific research, but in the hands of the Prince of Monaco proved very successful. Dredges of all kinds will occasionally be needed, and a complete outfit of small nets for use in inshore waters from the dinghy or motor-boat.

Work between Stations.

Under this heading all direct work on whales that the 'Discovery' will be able to do is to be considered. As the Committee is aware, it is of the first importance that as many whales as possible should be marked. If this can be accomplished satisfactorily it may be expected that information of the greatest value will be obtained on the migrations of the various species, on their rate of growth (especially if calves can be marked) and perhaps on their longevity; while if we were successful in marking any considerable number the returns would provide interesting data on the intensity of hunting. It is feared that the ship herself may prove to be too slow and unhandy to mark whales; but in good weather it can be done from the motor boat, which should be fitted with a special stage in the bow for the marksman. The auxiliary vessel, already referred to in connection with trawling, is being built on the lines of a whale-catcher, and will have a speed of 12 knots. In addition to trawling she will be largely employed in marking whales, and everything possible is being done to render her efficient in this work.

Apart from marking it should be possible for those on the ship to make useful observations on living whales. A special whale log-book will be maintained, in which records will be kept of all whales sighted, the following observations being regarded as of particular importance :—

(1) Species. Certainty on this point will require considerable experience.

(2) Direction and speed of movement. If a range-finder can be employed (which may be difficult owing to the brief period of exposure at the surface) it should be possible with time records and compass bearings to plot successive positions of a whale or school of whales and thus to determine the rate and direction of their movement with some accuracy; while if the ship could follow the whales a series of observations might be made.

(3) Periods of exposure and submergence, association in schools of similar size or the same sex (if practicable), association of mothers with calves, pairing habits, etc.

(4) Distribution in relation to special conditions of ice, plankton and hydrography.

These observations are, of course, of particular importance in the larger species, which possess economic value. When circumstances permit, however, it is proposed to extend them to the smaller forms. If practicable, specimens will be harpooned, measured and subjected to detailed examination, selected individuals being preserved in salt. When large whales are sighted the ship should diverge from her course and endeavour to come up with them, but it will not be advisable to interrupt the work at a station on this account. The possibility of providing the ship with a light swivel gun, shooting small harpoons is now being explored. With a gun of this kind small species of whale up to about 25 ft. in length might be obtained.

Much other work can be done between stations. Surface temperatures and salinities will be regularly taken at intervals of four hours, and more frequently when there is reason to expect any rapid change. The distance thermograph, which has been sanctioned by the Committee, will give a running record of surface temperatures. By the use of the Knudsen full-speed water-bottle it should be possible to obtain records of salinity and temperature at some distance below the surface, and if this instrument proves reliable it should be of great assistance in providing data from a stratum but little affected by surface movement of water and the sun's action, thus giving timely warning that the ship had passed from one zone of hydrographic conditions to another.

The full-speed torpedo indicator should perform the same function for the plankton that the Knudsen water-bottle does for salinity and temperature, with the additional advantage that the automatic form, if successful in operation, will provide a continuous record of the occurrence of some of the most important organisms in the water. It is difficult to over-estimate the value of such a record, and, though it will be useful in all seas, it will prove of especial benefit in southern waters in determining whether the plankton is uniformly distributed or is localised in small patches. A correct appreciation of this point is essential before we can form a true estimate of the value of our work on the stations.

Whenever the ship is in sufficiently shallow water the echo-sounding gear should be operated at short intervals and its reliability checked on every station. A second apparatus for determining greater depths should be installed if possible. If it proved satisfactory in its performance it would result in an immense increase in our knowledge of the topography of the ocean bottom in the South Atlantic, and this is a factor of importance in the distribution and movements of water-masses with their included plankton.

On shore, apart from such work as may be possible at whaling stations, there will be opportunities to inspect rookeries of seals, sea-elephants and penguins. Additional information on the natural history of the different species will be valuable, and, whenever practicable, a census of the population should be taken.

On Working up Results.

The Committee will realise that all the results obtained cannot possibly be worked up on board ship, and that, even with the help of Mr. Matthews and Mr. Clowes on the shore station and with a considerable library, much must remain which can only be accomplished satisfactorily in England. Both on the ship and at the shore station our time will be fully occupied in obtaining, so far as we may be able, the results which are essential to the conduct of our economic enquiries, leaving such work as appears to be of purely scientific interest for later consideration. But it is evident that no hard and fast line can be drawn between economic and purely scientific results, for data which seem at the time to have little economic value may subsequently be found to possess great importance from this point of view.

As regards hydrographic work, it will be possible on the ship to maintain, up to date, the records of temperature, phosphate content and of hydrogen-ion concentration. It is most improbable, however, that the full series of salinity determinations can be made on board, and these results cannot, therefore, be plotted until the samples have been titrated at the shore station by Mr. Clowes. The same remark applies to the estimation of dissolved oxygen.

The biological collections are likely to present much greater difficulty. All the plankton collections at principal stations should be preserved, and it may be expected that they will quickly attain a formidable bulk. The contents of the larger nets can probably be sorted on board, keeping only small samples of the abundant organisms. This can scarcely be done with hauls of the finer nets, but it may be possible to institute some simple volumetric comparison of the samples with a rough percentage estimate of the principal constituents. On the ship we must concentrate our attention on the more abundant—and hence more important—forms, identifying them as nearly as possible and recording their comparative abundance. In the special observations to be made during our intensive study of the whaling areas every effort must be made to keep abreast of the collections, and if, with the help of Mr. Matthews at the shore station, we can succeed in this and can identify all the important species, it will not be necessary to preserve the samples.

If we are successful in our work, the collections made at the principal stations should result in a considerable increase in our knowledge of the plankton of the South Atlantic, and, ultimately, all these collections should, if possible, be worked out in detail and the results published in the Reports of the Expedition. These matters will require very careful consideration, but are rather outside the scope of the present note.

Outline Programme for the First Year's Work.

It now seems probable that the 'Discovery' will be leaving England about the end of May. If she sails direct to South Georgia, she will arrive in July, in the middle of the Antarctic winter. This is clearly undesirable, and it will be better, as Sir Sidney Harmer has already suggested in his memorandum dated November, 1923, if advantage is taken of the outward journey to do some work on the African coast, more especially as the ship will arrive there while the whaling season is in progress.

Work may be begun in the Gulf of Guinea, which appears to be the northern limit of the migrations of southern whales. The conditions here are no doubt governed by the two great currents—the Equatorial (a continuation of the Benguela) which flows in a westerly direction just south of the Equator, and the Guinea or Counter-Equatorial current which flows eastwards between the Equatorial and the African coast. The area will be best examined by running longitudinal lines of stations across the currents. It is suggested that three of these lines should be taken, extending from the coast to 5° S. Lat. and in the longitude respectively of Cape Palmas, Cape Three Points and Lagos.

It will be useful to touch at Fernando Po and possibly at Annobon (where a new company with a floating factory is about to start operations), and during the subsequent voyage along the West African coast all the other whaling stations at Cape Lopez, Elephant Bay, Walfisch Bay and Saldanha Bay can be visited. It is thought that valuable information may be obtained even by brief visits to these stations. The managers' views will be of interest, and if whales are being dealt with it will be possible to obtain useful data on a number of points.

On the West African coast the Benguela current may be examined by means of latitudinal lines of stations which may conveniently be taken off Elephant Bay and Walfisch Bay, with shorter lines further south to investigate the upwelling of cold bottom-water near the coast.

It will be necessary to coal either at Walfisch Bay or at Cape Town, after which a course may be laid for Stanley, a series of stations being taken on the way.

On leaving Stanley the ship will either run a line of stations direct to South Georgia, or, if ahead of our time-schedule and the weather happens to be particularly favourable, the opportunity might be taken to visit Beauchêne Island, where there is a fur-seal rookery, and to spend one or two days in trawling on the Burdwood Bank.

Captain Stenhouse and I estimate that the following time will be spent on the outward run :—

	DAYS.
London to South Georgia on the route indicated	100
About 110 stations at an average of 4 hours each	18
Halts for coaling at Las Palmas, Cape Town and Stanley	10
Halts at five African whaling stations	5
Divergence from course in following whales	4
	137

If the ' Discovery ' leaves England on May 31st, she will thus reach South Georgia on October 15th, at the beginning of the whaling season.

I have outlined a very full programme for the outward run. If, by an earlier start, a little more time can be given to it, it will be a very great advantage.

On arrival at Grytviken some time must necessarily be spent in an inspection of the shore station, in discharging water and plankton samples, and in taking off fresh supplies. The water-samples are likely to be very numerous, and it is probable that Mr. Herdman will need to remain ashore when the ship puts to sea in order to help Mr. Clowes in the work of titration.

The ' Discovery ' will now begin her intensive study of the whaling grounds, using Grytviken as a base. How long this work will require is, of course, largely a matter of conjecture, but it is thought that it may usefully be continued until the end of the year.

On completion of this work the ship should visit the South Shetlands, preferably taking a circuitous route in order to examine as large an area as possible. From South Georgia a course should be laid for the South Sandwich Islands, and thence, in a westerly direction, skirting the pack-ice to Deception Island. From this base a study can be made of the neighbouring whaling grounds, while the floating factories and shore station can be visited. If conditions are found to be favourable an effort should be made to proceed south to the Gerlache Strait and Neumayr Channel. In March the ship should return north, taking (if weather permits) a series of stations from the South Shetlands to Cape Horn, and thence proceeding to South Georgia.

While in the South Shetland area every endeavour must be made to avoid heavy pack-ice. If the season is found to be an " open " one the opportunity should be taken to work round the southern side of Anvers Island, returning to Deception along the western coasts of the islands forming the Palmer Archipelago.

Throughout this southern cruise observations on whales should be made and, whenever weather permits, stations should be taken at intervals of not more than 50 miles. It is hoped that it will be possible to combine survey work with the biological observations. Running surveys will be made whenever practicable, and soundings taken at frequent intervals.

Arriving in South Georgia in March, the remainder of the season, until the end of May, should be spent in a fresh survey of the whaling grounds. It will probably be found that a considerable change has occurred, and it will be valuable to compare the conditions with those prevailing in the early part of the season.

In putting forward these proposals for a year's work, I have endeavoured to give an outline of what I consider to be the most profitable way of attacking the problems with which we are concerned. It is possibly too ambitious a programme, and bad weather and other circumstances which cannot be foreseen may prevent us from carrying it to completion.

STANLEY KEMP.

12th February, 1925.


WATERLOW & SONS
LTD.
LONDON
DUNSTABLE
AND
WATFORD