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by

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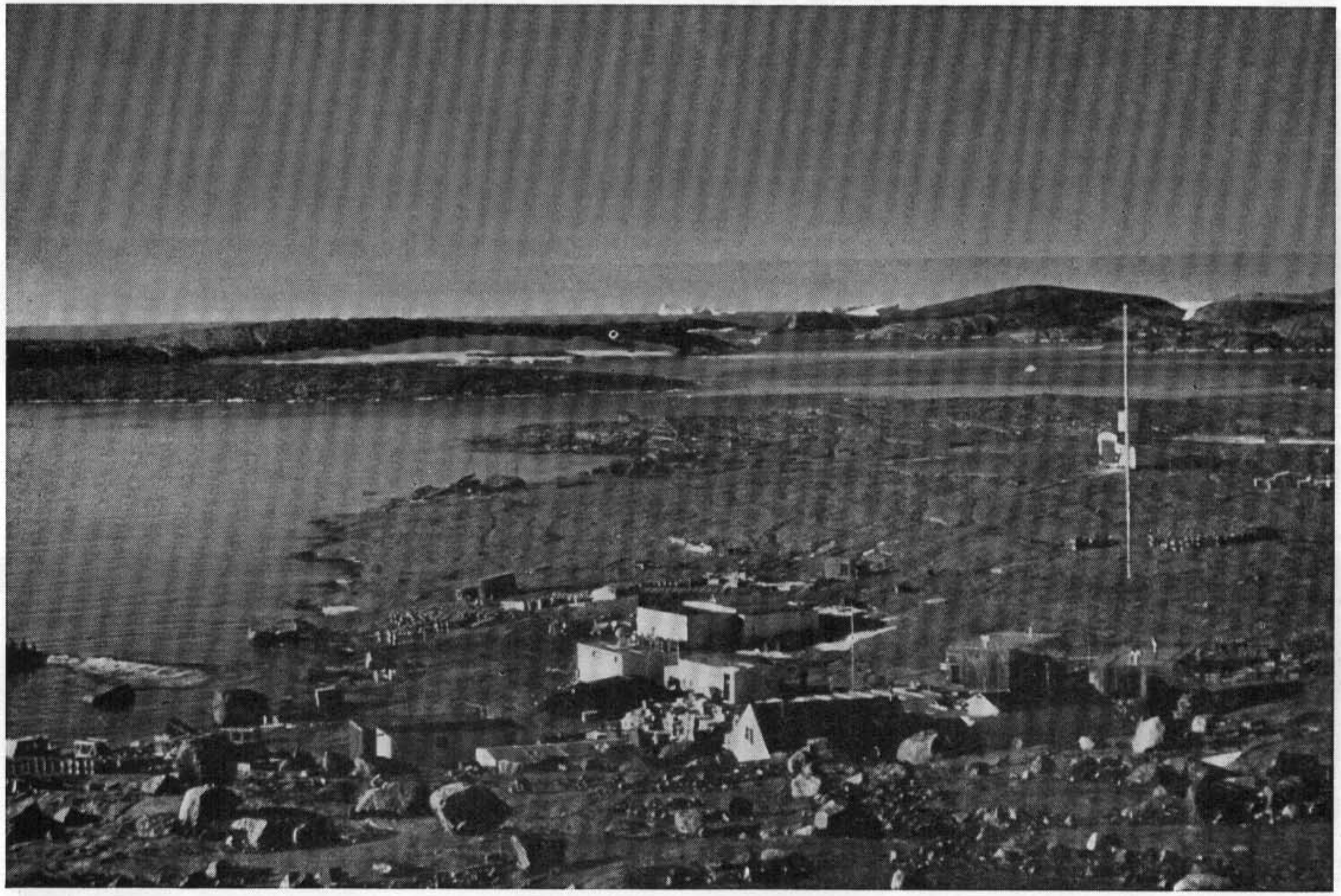


PLATE 2—Mawson and the rocky islets to the north.

PLATE 3—The coastline west from Mawson.

SUMMARY

An account is given of the hydrology of the inshore waters near Mawson, Antarctica (67°36′S. lat., 62°53′E. long.) covering the period 19.6.56 to 10.2.57. The results were obtained at two stations, one in 25 to 30 metres and the other in over 100 metres of water. Samples for analytical treatment were taken at intervals throughout the water columns. During the same period, attempts were made to investigate the size and qualitative composition of the phyto- and zooplankton communities and examine the influence of the environment upon their development.

INTRODUCTION

The physical and chemical characteristics of the water masses south of the Antarctic Convergence are now reasonably well known, with the exception of those waters immediately surrounding the coastline of Antarctica. Our knowledge of this far southern sector is limited to the isolated summer observations of research vessels. For the greater part of the year, when the sea surface is frozen, there is no direct information. A similar situation exists regarding the plankton communities. Isolated plankton hauls have been made by shore based expeditions through holes in the ice, and by ships during summer cruises. Although the species of organisms gathered have been described, little or no information exists on plankton ecology.

It is hoped that the present account, notwithstanding the fact that it describes conditions during only one season in an isolated locality, will prove of interest for it is the first attempt to carry out a continuous series of related hydrology and plankton observations from winter through into summer within the Antarctic pack ice belt.

The investigation, undertaken at Mawson (67°36′21″S. lat., 62°52′ 48″E. long.), an Australian base set up in MacRobertson Land early in 1954, formed part of the scientific programme of the 1956 Australian National Antarctic Research Expedition.

The site chosen for Mawson is a small, ice-free granite outcrop enclosing a miniature harbour, flanked on either side by ice cliffs and sheltered from the north by a number of small rocky islands (Map 1 and Plates 1-3). On the eastern side of the horseshoe, the ground falls evenly to the shoreline affording easy access to the water or sea ice. The floor of the harbour falls away rapidly to a depth of 30 metres within 100 yards of the southern shoreline, increasing to approximately 50 metres at the harbour mouth. Within 500 yards of the western arm of the harbour, the depth of the water is somewhat in excess of 100 metres. Because of the strong winds, the rock in the area of Mawson remains largely snow-free throughout the year and very little snow collects on the sea ice so that problems associated with the accumulating of winter snow are fortunately not present. The wind has certain disadvantages, however, as it delays the formation of sea ice in autumn which in turn affects the marine programme. Climatic data from 1956-57 are summarised in Table 1.

Although it was hoped that five stations for hydrology and plankton observations might be established and kept in operation, a number of practical considerations reduced this number to two. Station 1 was situated in 30 metres of water within the harbour and Station 2 in 100 metres of water some 400 yards west of the harbour mouth. After a great deal of preparatory work, observations were commenced in June 1956 and continued until February 1957.

Mindful of certain deficiencies in methodology and the isolated nature of the work, care has been taken to avoid over-detailed analysis of results. The conclusions which have been drawn are tentative and may require considerable modification should further work be undertaken in this or other similar areas in the future.

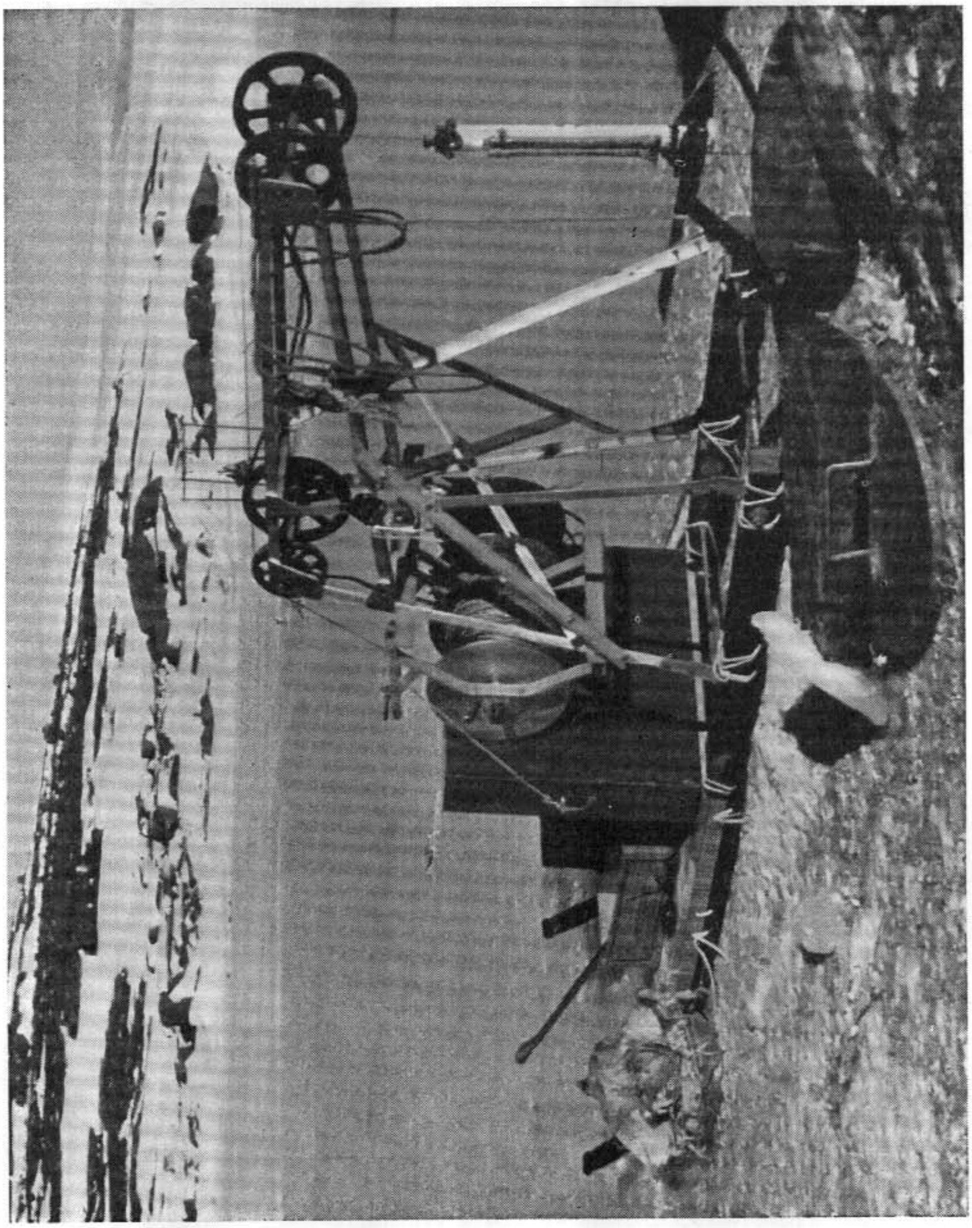
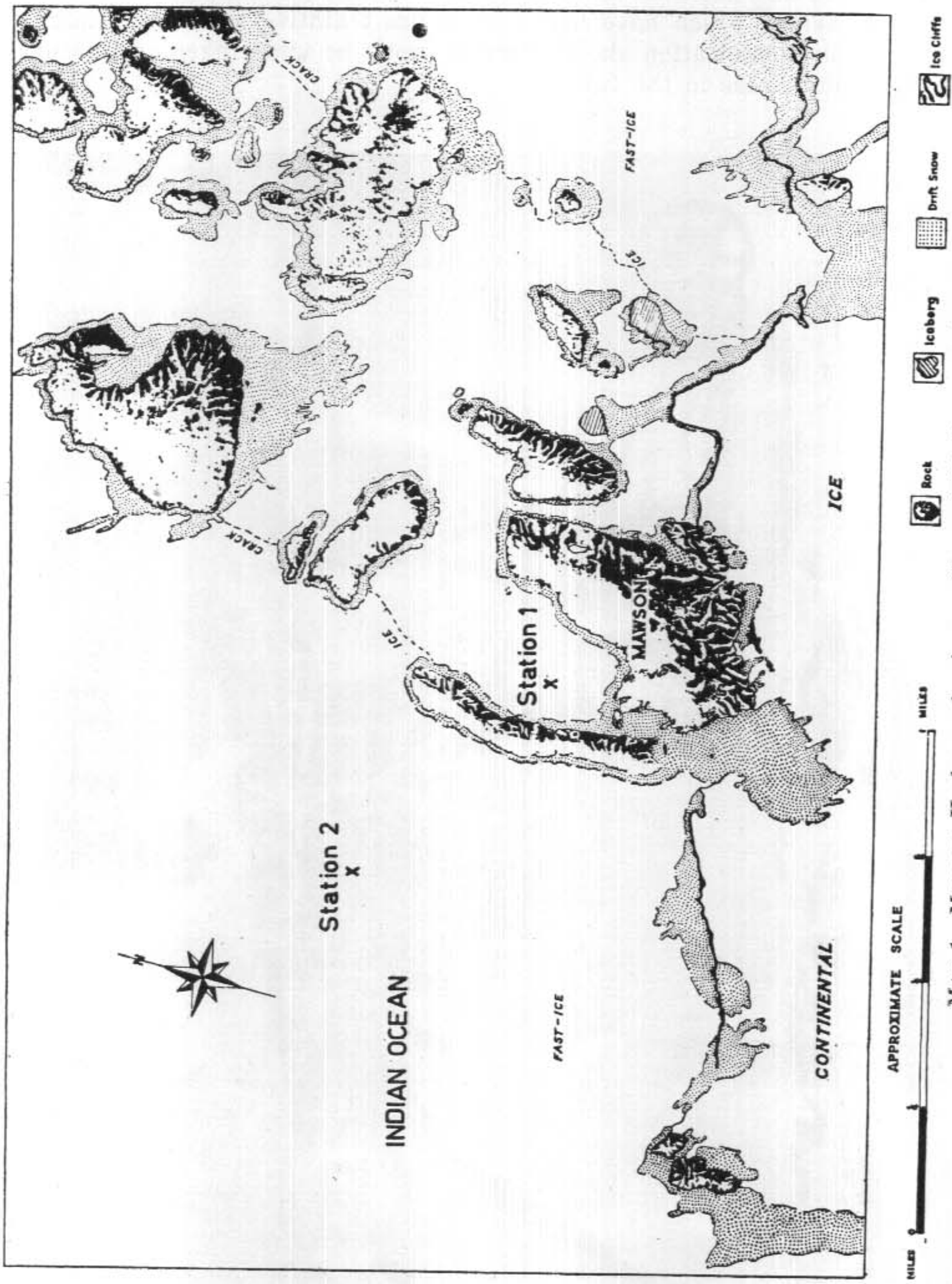


PLATE 4—The winch and equipment on the sea ice at Station 1.



MAP 1—Mawson Harbour, showing positions of Stations 1 and 2.

TABLE 1

Climatic data from Mawson, 1956–57

Month	*Temperature (°F)*					*Wind (m.p.h.)*			*Sunshine (hrs.)*		
	Highest max.	*Lowest min.*	*Lowest max.*	*Highest min.*	*Monthly mean*	*Highest daily mean*	*Lowest daily mean*	*Monthly mean*	*Highest daily*	*Average daily*	*Days of Blizzard**
March	28.1	−4.0	8.4	17.1	11.5	41	9	22	13.5	7.8	1
April	28.0	−4.6	3.2	17.9	10.5	45	9	26	8.1	2.5	6
May	23.1	−14.4	−7.9	16.0	5.6	60	13	27	6.9	1.7	2
June	22.0	−17.4	−11.4	16.1	3.0	52	7	26	0.9	..	4
July	30.6	−23.0	−17.0	15.0	0.9	36	4	21	4.7	0.8	3
August	16.3	−30.0	−22.1	10.5	−6.7	58	5	22	9.1	4.2	4
September	17.6	−18.7	−7.3	13.5	0.0	57	9	25	9.8	5.1	1
October	19.6	−11.3	1.2	15.3	8.0	74	8	27	15.4	6.2	4
November	36.1	4.6	18.4	27.5	22.2	55	10	25	17.7	8.2	2
December	46.9	23.2	30.9	37.3	34.2	33	4	17	18.8	10.7	..
January	43.1	21.7	27.7	37.2	33.2	50	6	21	18.3	9.2	2

* Blizzard day: visibility 100 yards or less over period of eight hours with winds reaching at least 60 m.p.h.

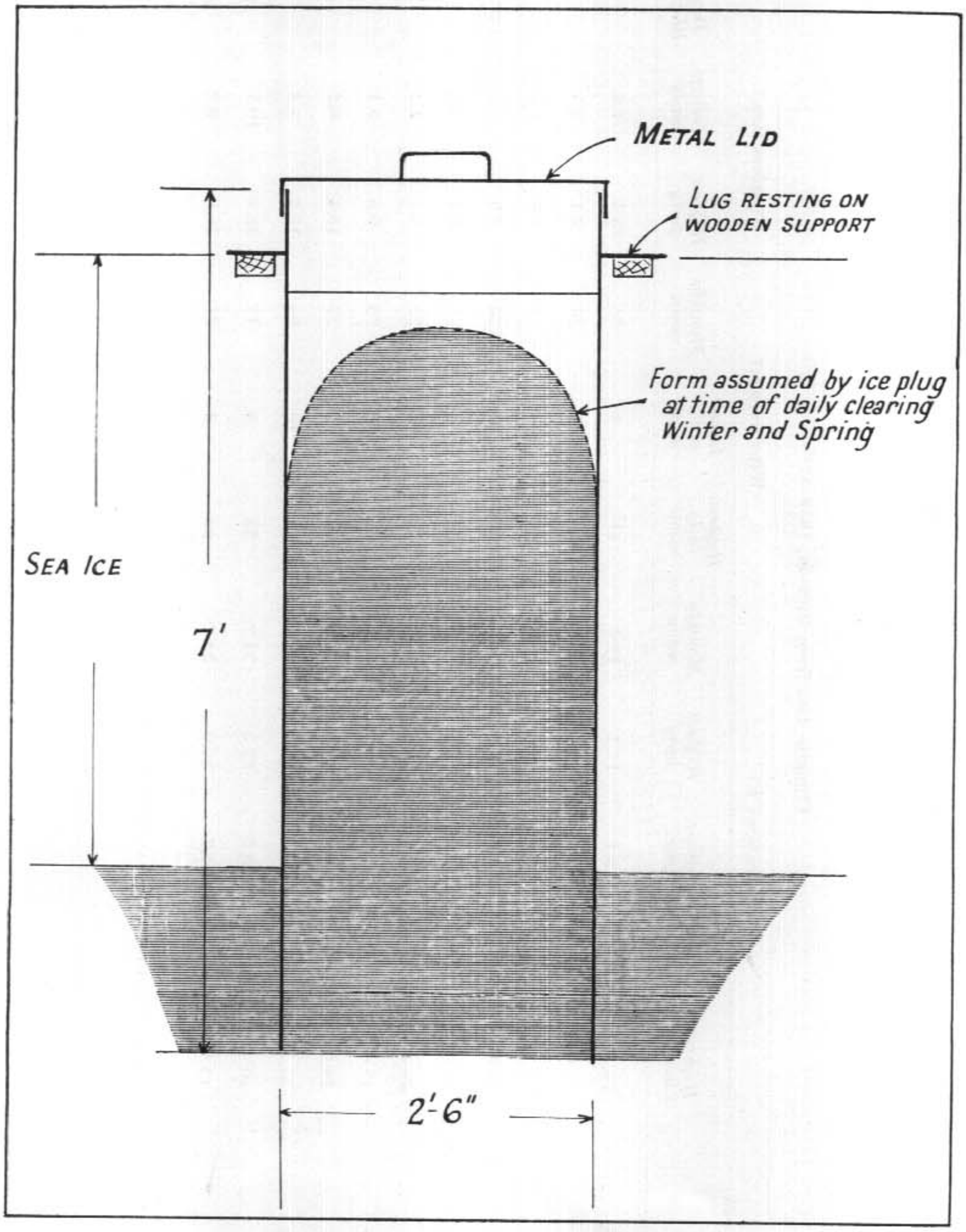


FIG. 1—Metal tube for access through sea ice.

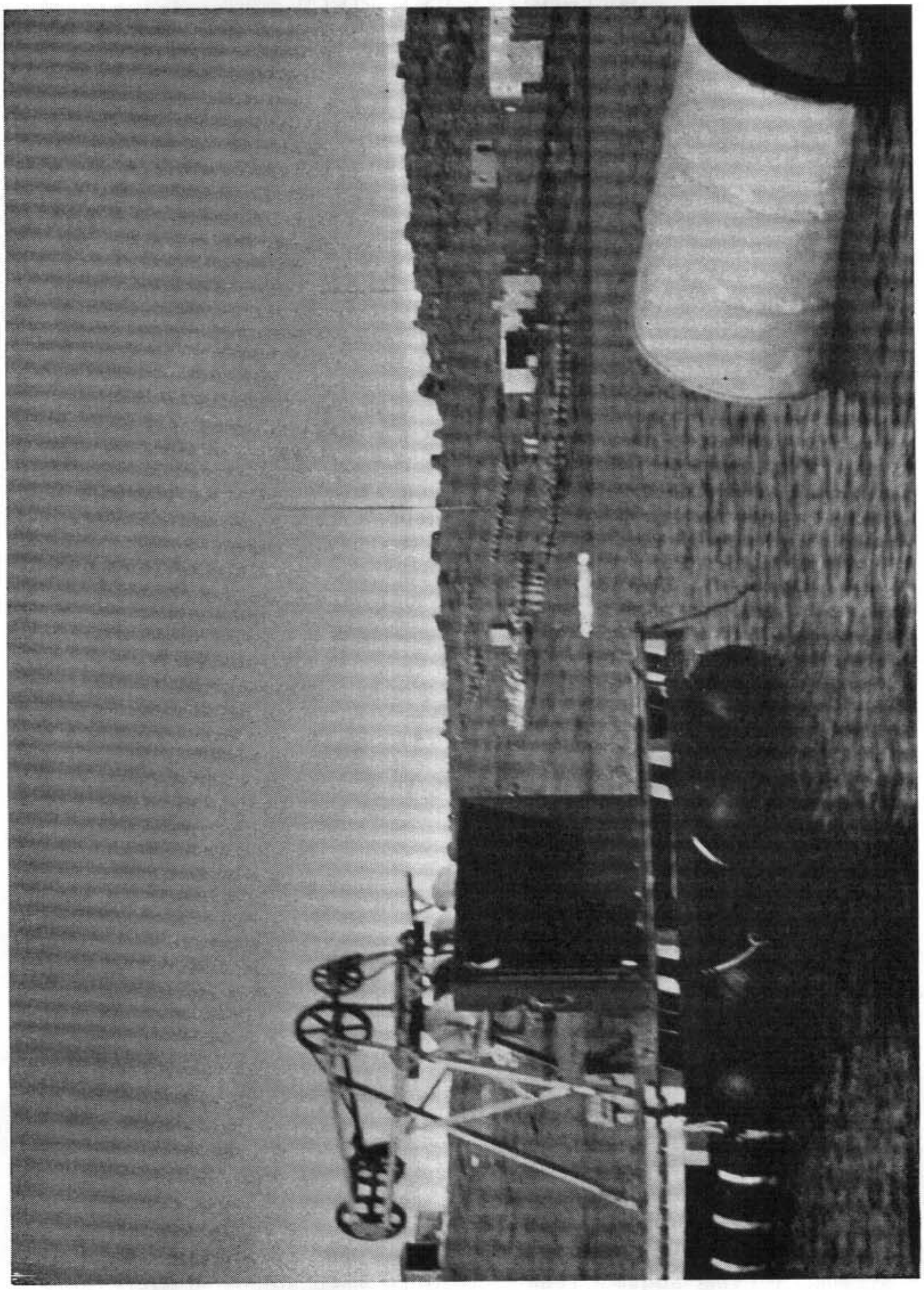


PLATE 5—The winch mounted on a rubber and wooden pontoon at the position of Station 1.

METHODS IN THE FIELD

Access through the sea ice. The sea in the vicinity of Mawson is normally frozen over for the greater part of the year to a recorded maximum thickness of 6 feet. To obtain ready access to the water, holes were dug in the sea ice soon after its formation and painted metal tubes 2′6″ in diameter and 7′ long were placed in them with the upper 6″ of the tubes protruding above the ice surface. (Figure 1). Four metal lugs, each 6″ long and resting on a light timber framework, supported the tubes until they become frozen in position. Lids were provided to exclude snow. Each day it was necessary to clear the ice formed in the upper part of the tubes, though, with the onset of summer, the need for daily clearing gradually decreased. In the final stages of the programme, the tubes were found to be unnecessary and were removed.

The winch equipment. A hand-operated winch (Plate 4) was built of aluminium angle. The winch carried a cable drum housing several hundred metres of standard galvanised cable for carrying Nansen bottles and nets. The amount of cable played out was measured by fixing to the forward pulley wheel a small lug, suitably arranged to operate a tally counter mounted on the winch frame. The rim of the pulley wheel was marked in tenths of the full circumference and the whole arrangement was calibrated in metres. It proved to be quite reliable.

During the greater part of the programme, the winch was lashed to sledge runners on which was built a small wooden platform to carry Nansen bottles and other gear. After the ice broke out, the winch was operated from a small pontoon (Plate 5).

Hydrology samples. At Station 1, samples were taken from the surface, and from depths of 5, 10, 15, 20 and 24 metres; at Station 2 sampling was from the surface, 10, 25, 50, 75 and 100 metres. The stations were occupied on alternate weeks.

The principal difficulty experienced was that the water in the Nansen bottles became frozen or semi-frozen so rapidly after surfacing that subsamples could not be drawn off in the open and it was necessary to return the bottles to the laboratory for thawing. During the winter months, this entailed a serious wastage of the few hours of daylight available, especially as it commonly required up to three hours in the laboratory before the water could be withdrawn. So much trouble was caused by the end sections of the Nansen bottles being forced apart by the expansion of the enclosed freezing water that it became necessary immediately after raising the Nansen bottles to the surface to drain part of each sample through the closing mechanism into separate pyrex beakers.

As soon as possible after their return to the laboratory, aliquots were taken in the normal manner for the determination of dissolved oxygen. Further aliquots, completely filling 50-cc. stoppered flasks, were then taken for the determination of pH and Eh. The remainder of the contents of each Nansen plus the excess from each beaker were run into separate clear-glass, two-litre Winchester flasks for determinations of chlorinity, dissolved phosphates, buffer capacity and chlorophyll.

Towards the height of the summer, after the breakout of the sea ice, it was found possible to empty the Nansen bottles in the field in the normal manner so that, for several weeks, aliquots for the determination of dissolved oxygen were obtained and pre-treated without the usual delay.

Water temperatures. Surface water temperatures were recorded daily at both stations. After clearing the ice, a reversing thermometer was suspended approximately one foot below the surface for at least ten minutes. All temperatures have been corrected for mercury expansion effects.

Every week at alternate stations the water temperature at various depths was recorded in the usual manner with reversing themometers attached to the Nansen bottles. Because of the great differences between water and air temperatures and other practical difficulties, it was not possible to note temperatures in the field, these being taken later in the laboratory by returning the Nansen bottles reversed.

Unprotected reversing thermometers were also used for a time at Station 2 to check sampling depths. However, this precaution was found to be unnecessary as the cable was heavily weighted and the winch itself was not housed, as is normal, on a drifting ship. On the few occasions when the winch was used from the pontoon, drift was negligible.

Plankton hauls. Considerable difficulty was experienced in managing the practical aspects of this part of the investigation (1). Therefore the plankton results are, in many respects, seriously deficient.

Conventional N70 and N50 type nets were used. All hauls were run vertically at the rate of approximately one metre per second from bottom to surface, except for some horizontal hauls made during and after the breakout of the sea ice. It was necessary to adapt the N70 net to an N50 ring to fit the metal tubes. After the tubes were withdrawn, the ice holes were enlarged and it was then possible to use the N70 with its correct opening. Throughout the period of the programme, but especially during the winter months, great trouble was caused by the nets becoming partly filled with ice crystals. Although every effort was made to extract all the plankton in each catch by refiltering the thawed ice, it was never possible to clear the nets thoroughly. The results obtained are therefore of limited value, notably those from the winter period when zooplankton densities were very low. The times at which hauls were made were not standardised and depended to a large extent on prevailing weather conditions.

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(1) Some time was spent in designing and constructing an electrically operated plankton pump which it was hoped would eliminate the necessity for handling cumbersome nets in extreme cold and would enable much larger volumes of water to be filtered than could be passed through vertically hauled nets. Time, however, did not permit preliminary trials and adjustments and the pump, in its existing form, was found to be unsatisfactory in tests at Mawson and had to be put aside.

Constant maintenance was needed to keep the nets serviceable under the harsh conditions to which they were exposed.

Radiation measurements. Measurements of incident solar radiation were made in depths up to 10 metres below the surface, using a specially constructed thermopile linked with a sensitive calibrated galvanometer supplied by the Kipp Instrument Company of Holland. Unfortunately, underwater radiation values could not be checked against variations above the surface with this apparatus.

As it was possible to obtain readings beneath the sea ice only by lowering the thermopile down the sampling tubes at Stations 1 and 2, the results obtained, although useful, cannot be said to represent natural conditions.

LABORATORY METHODS

Hydrology. The analytical procedures were, for the most part, standard. Only those which differed from normal practice or in which modifications were necessary will be described in any detail.

Dissolved oxygen was determined by the well-established Winkler method. As already indicated, however, it was not normally possible to subsample and make preliminary additions of reagents in the field. This was done as soon as possible after return to the laboratory. Although there was no way of estimating the error involved in this unavoidable practice, the results in general appear reasonable. Nevertheless, they are subject to doubt and the need for more elaborate field equipment to overcome sampling problems is clearly indicated.

pH and buffer capacity values were determined electrometrically with a Cambridge bench-type meter and glass electrode. The accuracy of the instrument was checked with appropriate buffer standards after each run of twelve measurements. The normality of the HCl used to determine buffering capacity was checked against standard NaOH after return to Australia.

Electrode potential measurements were made by means of a platinum electrode and a Cambridge bench-type meter with the minimum possible delay after collecting samples. In general, determinations could be made within four to six hours, although the time lapse was longer during blizzards when the sensitive galvanometer exhibited irregular behaviour and could not be used. Radio transmissions from the station at Mawson caused similar trouble.

Chlorinities were determined electrometrically with a temperature-chlorinity meter developed by Mr. B. Hamon of the C.S.I.R.O. Division of Fisheries and Oceanography, Cronulla. The instrument, checked with standard seawater after each set of readings, was found to be completely satisfactory. It enabled readings to be obtained rapidly and with greater ease than with the normally employed titration technique.

The equipment necessary for the determination of total phosphates was beyond the capacity of the Mawson laboratory. Dissolved phosphates were determined by the standard colorimetric technique using a Hilger Spekker absorptiometer.

Nitrates and silicates were not assayed.

Plankton. The volumes of all zooplankton catches were determined by the displacement method of Ealey (1954) but in most cases were too small to be measured with sufficient accuracy. Except for a brief examination of each catch, nothing was done with the preserved material until the author's return to Australia, when the numbers of individuals in dominant groups were estimated either from subsamples or entire catches.

As the present account is concerned with ecology rather than systematics, and because of the difficulties entailed in readily obtaining specific determinations of many plankton animals, attempts have been made to identify fully only the members of the most important group, viz. the copepods. It is hoped that systematic accounts of the several other groups in the catches may become available at some future date.

Information relating to the phytoplankton and smaller zooplankton was obtained in several ways. The catches from N50 nets were preserved and later examined microscopically in Australia to determine their species composition and to discover what organisms were dominant. Quantitative analyses of the net-caught material were not attempted, dependence for this type of data having been placed upon the technique about to be described.

After withdrawing aliquots for the determination of dissolved oxygen, Eh and pH, the remainder of the water in each Nansen bottle was run into separate clear glass Winchester flasks. The volume (approximately 900 ccs.) in each bottle was measured to the nearest cc. and the samples were run separately through an electrically operated continuous centrifuge revolving at 14,000 r.p.m. Any solid matter was retained in the centrifuge cup together with several ccs. of water. The main bulk of the sample was re-collected and kept for the remaining hydrological analyses. All the material in the centrifuge cup was transferred carefully with seawater free of suspended matter to a 10-ml. measuring cylinder and the volume was recorded. A small portion of the measured suspension was transferred to a Neubauer counting chamber and duplicate counts of any organisms present immediately carried out under the microscope using phase contrast illumination and appropriate magnifications.

The reliability of the counting technique used may be judged from Table 2, which shows the results of duplicate examinations of several representative samples. An analysis of variance carried out on these data showed that variation between duplicates was not significant, whereas a highly significant difference existed between counts on samples from the various depths. (F value required at 1% level, 6200; F value obtained from data, ∞).

TABLE 2.

Duplicate counts of diatoms from several samples.

	Station 1 (10.12.56) Replicate			Station 2 (17.12.56) Replicate	
Depth, m.	1	2	Depth, m.	1	2
0	10	10	0	9	12
5	41	51	10	144	130
10	114	160	25	60	83
15	173	117	50	27	15
20	90	136	75	5	9
24	103	113	100	3	5

The remainder of each suspension was then extracted with acetone according to the method given by Davis (1957) and the chlorophyll concentration measured with the Hilger Spekker absorptiometer using Ilford 608 filters. Before leaving Australia, a calibration curve was drawn up for the absorptiometer with chlorophyll solutions, the concentrations of which had been determined spectrophotometrically. The volume of suspension removed for counting purposes was too small to affect significantly readings obtained with the absorptiometer.

THE SEA ICE

The last of the sea ice formed during the 1955 season disappeared from Mawson on 25 January, 1956. From that date until the first ice began to form in the harbour about 14 March, this sector was free of fast ice and almost free of pack. Mainly because of an extended run of very windy periods, Mawson did not become fully ice-bound until relatively late in the 1956 season.

The surface of the harbour became ice-covered about 16 March and remained so throughout the season, but between 18 March and 22 May, six large breakouts occurred beyond the harbour mouth even though ice development was well advanced. On 4 May, when Station 2 was first established, the thickness of the new ice was 38 centimetres and must have been appreciably greater when it was carried away in the breakout of 13 May.

No further breakouts occurred after 22 May until the onset of the summer thaw and it was possible to keep a record of changes in thickness of the ice during that period. The measurements, which were made at a point near Station 2 until 17 November, are shown in Fig 2, together with thicknesses recorded towards the end of the season at Station 1.

The ice beyond the harbour reached a maximum thickness of 115 centimetres during September, gradually became thinner between mid-October and early December, and then deteriorated rapidly until its eventual breakout. It was not possible to reach Station 2 on foot after 17 December but the abrupt nature of the deterioration is shown clearly in the curve for the harbour ice, which in the three weeks between 17 December and 7 January, decreased in thickness by over 76 centimetres. It floated from the harbour on 16 January.

With the above summary as a background, it may be of interest to provide a fuller account of the characteristics of the sea ice not covered by the records of thickness.

Because of the strong winds, snow does not accumulate to any extent over the sea ice in the Mawson area. Snow depth usually does not exceed 5 centimetres. As early as August in 1956, many small areas had been entirely denuded of snow and by mid-October this erosion had spread to include the whole of Mawson harbour and much of the ice in the surrounding inter-island channels. It was noted that any snow retained temporarily after blizzards from September onwards was commonly moist and salty, indicating the presence of liquid brine in the fine pores of the underlying ice.

Towards the middle of October, it was noticed that the surface 15 centimetres of the sea ice was becoming slightly less dense and that sea-water was seeping up through the tide cracks in many places. Early in November, liquid brine appeared in small holes 30 centimetres deep dug for ice samples. It was realised that this was continuous, through fine pores in the ice, with the seawater beneath and represented a free water surface.

From this time onward, the deterioration of the ice became more and more rapid. Thawing in the tide crack zone was accelerated by tidal seepage and by the absorption of solar radiation by the adjacent rock. In addition to melting on the underside, the upper surface of the ice underwent marked ablation. On 19 December the lugs on the metal tube at Station 1, originally flush with the ice, were found to be 23 centimetres above the surface. Coincident with a decrease in thickness, the ice became increasingly porous and later became honeycombed with vertical holes.

From the end of the first week in December, pronounced thawing began to take place in a layer up to 15 centimetres or more in depth and several inches below the upper ice surface at the position of the free water level. This melting action spread rapidly, leaving a surface crust largely separated from the main body of ice below. The green colour of the sea became visible through the ice over many areas in mid-December and, by the end of the month, the separation of the ice from the shoreline was well advanced. Beyond the harbour, loose floes began to form, lanes of open water appeared and, by mid-January, the final breakout was imminent. Open water could be seen to the horizon on 26 January, 1957.

Unfrozen leads were seen from the air on a number of occasions during 1956. On 8 September, an extensive lane was reported 50 to 60 miles north of Mawson. Another was seen extending from Magnet Bay to Cape Ann in Enderby Land on 23 September and, during the same flight, small patches of open water were seen against the coastline west of Mawson. There were large areas of thin ice and open water in the Mackenzie Sea and Prydz Bay on 26 September. Further lanes were reported 40 to 60 miles north of the coastline west of Mawson on 10 October. Fast ice and dense pack was seen to extend 250 miles north of Mawson in a final reconnaisance flight made at the end of November.

HYDROLOGY

Water temperatures. The surface water temperatures recorded from Stations 1 and 2 are shown graphically in Figs. 3 and 4. They cover the period from 19.6.56 until 7.2.57. Although only two measurements were made at Station 2 after mid-December, it will be seen that the trends at both stations were very similar. During winter (1), the water temperatures remained consistently below —1.7°C. They rose sharply with the onset of summer to a brief period of maxima followed by a period of irregular but rapid declines towards the beginning of autumn. The data indicate an earlier rise in temperatures at Station 2 than in the harbour at Station 1 where interchange with outside water masses might be retarded. The general rise in the surface water temperature at Station 2 after 4 September, and before the rapid summer warming, began while the sea ice was thickest and was probably caused by the inflow of a new water mass. The rapid warming of the water at both stations with the onset of summer may be attributed almost entirely to solar radiation in situ. Temperature irregularities at Station 1 during and after the height of summer were associated with the final stages in the deterioration and ultimate breakout of the sea ice and with diurnal variations in solar radiation.

Variations in the temperature of the surface water during part of any 24-hour period were recorded on only two occasions; 15.11.56 and 19.1.57. These data are shown in Table 3. The maximum range in temperature of 0.05°C on 15.11.56 when the harbour ice was over four feet thick was barely significant compared with 0.55°C in open water on 19.1.57.

TABLE 3.

Daily variations in surface water temperature, Station 1.

Date: 15.11.56		Date: 19.1.57	
Time	Temp. (°C)	Time	Temp. (°C)
1100	—1.60	1000	—0.60
1200	—1.57	1100	—0.55
1300	—1.60	1200	—0.50
1400	—1.57	1400	—0.33
1500	—1.62	1500	—0.20
1600	—1.58	1600	—0.15
1700	—1.60	1700	—0.05
1800	—1.60		
1900	—1.60		
2000	—1.62		

Figs. 5 and 6 are profiles of temperature against time for Stations 1 and 2 respectively. Fig. 5 extends to 24 metres and Fig. 6 to 100 metres. Part of this information is summarised in Table 4. Only those surface water temperatures are included which were recorded during the fortnightly occupation of stations. The lowest, —2.20°C at 5 metres on 10.7.56, and highest temperatures, 0.95°C at surface on 23.12.56, for the

(1) In this and following discussions, winter refers to the period of the programme prior to 1 November, and summer to the period subsequent to that date.

year were both recorded at Station 1, giving an extreme range of 3.15 centigrade degrees (3.65 degrees if daily records be included). An examination of Table 4 will show that only the uppermost water layers were subject to appreciable variations in temperature and that most of the variation occurred during the summer period. The warmest temperatures during the summer were recorded close to the surface while the reverse, though less marked, was found during the winter months. The maximum difference between the mean temperatures for the summer and winter periods was only 1.55 centigrade degrees in the surface water at Station 1 and probably would have been less had it been possible to keep records for a full year.

TABLE 4.

Temperature means (°C) and ranges in temperature at various depths at Stations 1 and 2.

Depth (m.)	*Mean temp. (°C) June—Jan.*	*Extreme range*	*Mean Summer[1] temp. (°C)*	*Summer range*	*Mean Winter[2] temp. (°C)*	*Winter range*
STATION 1—						
0 ..	−1.25	2.95	−0.35	2.60	−1.90	0.30
5 ..	−1.50	2.15	−0.95	1.50	−1.90	0.50
10 ..	−1.65	1.45	−1.30	1.10	−1.80	0.35
15 ..	−1.55	1.45	−1.35	1.05	−1.85	0.25
20 ..	−1.65	0.90	−1.45	1.65	−1.80	0.15
24 ..	−1.60	0.70	−1.50	0.45	−1.80	0.15
STATION 2—						
0 ..	−1.45	2.60	−1.80	2.35	−1.85	0.20
10 ..	−1.65	0.80	−1.35	0.55	−1.80	0.15
25 ..	−1.65	0.30	−1.55	0.10	−1.70	0.20
50 ..	−1.55	0.25	−1.55	0.10	−1.65	0.20
75 ..	−1.60	0.30	−1.55	0.30	−1.60	0.10
100 ..	−1.60	0.45	−1.50	0.35	−1.60	0.15

[1] Summer—data obtained after 1 November.

[2] Winter —data obtained before 1 November.

Several features of the series of events illustrated in Figs. 5 and 6 are of interest. June, July, and to some extent August, were marked by lowering of temperatures in the surface layers under the influence of local climatic conditions. It can be seen that, at Station 2, the cooling effect extended well below the 50-metre level.

Although the mean air temperatures during August and September were lower than those for June and July, this did not result in a comparable drop in water temperatures. In fact, a slight rise was apparent, indicating the introduction of warmer water from other zones. Such introductions appeared to continue, with little influence exerted by local climatic conditions until the latter half of November, when the effects of increased solar radiation became apparent. At Station 1, it is clear that radiation caused significant increases in temperature throughout the water column. In the deeper water at Station 2, the effect was limited to the surface

40 metres. The relatively high temperatures recorded from 75 and 100 metres on 28.1.57 indicate the introduction of a further water mass and it is unfortunate that this development was not able to be traced.

Chlorinities. The trends in chlorinity at Stations 1 and 2 are shown in Figs. 7 and 8. Mid-winter was marked by the close and irregular apposition of waters highly variable in chlorinity. During the latter part of winter and early spring, a series of slightly less heterogeneous water masses were introduced from other zones. This frequent exchange, especially noticeable at Station 2, was terminated early in November by the introduction of a further system of relatively stable water which persisted throughout the summer, being modified in character only in the uppermost layers by the thawing of the sea ice. At the beginning of autumn when the programme was concluded, chlorinities throughout the system were slightly lowered.

Several features of the chlorinity data stand out for consideration, viz.; the remarkably low values commonly recorded both in summer and winter, the heterogeneity of the water systems during the winter and early spring, especially at Station 2, and the differences between the winter water at Station 1 and Station 2.

The low chlorinity of the uppermost layers of water during the summer period was brought about mainly by the rapid melting of the sea ice. A series of twenty measurements made between July and December 1956 on samples from the surface foot, excluding any snow, showed the chlorinity of the sea ice at Mawson to vary from 1.05 to 4.65‰. Since the ice was over four feet thick at the height of the season, the effect of its rapid melting will be readily apparent. Additional to this effect should be considered the influence of thaw water reaching the sea in appreciable quantities at this time of the year from the plateau ice close to the coastline and from the many icebergs in the region.

The chlorinity values recorded at both stations during the winter period exhibit certain features of interest. In the first instance, several of the values obtained at Station 2 (9.00‰ at 50 metres on 5.7.56; 9.60‰ at the surface on 16.7.56 and 13.50‰ at 75 metres on 30.7.56) are strongly suspect by normal standards. They have been placed on record partly because the reliability of the chlorinity meter could not be faulted at the time the determinations were made and partly because no faults could be traced to sampling technique. In addition, the values were associated to a varying degree with lowered values for dissolved phosphate and oxygen as well as decreased buffering capacity. pH and Eh did not appear to be affected. It has been felt justifiable to present these figures as tentatively valid but requiring confirmation.

Further, an examination of Figures 7 and 8 will show that the exceptionally low values already discussed are representative of a general condition in which the chlorinity of the water at both stations below the immediate surface was lower during the winter than in the summer.

Such characteristics, combined with depressed winter temperatures, produce conditions in which the liquid state is maintained in a water column, the freezing point of which has been exceeded.

In the absence of more extensive evidence, it is felt that only tentative suggestions should be made to explain the other features of the data listed above. Chlorinity and temperature values for the period February to June would be particularly illuminating, for the present figures seem to indicate the formation of a highly heterogeneous water system in autumn following the summer thaw and that some time is required before relative homogeneity is reached. It is possible that the mid-winter water sampled at Station 2 represents a final stage in the process of re-mixing and that this condition is not fully achieved until the introduction takes place of warmer, more saline water from other sources. The differences in chlorinity during winter between Station 1 and Station 2 seem to indicate that, for this part of the year at least, the stations were situated over different water systems. This does not seem unreasonable since the numerous islands in the area could well produce a complex and irregular current system.

It remains to explain the apparently anomalous low chlorinity values during the winter period. While admitting the need for confirmatory data, a probable solution is at once apparent. It has already been stated that considerable difficulty was experienced with plankton hauls because the nets normally became choked with ice in their passage from the bottom to the surface. From this, it may be inferred that the water below the surface was in the process of freezing and that the ice crystals formed were kept in suspension and disaggregated due to the general movement of the water mass. With a part of the water frozen out, the chlorinity of the remaining liquid phase would correspondingly rise to the point where further freezing would be averted. However, the chlorinity measured in the laboratory would be that of the liquid phase reduced by the melting of the solid phase, thus producing apparently unacceptable values. This process could have a greater effect on the chlorinity of the liquid phase during the winter than the formation of an ice layer at the surface.

It is also possible that the water could remain in a supercooled condition in which ice formation, except at the surface, does not take place until some foreign material such as a net is introduced as a centre of crystallisation. However, the nature and disposition of the ice in the plankton nets would hardly favour this view since the crystals so obtained showed no evidence of having been dependent on the net for their formation. Also, direct observation in the field pointed strongly to the presence of ice crystals at least in the surface layers of water visible to the eye. Typical instances of freezing conditions in the water columns have been illustrated in Figure 41A.

Density values for both stations have been presented in Figures 9 and 10. Their variability is pronounced and reflects the findings drawn separately from the temperature and chlorinity values from which they were derived.

Phosphates. The distribution of dissolved phosphates at Stations 1 and 2 is shown in Figures 11 and 12. At Station 1, the values ranged from zero to 1.81 μg. at./L and at Station 2 from zero to 1.7 μg. at./L. A certain degree of correspondence was found between phosphate level and chlorinity, notably during mid-winter and during and immediately following the main thaw period, as well as at Station 2 below 40 metres in the summer.

It should be noted that, whereas dissolved phosphate in excess of 1.61 μg. at./L was found in the surface 20 metres at Station 1, similar levels were recorded only below 40 metres at Station 2. The phosphate peaks at Station 1 occurred before the onset of summer and were only in part associated with peaks in chlorinity.

Oxygen. Unavoidable deviations from normal procedure in the taking of samples for the determination of dissolved oxygen have been described already and the need has been indicated, on these grounds, to treat the values obtained with caution. However, the values (Figures 13, 14) show a similar trend to those of chlorinity (Figures 7, 8). The argreement is rather closer for Station 2 than for Station 1, where the disturbing influence of biological agencies is more noticeable. In general, it will be seen that there was an inverse relationship between chlorinity and dissolved oxygen.

The highest values, 10.90 ml./L. at Station 1 and 12.90 ml./L. at Station 2, were obtained in the surface water at the height of the thaw. High values were also obtained in mid-winter. The lowest values at both stations, lying between 5.80 and 6.50 ml./L., occurred towards the latter part of the winter period and again, below the 15-20 metre level, during the summer. In general, the amounts of dissolved oxygen in the winter water were higher at Station 2 than at Station 1. To what extent biological activity influenced the levels of dissolved oxygen during the summer is discussed in a later section.

pH, buffer capacity and Eh. At Station 1, pH values were found to range from 6.87 to 8.62 and at Station 2 from 7.42 to 8.86. There was a general tendency at both stations for pH to increase slightly with depth. Apart from extreme values recorded close to the surface during the summer and in the surface 20 metres, particularly at Station 1, during mid-winter, the pH was found to remain comparatively stable.

Highly variable pH's were recorded at Station 1 (Fig. 15) during mid-winter, followed by a more regular period lasting until the onset of summer in which the pH showed an overall tendency to rise. With the beginning of summer, the pH, especially of the surface water, was affected markedly both by the thawing of the sea ice and by biological agencies. Two successive centres of influence may be recognized. The second coincided more closely with the thaw and, unlike the first, resulted in a sharp drop in pH which was most pronounced at the surface but still detectable at 24 metres. At the last week of sampling, the general rise in pH which was taking place prior to November and which was somewhat obscured by summer conditions could again be recognized.

As Station 2 was not sampled prior to July and could not be reached during the latter part of December and early January, there is no means of deciding whether the extremes of pH recorded at Station 1 at those times also occurred at this station. Otherwise the trends (Fig. 16) at both stations were rather similar although it should be noted that the pH's at Station 2 were rather lower than those at Station 1.

The buffer capacity values for Stations 1 and 2 given in Figures 17 and 18 are remarkably stable when considered in relation to the nature of the diverse water masses represented. Although extreme values for both stations lay in the range 0.48 to 2.35, it will be noted that this range may be placed within the limits 2.20 to 2.35 if the poorly-buffered summer surface water and, at Station 2, mid-winter water are not included.

Figures 19 and 20 indicate the trends in Eh that were observed at Stations 1 and 2. The values at Station 1 ranged from 320 to 440 mv. and at Station 2 from 310 to 440 mv. At both stations, the highest values were recorded during the winter period, although at Station 1, Eh's lower than 350 mv. were obtained during mid-winter and in excess of 400 mv. during the melting of the sea ice. Values lower than 350 mv. were also recorded in the surface layers during the thaw period at both stations. The close association at Station 1 during mid-winter and mid-summer of bodies of water having widely different Eh's should be noted.

Measurement of solar radiation. Figures 21 and 22 show the penetration of radiant energy into the surface 4.5 metres of water at Station 2 and the surface 10 metres at Station 1. It was not possible to take measurements below the undisturbed sea ice so that all readings represent penetration through an exposed water surface. It will be noted that zero readings were recorded immediately below the surface from the time the programme was commenced in mid-winter until the second half of September. Meteorological data from Mawson indicate that these conditions could be expected to have prevailed from the latter part of March. Therefore, it is clear that the absence of sea ice at the point measurements are taken is of no consequence during the winter period and it may be assumed that the amount of radiation penetrating the water at this time of the year is negligible.

During the period before the breakout of the sea ice, when positive radiation values were recorded immediately below the surface of the water and at depths down to nine metres, it is certain that lower values would have been obtained under natural conditions, i.e., with the sea ice undisturbed. Nevertheless, the striking qualitative differences between the summer and winter periods are immediately apparent. The series of readings obtained on 19 January, after the ice had left the harbour, ranged from 0.48 cal./cm.^{2}/min. immediately below the surface to 0.02 cal./cm.^{2}/min. at 10 metres. Approximately 90% of the radiant energy which penetrated the water surface was absorbed in the upper seven metres.

Figure 23 shows the radiant energy penetrating to various depths in the surface 10 metres at Station 1 between 1200 and 2200 hrs. on 12 December, 1956. The sea ice at this time was almost four feet thick. Maximum penetration occurred around 1300 hrs. when 0.03 cal./cm.^{2}/min. was recorded at 10 metres and 0.55 cal./cm.^{2}/min. immediately beneath the surface. At 2200 hrs., the highest value obtained was only 0.02 cal./cm.^{2}/min. immediately below the surface, falling almost to zero below 1 metre. Between 1200 and 1800 hrs., 90% of the radiation penetrating the surface was absorbed in the upper 5 metres and after 1800 hrs. in the upper 8 metres. The high proportion of daylight hours during the antarctic summer is reflected in the long daily period of subsurface illumination.

The significance of the radiation data will be discussed later in relation to the growth of the phytoplankton populations.

THE PLANKTON COMMUNITIES

List of phytoplankton species. In order to describe the plankton community as a whole and to indicate its principal elements, every effort has been made to identify as many as possible of the forms found in the catches. Nevertheless, it will be noted that a number of forms could not be determined specifically. Fortunately, most of these were rare in occurrence and of little or no ecological significance. However, several were of major importance and were examined with sufficient care to indicate that they may represent new species. Although a fully detailed systematic account of the phytoplankton has been avoided as beyond the scope of the present paper, brief descriptions of these species have been included, together with others in the list which could not be named satisfactorily. The descriptions, in simple alphabetical order, are given below.

Coscinodiscus sp. A (*Cestodiscus*). Valves disciform, punctate; the punctae arranged in radiating rows, only those rows corresponding with marginal ocelli reaching the centre of the valve, the 3 or 4 rows between each complete one variably shortened. Approximately 9 punctae in 10 μ along the rows. Margin free of punctae but marked with short, fine striae about 24 in 10 μ. Nine small ocelli evenly spaced about the margin, each one shaped like a rivet. Diameter of valve 50 μ.

Coscindiscus sp. B. Valves disciform, alveolate, the alveoles in radiating rows and of approximately the same size throughout the valve, 9 alveoli in 10 μ; some more heavily silicified than others, distributed in diagonal pattern over valve surface and 2-7 μ apart. Diameter of valve 55-60 μ.

Coscinodiscus sp. C. Valves disciform, alveolate, the polygonal alveoli in eccentric rows and decreasing in size towards the margin; non-fasciculate; margin not apiculate. Valves 20 μ in diameter.

Coscinodiscus pyrenoidophorus Karsten var. Differs from the form described by Karsten (1905) in having a triradiate, not circular, clear area at the centre of the valve.

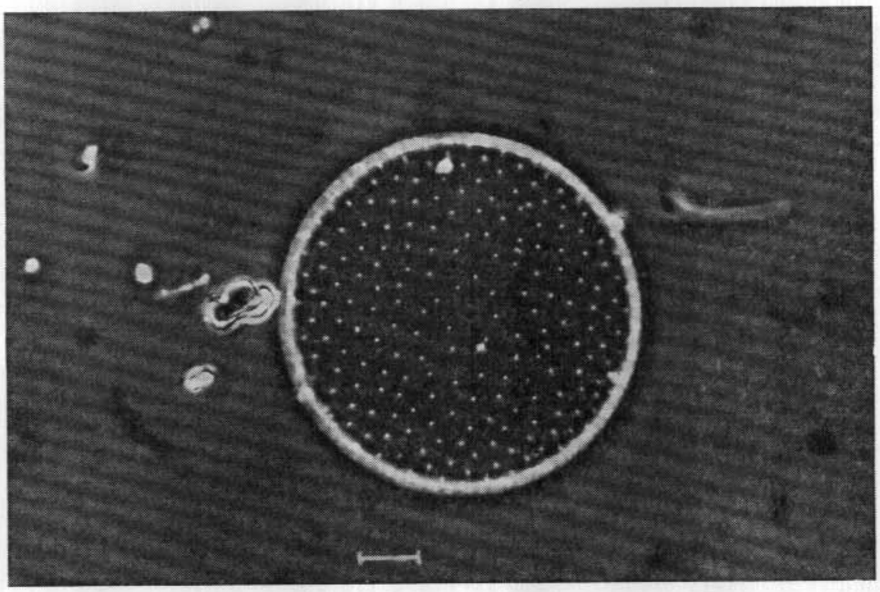

PLATE 6A—*Coscinosira* sp., scale line 10 μ.

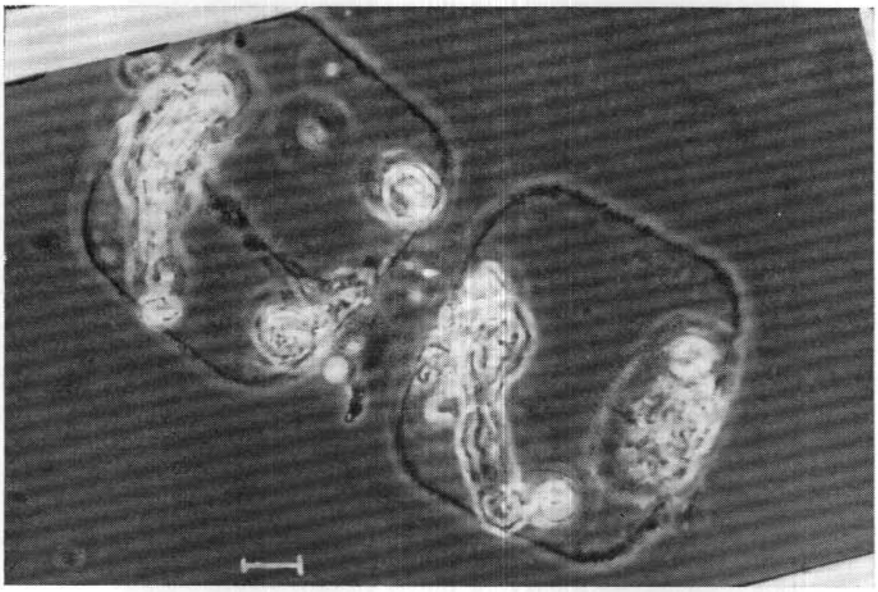

PLATE 6B—*Coscinosira* sp., scale line 10 μ.

Coscinosira sp. Valve surfaces slightly convex, more abruptly so at the margin, and bearing minute apiculae separated by intervals of 3-7 μ as well as faint, slightly irregular fine radial striae. No spinulae apparent. Cells form chains of varying length, the frustules joined by 6 or more slime strands. Diameter of valves 50-65 μ, approximately 50 μ across the girdle. (Plates 6*a* and *b*).

Hemiaulus sp. Processes tapering abruptly to rounded apices from the centre of which projects a short spine. A definite swelling apparent between the processes in the centre of the valve. Entire valvar surface bearing coarse punctae 1-2 μ in diameter and 1-2 μ apart.

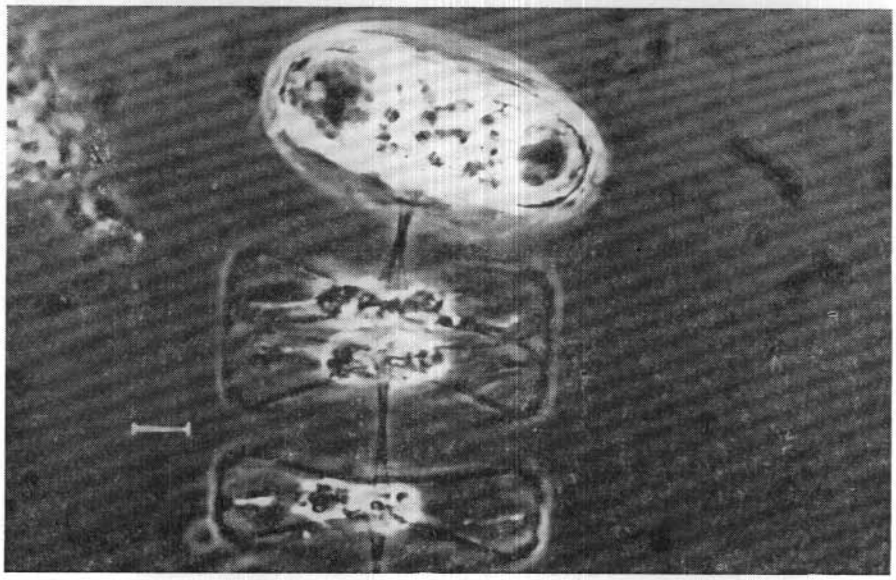

PLATE 7A—*Thalassiosira* sp., scale line 10 μ.

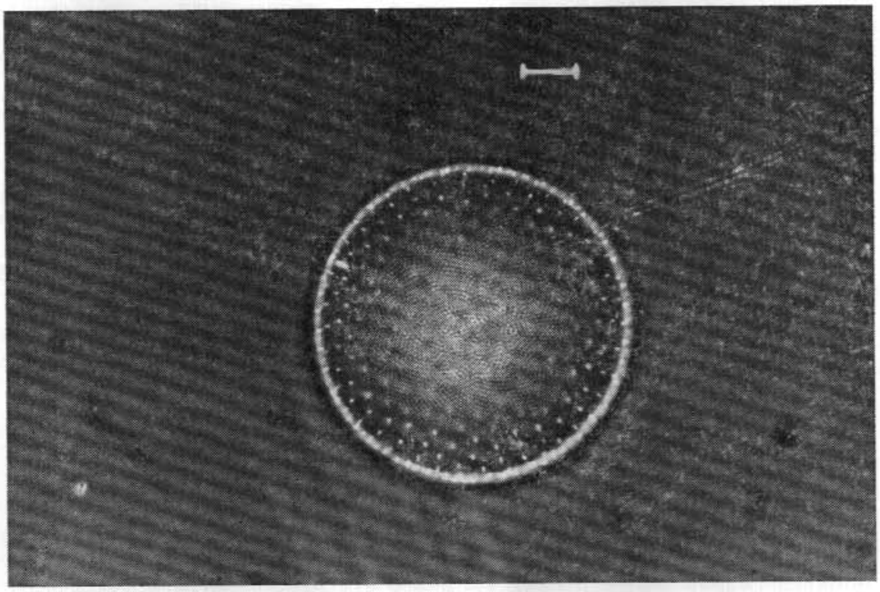

PLATE 7B—*Thalassiosira* sp., scale line 10 μ.

Thalassiosira sp. Frustules disciform, united to form chains of varying length. Valves concave and uniformly areolate. At regularly dispersed points 3-5 μ apart, individual areoles filled with skeletal material. Diameter of valves 50-60μ, pervalvar axis 20-25μ. (Plates 7*a* and *b*.)

Achnanthes sp. Valves elongate with parallel sides; lower valve with stauros; upper valve with raphe centric, straight; valve apices obtuse-rounded; median striae not shortened. Valves 35-50 μ long and 9-12 μ broad; 7-9 punctiform striae in 10 μ, approximately 4 punctae per stria.

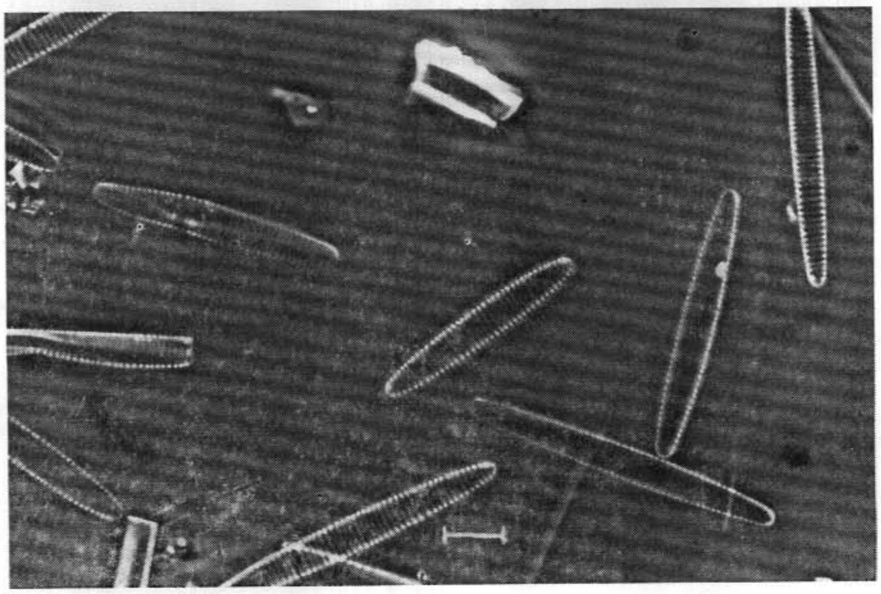

PLATE 8—*Fragilaria sublinearis* var A., scale line 10 μ.

Fragilaria sublinearis var. A. Frustules 55-60 μ long and 6-7 μ across the central section of the valve face. Generally similar to *F. sublinearis* V.H. and *F. sublinearis* V.H. var. *ambigua* Peragallo but less strongly silicified than the latter. Valves elongate elliptical with rounded apices; 9 striae in 10 μ. (Plate 8.)

F. sublinearis var. B. Frustules approximately 30 μ long and 10-12μ across the central section of the valve face. Similar to variety A but shorter and broader with parallel sides narrowing rather abruptly to bluntly pointed apices; 8 striae in 10 μ.

Gyrosigma sp. Striae rectangular, transverse striae more apparent than longitudinal; apices not rostrate; approximately 12 transverse and 12 longitudinal striae in 10 μ. Valves 160 μ long and 20 μ broad at the centre.

Navicula directa W.Sm. var. A. Differs from the type in having closer striation; 11 striae in 10 μ. 50-60 μ long and 7-8 μ broad at centre of valve.

N. directa W.Sm. var. B. Similar to the type species but narrowing slightly towards the median portion of the valve face; three pairs of median striae do not extend to raphe, 8 striae per 10 μ. Valves 120 μ long and 6-7 μ broad.

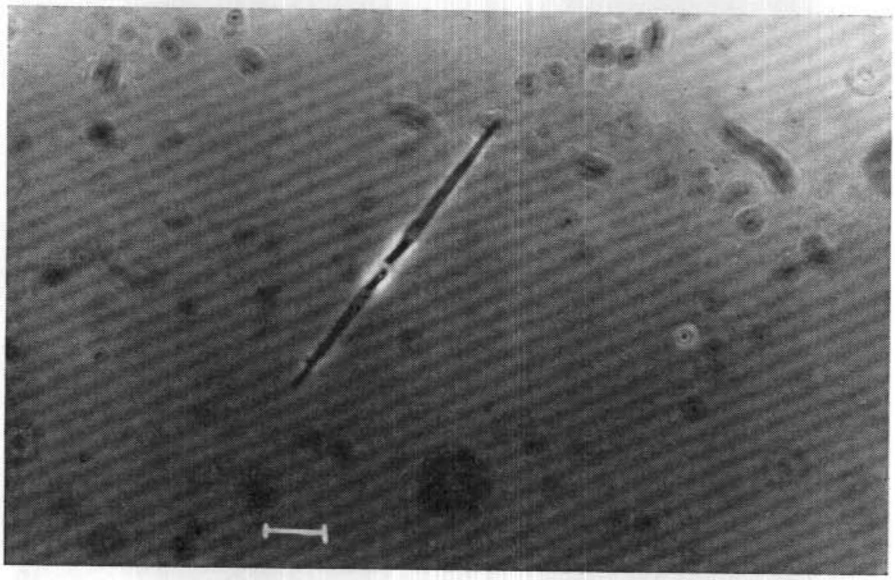

PLATE 9—*Nitzschia* sp. A, scale line 10 μ.

Nitzschia sp. A. Cells narrow, linear-lanceolate; apices acute, sometimes united by a slight overlap at the tips to form short chains, often solitary; structural details not discernible. Two chromatophores situated centrally. Frustules 60-70 μ long and 2-3 μ broad. Similar to *N. seriata* Cleve. (Plate 9.)

Nitzschia sp. B. Possibly a variety of the fresh water species *N. linearis* (Ag.) W. Sm. No inflexion perceptible in median portion of valve; 16 striae in 10μ, 12-13 carinal dots in 10 μ, two median carinal dots more distant than the others. Valves 110 μ long and 3 μ broad.

Nitzschia sp. C. Very similar to the fresh water species *N. subtilis* Grun. Valve 110 μ long and 8 μ broad; keel eccentric, 8 carinal dots in 10 μ the two median ones more distant than the others; striae very fine, more than 30 in 10 μ.

DIATOMALES

STATION	2	1	2	1	2	1	1	1	1	2	1	1	2	1	1
DATE	6.11.56	12.11.56	19.11.56	27.11.56	4.12.56	10.12.56	23.12.56	1.1.57	9.1.57	14.1.57	21.1.57	28.1.57	29.1.57	7.2.57	10.2.57
SPECIES:															
Asteromphalus Darwinii Eh.	×														
A. Hookeri Eh.						×		×			×				
Biddulphia aurita (Lyngbye) de Breb.								×			×	×	×		×
B. striata Karsten								×	×	×	**X**	**X**	**X**	**X**	**X**
Chaetoceros criophilum Castr.												×	×	×	×
C. debilis Cleve											×	×	×	×	×
C. dichaeta Eh.								×			×	×	×	×	×
C. dicladia Castr.													×		
C. Schimperianum Karsten								×		×	×	×	×		
C. sociale Lauder						×	×		×	×					
Charcotia bifrons (Castr.) Peragallo											×	×	×		×
Corethron criophilum Castr.	×	×	×	×		×		×			×	×	×	×	
Coscinodiscus centralis Eh.						×	×	×	**X**	**X**	**X**	×	×	×	×
C. sub-bulliens Jorgensen															
C. decipiens Grun.						×	×				×	×	×		
C. eradens var. *parvula* R.					×						×				
C. lineatus Eh.					×	×	×							×	
C. oculus iridis Eh.					×							×	×	×	×
C. pyrenoidophorus Karsten var. ?												×	×	×	×
C. sp. A new species?														×	
C. sp. B new species?												×	×		
C. sp. C new species?						×	×					×	×	×	
Coscinosira sp.	×	×	×	×		**X**	**X**	**X**	×	**X**	**X**	×	×	**X**	×
Eucampia balaustium Castr.								×	×	×	**X**	**X**	**X**	**X**	**X**
Hemiaulus sp.					×										
Melosira oamaruensis Gr. x St.								×				×	×		
M. omma Cleve					×	×		×				×	×	×	×
Rhizosolenia styliformis Brightwell												×	×	×	×
R. alata. v. truncata Karsten												**X**	**X**	×	×
Thalassiosira antarctica Karsten						×	×				×				
Thalassiosira sp.	×	×	×	×		×	×				**X**	×	×	×	**X**
Achnanthes sp.					×	×		×	×		×	×	×	×	×
Amphiprora striolata Grun.	×	×	×	×	×	×		×				×	×		
Amphora Bongrainii Peragallo								×		×	×	×	×		×
Cocconeis imperatrix A. Schmidt	×	×	×	×	×	×	×	×			×	×	×	×	×
Cocconeis magnifica Janisch												×	×		
C. costata (Greg.) Cleve	×	×													

X indicates most abundant or dominant species in each catch.

DIATOMALES—*continued*

STATION	2	1	2	1	2	1	1	1	1	2	1	1	2	1	1
DATE	6.11.56	12.11.56	19.11.56	27.11.56	4.12.56	10.12.56	23.12.56	1.1.57	9.1.57	14.1.57	21.1.57	28.1.57	29.1.57	7.2.57	10.2.57
SPECIES															
Diploneis crabro Eh...														X	
Fragilaria linearis Castr.												X	X	X	X
F. sublinearis V.H. var. A	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**	**X**	**X**
F. sublinearis var. *ambigua* Peragallo ..	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	X		X	**X**	**X**		**X**
F. sublinearis var. B					X		X	X			X	X	X	X	X
Fragilariopsis antarctica Castr.												X	X		
Gyrosigma sp.															
Licmophora abbreviata Ag.														X	
Navicula directa W. Sm. var. A								X	X	X		X	X	X	X
N. directa W. Sm. var. B												X	X		
Nitzschia dubia W. Sm. var. *australis* Perag.								X							
N. angularis W. Sm.								X							
N. angularis W. Sm. var. *affinis* Grun. ..							[illegible]								
N. seriata Cleve					X	X	[illegible]				X	X	X		
N. sp. A	X	X	X	X	X	X		X		X		X	X	X	
N. sp. B new species?							X				X	X	X	X	X
N. sp. C new species?	X	X	X	X								X	X	X	
N. bilobata W. Sm. var. *minor* Grun. ..													X		X
Scoresbya kempii Hendey														X	
Stauroneis crucicula W. Sm.								X			X	X	X	X	X
Synedra pelagica Hendey					X								X	X	X
S. ulna (Nitzsch) Eh.					X	X		X						X	X
S. ulna var. *amphirhynchus* Kg.								X			X				

DINOFLAGELLATA

STATION	2	1	2	1	2	1	1	1	1	2	1	1	2	1	1
DATE	6.11.56	12.11.56	19.11.56	27.11.56	4.12.56	12.10.56	23.12.56	1.1.57	9.1.57	14.1.57	21.1.57	28.1.57	29.1.57	7.2.57	10.2.57
SPECIES															
Peridinium depressum Bailey	X	X	X	X	X	X	X		**X**	X	X				X
P. oceanicum van Hoffen															X
SILICOFLAGELLATA															
Dictyocha gracilis Kutz.								X	X		X	X	X	X	X

X indicates most abundant or dominant species in each catch.

As is usual in antarctic waters, the diatoms dominated the phytoplankton, both in numbers and diversity of species. Altogether 26 genera of diatoms, including 56 species were found. Of these, 12 genera and 31 species represented the Centrales and 14 genera and 25 species the Pennales. Only one genus and two species of Dinoflagellata and one species of Silicoflagellata appeared in the catches.

Table 5 shows the distribution in the numbers of species found in from one to 15 catches. Seven species occurred in more than 10, 16 in from 5 to 10, and 33 in 5 or less of the hauls. Those species which were most widespread did not necessarily occur in abundance. Similarly, those species which achieved dominance were not always found to be widespread. *Cocconeis imperatrix* was found in 13 of 15 hauls, but was never found in large numbers, whereas *Rhizosolenia truncata,* which occured in only four hauls, was a dominant form in two of them.

TABLE 5.

Distribution of phytoplankton species found in from one to 15 catches.

Number of catches.	Distribution of species.	Number of catches.	Distribution of species.
15	—	7	3
14	2	6	5
13	2	5	7
12	1	4	9
11	2	3	3
10	2	2	6
9	2	1	10
8	3		

Those species which achieved dominance have been listed in Table 6. The number of hauls in which they were found and the number of hauls in which they were dominant have also been indicated. As cell counts of individual species were not undertaken, the designation of dominance was based on general microscopic observation to meet the aim of indicating those species in each haul which were most important. The number of dominant species in each haul varied from two to six. It is of interest that *Peridinium depressum* was sufficiently common in one haul to be classified as dominant. Of the dominants, the most important species were *Fragilaria sublinearis* var *ambigua* and *F. sublinearis* var. A (Plate 6.)

TABLE 6.

Dominant organisms in the phytoplankton.

Species.	Number of hauls in which species occurred.	Number of hauls in which species dominant.
Diatoms—		
Biddulphia striata	8	5
Coscinodiscus centralis	10	3
Eucampia balaustium	8	5
Rhizosolenia truncata	4	2
Fragilaria sublinearis var. A	14	14
F. sublinearis var. ambigua	13	11
Coscinosira sp.	14	6
Thalassiosira sp.	11	2
Dinoflagellates—		
Peridinium depressum	11	1

It may be seen from the list of species and their distribution that the qualitative diversity of the phytoplankton populations increased markedly from the beginning to the end of summer. There was no important qualitative difference between the populations at Station 1 and Station 2. The number of species found in the haul of 6.11.56 was 12. By 1.1.57, the number had increased to 26. There was then a drop between 9.1.57 and 14.1.57 to 10 and 11 species respectively, and this was followed by a rapid increase to a maximum 42 species on 29.1.57. Thirty-one species were found in the last haul of the series which was taken on 10.2.57.

The first plankton haul was run on 27.6.56 and was followed by others on 9.7, 30.7, 6.8, 13.8, and 20.8.56, but no living plant material was recovered. In order to save the nets from needless damage and to ensure their availability for the summer period, it was necessary to discontinue hauls during September and October. The first sign of phytoplankton was obtained in mid-September from the examination of the residues of water samples run through the continuous centrifuge. *Fragilaria sublinearis* var *ambigua, F. sublinearis* var. A, *Amphiprora striolata* and *Nitzschia* sp. A (Plate 9) were recognized, but it was not until the end of October that active growth began. At this time, net hauls were re-commenced. *Fragilaria sublinearis* var. *ambigua* and *F. sublinearis* var. A were clearly dominant until the beginning of December when *Coscinosira* sp. (Plate 6) also became abundant. These three forms dominated the populations until the end of the year. Early in January there was a strong outburst of *Coscinodiscus centralis,* accompanied by increased numbers of the dinoflagellate, *Peridinium depressum.* By mid-January, the numbers of C. *centralis* had decreased and dominance was shared between this species, *F. sublinearis* var. A. and *Coscinosira* sp. Towards the latter part of January, the complexity of the population increased markedly and the number of dominant species rose to six. Until the hauls were terminated, *F. sublinearis* var. A., *Eucampia balaustium* and *Biddulphia striata* made up a consistently dominant group, augmented at intervals by *Thalassiosira* sp. (Plate 7), *Coscinosira* sp., F. *sublinearis* var. *ambigua, Rhizosolenia truncata* or *C. centralis.* Many other of the listed species were present in considerable numbers but were less important than those mentioned above.

The examination of suspended matter extracted from sea water samples by continuous centrifugation has shown that the foregoing description of the character of the phytoplankton populations based on the material obtained in net hauls is not fully representative of conditions in the field. This is because a centrifuge, unlike a net, is able to remove practically all the living organisms in a given volume of water.

It should be indicated, therefore, that *Nitzschia* sp. A.,which was uncommon or rare in the net hauls was, in reality, between mid-September, 1956, and mid-January, 1957, the most abundant organism in the phytoplankton. During the latter part of January, it became associated with, and was finally exceeded in abundance by, another small pennate form which was not identified and was not found in the net hauls. This unidentified diatom was present in far greater numbers than the dominant species in netted material taken at the same time. It is also of interest to note that a *Chlamydomonas*-type alga was found in considerable numbers in the surface five metres during the height of the thaw period at Station 1 when the normal phytoplankton was restricted to the water below the 5-metre level. Whether these large populations of small phytoplankton organisms contribute more to the productivity of the area than the less numerous, but considerably larger, species making up the bulk of the net-caught material is not at present known.

The density of the phytoplankton populations. Cell counts were begun on 22.10.56 at Station 2 and 3.11.56 at Station 1 using a small fraction of the suspended matter extracted from sea water samples by continuous centrifugation. The results are shown in Tables 7 and 8 and Figures 24 and 25.

At Station 1, diatoms were first noticed in mid-September, but were not present in sufficient numbers to obtain reliable counts. In mid-November, the population varied from 0.1 x 10^6 to 0.4 x 10^6 cells/litre. After a slight drop around the end of November, it rose very rapidly to a recorded peak of 10.5 x 10^6 organisms/litre at 5 metres on 1 January. On this date, no phytoplankton was recorded in the uppermost layer where the chlorinity was only 0.62‰. Two centres of maximum density were apparent; one at 5 metres and the other at 15 metres. During January, the numbers dropped markedly and lay between 0.9 x 10^6 and 1.5 x 10^6 organisms/litre on the last day of sampling.

The populations in the surface 25 metres at Station 2 were generally lower than those at Station 1. However, it should be noted that, during the peak period at Station 1, Station 2 was not occupied. The last sampling at Station 2, which was a week later than that at Station 1, indicated a further increase in numbers in the surface 20 metres. Although the highest phytoplankton densities were recorded in the surface 25 metres, quite large populations occurred throughout the water column, especially in the latter part of January.

It will be clear from Tables 7 and 8 that the populations were made up almost entirely of diatoms. Late in the summer, dinoflagellates and silicoflagellates were sufficiently common to be counted, but were of comparatively minor importance. Of particular interest was the observed partial displacement of the normal diatom flora in the surface water at Station 1 in mid-December and its almost complete displacement by an assemblage of unidentified small green flagellates in the surface water at Station 2 in mid-January.

TABLE 7

Numbers of phytoplankton organisms/litre of sea water at Station 1 (× 10^{-6})

DATE ..	3.11.56	12.11.56	22.11.56	10.12.56		23.12.56	1.1.57	9.1.57		21.1.57		
Depth (m.)	*Diatoms*	*Diatoms*	*Diatoms*	*Diatoms*	*Chlamydomonas*	*Diatoms*	*Diatoms*	*Diatoms*	*Dino-flagellates*	*Diatoms*	*Dino-flagellates*	*Silico-flagellates*
0 ..	0.096	0.117	0.086	0.089	0.240	1.018	..	0.510	0.009	0.883	0.004	..
5 ..		0.163	0.097	0.394	0.009	5.120	10.493	1.421	0.020	1.188	0.008	0.001
10 ..		0.229	0.130	0.791		3.979	6.408			0.864	0.043	..
15 ..		0.394	0.191	0.852		2.771	8.216			1.348	0.004	..
20 ..		0.216	0.156	0.705		1.368	2.790			1.191	0.003	0.001
24 ..		0.206	0.130	0.497		1.075	1.660			1.547	0.001	..

TABLE 8

Numbers of phytoplankton organisms/litre of sea water at Station 2 (× 10^{-6})

DATE	22.10.56	6.11.56	19.11.56	4.12.56	17.12.56	14.1.57			28.1.57		
Depth (m.)	*Diatoms*	*Diatoms*	*Diatoms*	*Diatoms*	*Diatoms*	*Diatoms*	*Green flagellates*	*Dino-flagellates*	*Diatoms*	*Dino-flagellates*	*Silico-flagellates*
0	0.048	0.064	0.103	0.654	0.066	0.007	0.118	..	2.036	..	..
10	0.064	0.079	0.130	0.193	0.852	0.956	..	0.003	2.455	..	0.003
25	0.068	0.052	0.109	0.139	0.400	0.600	..	..	1.639	0.003	0.003
50	0.043	0.021	0.077	0.217	0.137	0.634	..	..	1.502	0.001	0.004
75	0.057	0.013	0.043	0.137	0.061	0.257	..	..	1.455	..	0.003
100	0.004	..	0.004	0.022	0.035	0.106	..	..	1.195	0.001	0.003

Chlorophyll estimations. The chlorophyll content of the phytoplankton at Stations 1 and 2, expressed in mg./m.^{3} of sea water, is shown in Figures 26 and 27. Positive values were not obtained until after 12.11.56 at Station 1 and after 19.11.56 at Station 2 as the volumes of water extracted were insufficiently large to enable detection of the small concentrations of chlorophyll present prior to these dates. The highest concentration of chlorophyll at Station 1 were reached during the latter part of December with a maximum 3.92 mg./m.^{3} at the 5-metre level. Towards the end of December and in January, the chlorophyll content of the surface 5 metres dropped markedly and the highest values were then recorded at depths between 10 and 20 metres.

Although a general correlation was evident at Station 1 between cell counts of phytoplankton and chlorophyll concentration, an examination of Figures 24 and 26 will show that, during the period of peak growth, maximum production of chlorophyll preceded maximum numbers of phytoplankton by approximately one week. Similar, though less marked, relationships were apparent at Station 2. The chlorophyll concentrations were generally lower than at Station 1, but this cannot be taken to indicate the absence of a high peak period, since Station 2 could not be reached between mid-December and mid-January. It is of interest that high chlorophyll values were recorded in the 75 to 100-metre zone at the end of January and that the phytoplankton at these depths, although lower in numbers than the surface population, contained larger amounts of chlorophyll.

It is apparent that an invariably close relationship should not be expected between cell count and concentration of photosynthetic pigment. The degree of correlation will be affected by such factors as general hydrological conditions, as well as stage of growth and species composition of the population.

List of zooplankton species. For reasons already given in introducing the species of phytoplankton, full identification of all the members of the zooplankton has not been possible. The following list includes organisms captured in net hauls as well as those extracted from the water by centrifugation. Pressure of other work prevented the writer from paying the smaller protozoa any more than passing attention, although they often occurred in very large numbers. As mounted and stained preparations could not be made, their identification will depend upon future work in the field.

PROTOZOA

Flagellata (Mastigophora) (The organisms below have been included with the protozoa, rather than with the algae, to make clear that they were not found to contain chlorophyll.)

Chrysomonadina

Coccolithophoridae

Protomonadina

Bodonidae

Bodo sp. (Type " c " flagellate of Tables 9 and 10). 7.5 μ in length and 6 μ broad.

Bodo sp. (Type " d " flagellate of Tables 9 and 10). 5 μ in diameter, with relatively long trailing flagellum.

Monadidae

?*Monas* sp. (Type " a " flagellate of Tables 9 and 10). Spherical, colourless, 4.7 μ diameter.

?*Monas* sp. (Type " b " flagellate of Tables 9 and 10.) Subspherical, with granular protoplast, 12-17 μ diameter.

Rhizomastigina

Mastigamoebidae

?*Mastigamoeba* sp. (Type " e " flagellate of Tables 9 and 10.) Amoeboid flagellate with coarsely granulate protoplast, 5-6 μ diameter.

Ciliophora

Oligotricha

Tintinnidae

Cymatocylis ecaudata (Ficrentini)

Laackmaniella prolongata Laak.

Hypotricha (several species).

COELENTERATA

Siphonophora

CTENOPHORA

Cydippidae

CHAETOGNATHA

Sagitta gazellae Ritter—Zahony.

Eukrohnia hamata Mobius.

ANNELIDA

Polychaeta. This group was represented by larval worms.

ARTHROPODA

Crustacea

Calanoida

Calanus simillimus Giesebrecht.

Calanoides acutus Giesebrecht.
Ctenocalanus vanus Giesebrecht.
Metridia Gerlachei Giesebrecht.
Paralabidocera antarctica I. C. Thompson.
Scolecothricella glacialis Giesebrecht.
Valdiviella insignis? Farran.

Cyclopoida

Oncaea curvata Giesebrecht.
Oithona similis Claus.

Harpacticoida

Harpacticus chelifer Müller.

Amphipoda (Several species).

Malacostraca

Euphausidacea

Euphausia crystallorophias Holt and Tattersall.

CHORDATA

Tunicata

Salpa fusiformis Cuvier.
Fritillaria sp.

THE ZOOPLANKTON COMMUNITIES

For convenience in presentation, the account of the zooplankton has been divided into three sections. The first will describe the assemblage of organisms extracted from the water by centrifugation; the second, those organisms captured by the N50 net but too small to be retained by the N70; and the third, the larger planktonic animals caught with the N70.

PROTOZOA

Tables 9 and 10 summarise all the data gathered in relation to the protozoan plankton extracted from sea water samples by continuous centrifugation. Where possible, the numbers of organisms (x 10^{-6}) have been included. In cases where the organisms were not sufficiently abundant to be counted, their presence has been indicated with a cross (x). The types of protozoan comprising each count have also been indicated. Figures 28 and 29 show the distribution of population densities for comparison with hydrological and phytoplankton data similarly presented.

Seven groups of protozoa were recognised in the centrifuge extracts, each exhibiting a distinctive distribution pattern through the period of the programme. The variation in abundance from group to group was outstanding. In several respects, the findings at both stations were similar, although protozoa were not found until late August at Station 1, whereas they appeared at Station 2 from the first date of sampling.

TABLE 9

THE PROTOZOA EXTRACTED BY CENTRIFUGATION FROM WATER SAMPLES AT STATION 1

(counts × 10^{-6})

The following listed in table in order of abundance in each sample:

1. Type "a" flagellate ?*Monas* sp.
2. ,, "b" ,, ?*Monas* sp.
3. ,, "c" ,, *Bodo* sp.
4. ,, "d" ,, *Bodo* sp.
5. ,, "e" ,, ?*Mastigamoeba* sp.
6. Free-swimming ciliata
7. Coccolithophoridae

Depth (*m.*)	DATE												
	22.8.56	5.9.56	17.9.56	2.10.56	16.10.56	3.11.56	12.11.56	27.11.56	10.12.56	23.12.56	1.1.57	9.1.57	21.1.57
0	X^{3}	..	X^{3}	X^{3}	X^{3,6}	0.004^{3,6}	0.009^{3,6}	0.338^{6,3,4}	21.444^{1,2}	7,826^{1,2}	..	0.112^{4,3}	0.063^{3}
5	X^{3,7}	X^{3}	X^{3}	X^{3}	X^{4}		0.017^{3}	0.034^{6,3}	..	..	X^{3}	..	0.018^{3}
10	X^{3}	..	..	X^{3}	X^{6}		0.004^{3}	0.017^{6,3}	..	..	..		17,311^{5}
15	X^{3,7}	..	..	X^{3}	X^{3}		0.009^{3}	..	..	..	X^{3}		22,534^{5}
20	X^{3,7}	..	..	X^{3}	X^{3}		0.022^{3}	0.009^{3}	0.004^{3}	..	X^{3}		13,433^{5}
24	X^{3}	..	..	X^{3}	X^{3}		0.021^{3}	..	0.004^{4}	X^{3}	X^{3}		15,828^{5}

TABLE 10

THE PROTOZOA EXTRACTED BY CENTRIFUGATION FROM WATER SAMPLES AT STATION 2

(counts × 10^{-6})

Depth (*m.*)	DATE														
	6.7.56	17.7.56	31.7.56	14.8.56	28.8.56	11.9.56	25.9.56	9.10.56	22.10.56	6.11.56	19.11.56	4.12.56	17.12.56	14.1.57	28.1.57
0 ..	..	..	..	..	..	..	X^{3}	..	0.022^{3}	0.076^{3}	0.023^{3}	0.008^{4}	21,964^{1,2}	0.128^{1,2}	1.138^{5,3}
10 ..	..	..	..	..	X^{3}	..	X^{3}	..	0.026^{3}	0.129^{3}	0.004^{3}	0.017^{3,4}	X^{6}	..	1.171^{5,3}
25 ..	X^{7}	X^{7}	X^{7}	..	..	X^{7}	X^{3}	..	0.009^{3}	0.004^{3}	..	..	0.009^{3}	0.009^{3}	0.672^{5,3}
50 ..	X^{7}	X^{7}	X^{7}	..	X^{3}	X^{7}	X^{3}	X^{3}	0.004^{3}	..	..	..	..	..	0.452^{5,3}
75 ..	..	..	..	..	..	..	X^{3}	..	0.039^{3}	..	..	0.009^{3}	0.004^{3}	..	0.493^{5,3}
100 ..	..	..	..	..	..	..	X^{3}	X^{3}	0.004^{3}	..	0.009^{3}	0.013^{3}	0.009^{3}	..	0.016^{3}

At Station 2, Coccolithophores were found in very large numbers between 25 and 50 metres during July and again towards the middle of September, but not at any other time. They were recorded at Station 1 between 5 and 20 metres only on 22.8.56. Type " c " flagellates, probably Bodonids, first appeared in the extracts on 22.8.56 at Station 1 and during the following week at Station 2, after which they were recorded sporadically at all depths in numbers as high as 0.076 x 10^6/litre until the conclusion of the programme.

Types " a " and " b " flagellates were found only close to the surface between 10.12.56 and 23.12.56 at Station 1 and 17.12.56 and 14.1.57 at Station 2, but were present in numbers reaching almost 22 x 10^6/litre. Type " d " flagellates were noted only rarely and never occurred in any numbers.

Free-swimming ciliates were found during November at Station 1 in the surface 10 metres where they formed the bulk of the protozoan population. A single ciliate was found in the 10-metre sample from Station 2 on 17.12.56.

Type " c " flagellates were recorded only in the latter part of January between 75 metres and the surface, but were present in very large numbers, especially at Station 1.

The Tintinnids, *Cymatocylis ecaudata* and *Laackmaniella prolongata* occurred as relatively minor constituents in N50 net hauls at both stations from the end of December until the programme was concluded on 10.2.57. The former species was the commoner of the two. These organisms were found rarely in the centrifuge extracts.

The numbers and distribution of the various groups of zooplankton organisms caught with the N70 net are shown in Table 10 and Figures 30-32. As volumes were generally too small to be determined with accuracy, dependence has been placed on counts to indicate the size of the catches. Prior to 4.12.56, it was necessary to use a 50-cm ring with the N70 net. The counts obtained for catches during that period have therefore been adjusted to make them comparable with counts of later vertical hauls.

COELENTERATA

Isolated siphonophores were found only occasionally but, from their distribution, are propably present throughout the year. Ctenophores were first recorded in small numbers early in December at Station 2. Late in January and early in February, 1957, they were more common and, from observations made on arrival at Mawson in 1956, would have been recorded in greatest abundance later in February. Those in the catches suffered too much damage to be counted.

CHAETOGNATHA

Only two chatognathous worms were taken, at Station 2 early in December, 1956.

POLYCHAETA

It was not until mid-January 1957 that members of this group, in the form of larvae, were obtained in the hauls, after which they were found as a significant proportion of the population in every haul until the programme closed.

CRUSTACEA

Copepoda. This group largely dominated the zooplankton during the period of the investigations. With few exceptions, copepods were taken in greater or lesser numbers in every plankton haul. It is of interest to note that large populations occurred at both stations during the mid-winter period. At Station 1, numbers remained low from July until the latter part of December, after which the populations generally became larger with peaks in early January and early February. Of the two horizontal tows run consecutively on 8.1.57, that in which the net was kept at the surface returned much greater numbers than that run 1 metre below the surface. The horizontal tow of 19.1.57 was less successful than the accompanying vertical because of the high concentration of diatoms in the surface layers and the scattered distribution of the zooplankton throughout the water column. At Station 2, in addition to the mid-winter peak, smaller peaks were recorded early in September, in late October and early December. A marked increase was detected with a horizontal haul on 8.1.57 but its magnitude cannot be compared with previous data because a vertical haul was not possible at the time.

Altogether, 10 genera and 11 species of copepod were identified. Nine species were found at each station. *Calanus simillimus* and *Harpacticus chelifer?* were not found at Station 2 while *Metridia Andraena* and *Valdiviella insignis?* were not found at Station 1. None of these species formed important components of the hauls.

Tables 12 and 13 show the distribution of species at both stations. No more than 5 species occurred in any one haul at Station 1 and no more than 6 in any one haul at Station 2. At Station 1, during mid-winter *Scolecothricella glacialis* was dominant. From August onward, no one species was of particular importance until *Oncaea curvata* appeared and became dominant in the latter part of November. This species was displaced briefly by *Paralabidocera antarctica* early in January and later, in February, with the return of *Scolecothricella glacialis*.

At Station 2, *Scolecothricella glacialis* was an occasional dominant between July and September. From the latter part of October until early December, *Oncaea curvata* was dominant. Only *Paralabidocera antarctica*

TABLE 11

NUMBERS AND DISTRIBUTION OF ZOOPLANKTON ORGANISMS AT STATIONS 1 AND 2 BETWEEN 1.5.56 AND 10.2.57

(Five minute horizontal hauls in heavy type)

(X indicates numbers not recorded)

NUMBER OF ORGANISMS

Date	Time (hrs.)	Tintinnids	Siphon-ophora	Cteno-phora	Chaetog-natha	Polychaeta	Copepoda	Amphipoda	Euphausid-acea	Tunicata
Station 1										
1.5.56	1400						..	1		1
27.6.56	1330						1,650			
9.7.56	1330						56			
6.8.56	1415						..			
17.9.56	1400						34	72		
1.10.56	1430						4			
15.10.56	1415						6			
12.11.56	1415						60	4		
27.11.56	1630						42	4		
10.12.56	1345						19	28		
23.12.56	1100	X					155	15		
1.1.57	1430	X	1				112	9		
8.1.57	**1910**	X					18,200	10		
8.1.57	1920	X					8,250	3		
19.1.57	**1315**						135			
19.1.57	1330					80	370	3	320	
21.1.57	1445	X				40	310		80	
21.1.57	**1915**	X				30	660	10	240	
28.1.57	1335	X				20	130			
7.2.57	1910	X	1			100	4,460		1,090	80
10.2.57	1345	X		X		50	5,600	2	2,600	80
Station 2										
4.7.56	1430						3,360			
16.7.56	1400						114			
30.7.56	1400						16			
13.8.56	1200		1				88	4		
10.9.56	1130		1				236	2		
24.9.56	1130									
9.10.56	1200									
22.10.56	1430						232			
6.11.56	1430		1				78	10		
19.11.56	1445						26			
4.12.56	1445		1	X	2		245			
8.1.57	**2000**						50,900			
14.1.57	**2030**	X					1,150			
29.1.57	**1925**	X		X		45	280		35	

was recovered from the horizontal hauls of January. It should be noted that, whereas *Oncaea curvata* was found at Station 2 throughout the winter period, this species did not appear at Station 1 until November. Apart from a record on 27.6.56, the same finding applies to *Calanoides acutus* which was not recovered at Station 1 until mid-January. This species was always found in the immature condition. *Scolecothricella glacialis* was immature at both stations during summer and adult during the winter.

Amphipoda. At Station 1, amphipods were captured mainly in small numbers at intervals throughout the programme but most consistently between mid-November and early January. An isolated peak was recorded in mid-September and a lesser one early in December. Members of this group occurred less frequently at Station 2 although the species appeared to be the same as those at Station 1.

Euphausidacea. Only one species, *Euphasia crystallorophias,* in immature stages of development was found in the hauls. Calyptopis stages were recorded first at Station 1 in mid-January in a vertical haul, but not in a horizontal haul carried out immediately beforehand. The species was present in both vertical and horizontal hauls several days later. It was not found at Station 1 at the end of January but furcilia stages were found at Station 2 at this time. Both calyptopis and furcilia stages were recovered in early February at Station 1, when they approached the copepods in abundance.

TUNICATA

Salpa fusiformis was recovered in only one haul: 1.5.56. However, it was frequently noticed in the surface water late in February and during the first formation of the sea ice in March, 1956, before the programme had been commenced.

Fritillaria sp. was found making up a small proportion of the two catches carried out at Station 1 early in February 1957.

MARINE BACTERIA

Motile, rod-shaped bacteria were recorded on a number of occasions in centrifuge extracts in water samples in Stations 1 and 2. These observations are summarised in Table 14. Bacteria noted during and prior to September did not appear to be associated particularly with any other group in the plankton but those noted subsequent to September were consistently associated with the larger populations of protozoa.

TABLE 12

DISTRIBUTION OF COPEPOD SPECIES AT STATION 1

(Bold crosses indicate the most abundant species in each haul)

Date	*Calanus simillimus*	*Calanoides acutus*	*Ctenocalanus vanus*	*Metridia Gerlachei*	*Metridia Andraeana*	*Paralabidocera antarctica*	*Scolecothricella glacialis*	*Valdiviella insignis*	*Oncaea curvata*	*Oithona similis*	*Harpacticus chelifer*
27.6.56	×	×					**×**			×	
9.7.56							**×**			×	
6.8.56											
17.9.56			×				×			×	
1.10.56										×	
15.10.56			×							×	
12.11.56									×	×	
27.11.56							×		**×**	×	
10.12.56						×			**×**		
23.12.56									**×**	×	
1.1.57				×					**×**		
8.1.57						**×**					
19.1.57		×		×		×			**×**	×	
21.1.57		×				×	×		**×**	×	×
28.1.57		×					×		**×**	×	
7.2.57		×					**×**		×	×	
10.2.57		×					**×**		×		

TABLE 13

DISTRIBUTION OF COPEPOD SPECIES AT STATION 2

(Bold crosses indicate the most abundant species in each haul)

Date	*Calanus simillimus*	*Calanoides acutus*	*Ctenocalanus vanus*	*Metridia Gerlachei*	*Metridia Andraeana*	*Paralabidocera antarctica*	*Scolecothricella glacialis*	*Valdiviella insignis*	*Oncaea curvata*	*Oithona similis*	*Harpacticus chelifer*
4.7.56		×		×			**×**	×	×	×	
16.7.56		×		×	×		×		×		
30.7.56							**×**		×		
13.8.56		×			×		×		×	×	
10.9.56		×					**×**		×	×	
24.9.56											
9.10.56											
22.10.56		×	×	×					**×**	×	
6.11.56		×		×					**×**		
19.11.56									**×**		
4.12.56		×				×	×		**×**	×	
8.1.57						**×**					
14.1.57						**×**					
29.1.57						**×**					

TABLE 14

BACTERIA IN SEA WATER FROM STATIONS 1 AND 2

Station 1

Depth (*m.*)	5.9.56	28.11.56	10.12.56	23.12.56	21.1.57
0		X	X	X	X
5	X	X			X
10					X
15	X				X
20					X
24					X

Station 2

Depth (*m.*)	14.8.56	25.9.56	17.12.56	29.1.57
0		X	X	X
5				
10				
15				
20				
24				
50	X			

DISCUSSION

Hydrological conditions during the summer and winter periods. The hydrological data for Stations 1 and 2 have been summarised in Tables 15 and 16 to indicate the principal differences and similarities both between stations and between the summer and winter periods. Figures 33 to 40 show the same results diagrammatically. The period June to October, inclusive, has been designated winter and from November, when air temperatures rose sharply, to the completion of the programme, summer.

Temperature trends were similar at both stations with warmer conditions prevailing throughout the water column during the summer. The greatest extremes occurred in the surface 25 metres. In the winter the warmest water was close to the bottom, whilst in the summer highest temperatures were recorded at the surface. The mean temperatures were consistently below 0°C.

It was apparent that the influence of local climatic conditions was largely responsible for temperature fluctuations in the surface 25 metres. At greater depths, it seems likely that a significant part of the summer rise in temperature was due to the presence of warmer waters introduced from other zones. In this connection, it should be noted that the summer water at 75 to 100 metres at Station 2 was higher in temperature than that in the 25- to 50-metre layer above. As would be expected, local conditions had a slightly more marked effect on the water at Station 1 which was close inshore than at Station 2 which was in deeper water and rather more subject to outside influences.

With the exception of the water immediately below the surface, the chlorinity of the summer water at Station 1 was higher than that at Station 2 (Fig. 34). A higher mean figure for the surface water was probably obtained at Station 2 because this station was inaccessible at the height of the thaw period when exceptionally low chlorinities occurred.

The chlorinity of the winter water was considerably lower at Station 2 than at Station 1 and the relative homogeneity of the below surface summer water was not apparent during the winter. At Station 1 the chlorinity increased down to 5 metres, was comparatively stable between 5 and 15 metres, increased to 20 metres and was again stable below this depth. A fairly uniform increase was evident to a maximum 16.86‰ at Station 2, falling away to 16.32‰ at 50 metres and then increasing again to 17.29‰ at 100 metres.

The increase in chlorinity of the winter water with depth in the surface 20 to 25 metres (Fig. 34) as well as the decrease in chlorinity around 50 metres at Station 2 probably represents the existence of sinking and mixing processes following the formation of relatively dense water at the surface associated with sea ice accumulation. Subsurface formation of ice crystals, if confirmed, would also influence the chlorinity

TABLE 15.

Summarised Hydrological Data for Station 1.

Depth. M.	Temp. (°C)		Chloriuity (‰)		Salinity (‰)		σt		Oxygen (ml./L.)		% O_2 satn.		pH		Buffer capacity		PO_4 (μg. at. L.)		PO_4/Cl		Eh (mv.)	
	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
0	−0.35	−1.16	12.29	18.10	22.21	32.70	20.01	26.34	8.91	8.13	103.8	96.7	7.82	7.64	1.694	2.267	0.65	1.42	1.6	2.4	357	407
5	−0.95	−1.60	18.84	18.53	34.04	33.48	27.38	26.95	8.51	7.72	105.0	92.3	8.01	7.83	2.337	2.304	1.23	1.45	2.0	2.4	355	393
10	−1.30	−1.80	18.92	18.55	34.18	33.51	27.51	27.00	7.99	7.66	97.8	91.9	8.04	7.98	2.340	2.321	1.23	1.42	2.0	2.4	357	385
15	−1.35	−1.85	18.94	18.56	34.22	33.53	27.54	27.01	7.78	7.67	95.0	91.9	8.04	8.02	2.340	2.322	1.29	1.42	2.1	2.4	361	388
20	−1.45	−1.80	18.83	18.70	34.20	33.78	27.54	27.21	7.22	7.12	88.6	86.5	8.06	8.08	2.341	2.333	1.42	1.55	2.3	2.6	360	390
24	−1.50	−1.80	18.95	18.69	34.23	33.77	27.56	27.19	7.32	7.12	89.1	85.7	8.05	8.08	2.340	2.332	1.45	1.58	2.4	2.6	362	400

S=Summer means (November to January inclusive).
W=Winter means (June to October inclusive).

TALBE 16.

Summarised Hydrological Data for Station 2.

Depth M.	Temp. (°C)		Chlorinity (‰)		Salinity (‰)		σt		Oxygen (ml./L.)		% O_2 satn.		pH		Buffer capacity		PO_4 (μg. at. L.)		PO_4/Cl		Eh (mv.)	
	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
0	−0.71	−1.84	14.83	15.97	26.80	28.86	21.55	23.21	9.82	9.10	115.4	107.1	8.07	7.65	2.032	2.164	1.00	1.19	2.1	2.3	346	416
10	−1.36	−1.81	18.70	16.68	33.78	30.14	27.19	24.21	8.12	9.01	98.9	105.3	7.94	7.79	2.330	2.130	1.42	1.32	2.4	2.5	360	405
25	−1.56	−1.71	18.80	16.86	33.96	30.46	27.31	24.95	7.40	8.53	89.5	98.1	7.95	7.88	2.335	2.192	1.45	1.29	2.4	2.4	362	397
50	−1.57	−1.65	18.82	16.32	34.00	29.49	27.44	23.73	7.28	8.14	88.3	95.2	7.96	7.91	2.335	2.180	1.55	1.19	2.6	2.3	365	397
75	−1.52	−1.61	18.81	17.03	33.98	30.77	27.36	24.76	7.07	7.67	85.4	89.8	7.98	7.98	2.336	2.226	1.61	1.55	2.7	2.8	365	396
100	−1.50	−1.63	18.87	17.29	34.09	31.24	27.45	25.15	7.09	8.26	86.2	97.9	7.98	7.96	2.337	2.204	1.61	1.48	2.7	2.7	366	395

S=Summer means (November to January inclusive).
W=Winter means (June to October inclusive).

profile as the ice tended to float to the surface away from its centre of formation.

That freezing conditions may exist well below the surface is shown clearly in Figures 41 and 41A relating temperatures and chlorinity. Figure 41 includes mean values for the summer and winter periods whilst Figure 41A contains data obtained on specific sampling dates in June and July. The mean winter values show that the surface 5 to 10 metres at Station 1 and the surface 50 metres at Station 2 were exposed to freezing conditions while particular values indicate that similar conditions may extend to 100 metres, largely dependent upon the prevailing chlorinity of the water column.

At both stations with the exception of a shallow surface layer, chlorinities were higher during the summer than in the winter. This condition was most marked at Station 2 and is of particular interest since it is contrary to the findings of Deacon (1937). In the absence of fuller data from Mawson and from other areas in close proximity to the Antarctic coastline, the present observations must be treated with reserve. Nevertheless they suggest processes bringing about the return of imperfectly mixed late summer waters to the coastline during winter and replacement by warmer, more saline water in the summer period.

It would be of considerable interest to know whether such processes operate with any degree of regularity and if so, the extent of their occurrence. Quantitative differences in chlorinity indicate that Stations 1 and 2 were situated over distinct water systems during the winter but that the subsurface summer water at both stations was essentially similar in origin. That lowering of chlorinity during summer was largely restricted to the surface 10 metres suggests that extensive vertical mixing is delayed until the warm, poorly saline surface water has moved further from the coastline. This seems reasonable to expect because the sea ice, although melting, effectively excludes sub-aerial mixing influences until the latter part of the summer when it breaks out and is dispersed to the north.

The data for temperature and chlorinity have been related as temperature-chlorinity curves in Figure 41 which effectively demonstrates the features discussed above. The curve of freezing point as a function of temperature and chlorinity has also been included. It shows clearly the extent to which the winter water at both stations was exposed to freezing conditions. Of the winter water at Station 2, it may be calculated that, to establish equilibrium, approximately 7.6% at 10 metres, 1.4% at 25 metres, and 1.1% at 50 metres would have been present in the form of ice crystals. At Station 1 at 5 metres, 2.5% of the water must have been frozen out.

Curves of σt against depth for summer and winter at Stations 1 and 2 are shown in Figure 35. They follow closely the curves of chlorinity against depth already described. The instability and relatively low density of the winter water at Station 2 is noteworthy, and supports the suggestion that this water was probably of summer origin and still undergoing processes of mixing. The factors contributing to the turbulence of this water were probably varied but it would be interesting to assess the particular influence exerted by the separation and upward movement of ice crystals in the stratum subject to freezing, if such a process does take place.

It should be noted in Figure 36 that the percentage oxygen saturation of the winter water at Station 2 was generally higher than the summer water, whereas the reverse condition was observed at Station 1. The finding for Station 2 is compatible with the suggestion regarding the origin of the winter water. That a similar condition was not observed at Station 1 does not necessarily refute this suggestion, because levels of dissolved oxygen are affected by biological as well as physico-chemical agencies. It is probable that the dissolved oxygen in the winter water at Station 2 had suffered little or no depletion since the previous summer whereas part of the oxygen in the water at Station 1 may have been utilized by zooplankton. Certainly the greater chlorinity of the winter water at Station 1 would have been more favourable for plankton production than the poorly saline water at Station 2.

An examination of Figure 37 will show that, in general, pH values were lower during the winter than during the summer, although differences below 70 metres at Station 2 were slight and, at Station 1, winter pH values below 20 metres were slightly higher than in the summer. Changes in pH with depth were mainly restricted to the upper water layers and were rather more evident during the winter period. The increase in summer pH towards the surface at Station 2 was probably caused by biological activity. The influence of such activity at Station 1 was over-ridden by low pH's recorded at the height of the thaw when Station 2 was not sampled. Chlorinity, level of dissolved oxygen and temperature were largely responsible for the pH values recorded; this relationship is illustrated in Figure 43. Unlike pH, the buffer capacity of the waters was controlled principally by chlorinity and this may be seen by comparing Figures 38 and 34.

Figure 40 shows the variation in Eh with depth in the summer and winter waters at Stations 1 and 2. Apart from the distinct difference in Eh between winter and summer, it will be noticed that variations in each period were restricted to the surface 25 metres and that, where differences between stations in this zone were slight in the summer, there was a definite variance during the winter. Further, during this period at Station 1, the Eh fell to a minimum at 10 metres and then rose again with depth. Temperature (Fig. 44), pH (Fig. 42), and, as will be shown later, biological factors appeared to be the principal agents governing Eh. It is of interest that, whereas the highest Eh values were recorded in the poorly saline winter water at Station 2, the lowest Eh's were found in the surface thaw layer during the summer. No explanation is offered for this apparent anomaly.

In Figure 42, the relative homogeneity of the Eh-pH relationship in the subsurface summer water compared with the diversity of the winter water, and the similarity of the Eh-pH curves in the surface 10 and 25 metres respectively at Stations 1 and 2 during winter, are noteworthy. The milieu represented by these waters is markedly confined in comparison with the limits of pH and Eh possible in natural environments. (Baas Becking *et al.*, 1956.)

A discussion of the levels of dissolved phosphate in the sea water, since it bears so much on the activities of plankton, has been deferred to the following section.

The effect of the plankton community on some physio-chemical properties of the milieu. Among the properties of sea water liable to influence by biological agencies are the levels of dissolved phosphates and oxygen, the pH, buffer capacity and Eh. It will be relevant, therefore, to discuss briefly the extent of these influences as they apply to the present investigation.

Figure 39 shows the distribution of dissolved phosphates with depth in the summer and winter waters at Stations 1 and 2. The same data have been recapitulated in Figure 45 as ratios of dissolved phosphates to chlorinity to minimise the effect of salinity variation on the distribution patterns. Interpretation is made difficult because the curves reflect both past history and immediate processes taking place in the water. Because phytoplankton and bacteria were virtually absent during winter, it may be assumed that the ratios of dissolved phosphate to chlorinity in this water were established by processes operating at some time in the past. At Station 1 it will be noted that, although the chlorinity of the subsurface winter water was lower than that of the summer water, the levels of dissolved phosphate and the ratio of phosphate to chlorinity were higher. It will be observed also that the phosphate-chlorinity ratio of the winter water at this station was highest between 20 and 25 metres indicating the possibility of phosphate release *in situ* from the bottom muds. During the summer period, phytoplankton growth lowered the phosphate concentration and hence the phosphate-chlorinity ratio throughout the water column, although with greatest effect in the surface 5 metres. The maximum reduction in the phosphate-chlorinity ratio which occurred in the surface 10 metres at Station 2 was less pronounced that at Station 1 and there was little variation in the ratio below 50 metres. Further, at this station the ratio of phosphate to chlorinity between 25 and 70 metres was lower during winter than in summer. Although this may have been caused by the past history of the water, it is of interest to note that reductions in the levels of the dissolved phosphate at 25 and 50 metres on the first two sampling days during winter coincided with the presence of large populations of coccolithophores.

A comparison of Figure 13 with Figures 24 and 26 and of Figure 14 with Figures 25 and 27 will show that increases in the phytoplankton population during summer were associated with generally increased levels of dissolved oxygen. However, the correlations are not striking and it is probable that much of the increase, at least close to the surface, was associated with the melting of the sea ice and the introduction of thaw water from the mainland. Also, it would be expected that the tendency under these influences for the level of dissolved oxygen to rise would be partly cancelled by the oxygen requirement of the associated zooplankton.

From Figures 15 and 16, it will be noted that, at both Stations 1 and 2 exceptionally high pH's and, at Station 1, exceptionally low pH's were recorded in the surface 5 metres during the thaw period. The low pH, 6.87, at Station 1 coincided with the period of minimum chlorinity to which it may be attributed. However, although a similar correspondence might be expected between the high pH's and biological activity, none could be found; at least, in terms of chlorophyll concentration or population density. It is of interest that this highly alkaline surface water was found to have correspondingly low oxidation-reduction potentials and that the surface water of low pH at Station 1 had a relatively high Eh in excess of + 400 mv. (Figs. 19, 20).

The buffering capacity of the summer water did not appear to be affected in any way by biological activity.

Factors controlling plankton production and the complexity of the plankton community. By far the most important factor limiting the development of the plankton community in the waters under study is the supply of radiant energy for the primary biological activity in the chain of organic production—photosynthesis. The amount of radiant energy reaching and penetrating the sea in high latitudes depends upon two main factors; the elevation of the sun and the thickness and permanence of the sea ice.

From the time the programme was commenced in mid-June until the middle of September, it was found that the total radiant energy penetrating the surface of the water in the ice holes at Stations 1 and 2 was negligible. Attempts to obtain measurements during this period were all made at times when the sky was free of cloud and during the brightest part of the day. As it may be assumed from the elevation of the sun that such conditions would prevail at least from the end of March, the total period in any year when the amount of radiant energy absorbed by the sea water is negligible, even in the absence of ice at the surface, would be five to six months.

Under such conditions, photosynthetic activity would not be possible and it is not surprising, therefore, that phytoplankton was virtually absent during the winter period. However, the water was not entirely free of life. Coccolithophores were present in very large numbers, presumably carrying on an phagotrophic existence. There were also small concentrations of protozoa, principally flagellates, but also including occasional ciliate forms. Of the larger zooplankton, siphonophores and amphipods were low in numbers and sporadic in occurrence. Copepods characterised the scant zooplankton community of the period June to mid-September. *Scolecothricella glacialis* was the most prominent species although *Calanus simillimus, Calanoides acutus, Ctenocalanus vanus, Metridia Gerlachei, Metridia Andraeana, Valdiviella insignis, Oncaea curvata* and *Oithona similis* were also recorded. The nature and limited availability of the detrital food supply, combined with low water temperatures and to some extent, possibly, lowered chlorinities, especially at Station 2, are considered to be the principal factors which limited the size and complexity of the over-wintering community.

When positive measurements of radiant energy were obtained at the ice holes in the surface metre towards the end of September and early October, the sea ice was at its stage of maximum development. Near Station 2, it was 115 centimetres thick and must have been almost 150 centimetres thick at Station 1 (Fig. 2). Its presence must be assumed to have presented a serious barrier to the penetration of radiant energy into the water below. Nevertheless, towards the end of October, while the measured amount of radiation in the top metre below a water surface manually cleared of ice was only 0.01 to 0.05 cal./cm.^{2}/min. at the time of maximum elevation of the sun, up to 0.07 x 10^6 diatom cells/litre were recovered from the surface 75 metres at Station 2. Under the circumstances, however, it is almost certain that these organisms were not engaged in photosynthetic activity but had developed in isolated ice-free areas of water before being carried in close to the coastline. It is significant that chlorophyll in measurable concentrations was not recovered from seawater samples until 12 November at Station 1 and 19 November at Station 2. At this time, almost one month after diatoms were first obtained in countable numbers, both the elevation of the sun and the length of day had increased considerably, and measurable penetration of radiant energy was recorded through the ice-free sampling tube at Station 1 in the surface metre between 1100 and 1700 hrs. There is still a considerable doubt whether sufficient radiant energy could have been passing through the undisturbed sea ice, which was 96 centimetres thick at Station 2 and over 140 centimetres thick at Station 1, to enable *in situ* photosynthesis to take place. In this connection it is of interest to record the following observations made at this time after excavating new holes through the ice at both stations. It was found that the undersurface of the ice was providing anchorage for a vigorously developing community of diatoms. Since the algae were rich in chlorophyll and were obviously not transient, it seems reasonable to assume energy penetration through the ice was adequate for photosynthesis at this point, although the depth to which effective radiation might penetrate cannot be judged.

The results obtained in the present survey indicate that although a limited amount of phytoplankton growth and photosynthesis may take place beneath a thick layer of sea ice in areas far removed from open water, large-scale blooms do not take place until the ice is in an advanced state of disintegration. This may be seen by comparing Figure 2 with Figures 24 and 25. Consequently it would be expected that the magnitude of phytoplankton production from year to year would depend basically upon the extent and thickness of the sea ice and the earliness or lateness of its disintegration and dispersal.

A general association could not be found between increases in chlorophyll concentration and any of the hydrological conditions examined. However, it should be noted that once phytoplankton production began, its magnitude did not appear to be related proportionately to the incidence of radiant energy. In this connection, the data available are scarcely adequate for examination in any detail. In any case, it seems certain that the relationship is liable to be complicated by other factors such as increases in the zooplankton and changes in the species composition of the phytoplankton.

A comparison of Figures 30 and 31 with Figure 24 and of Figure 32 with Figure 25 will show that, following the intense phytoplankton bloom at Station 1 and coinciding with increased numbers of algae at Station 2, there was a marked increase in the zooplankton, including the protozoa. In several respects, the summer zooplankton populations were distinct from those of the winter period. Among the protozoa, several types of flagellates and tintinnids made their appearance. Of the larger animals not recorded during winter, the copepod *Paralabidocera antarctica*, the euphausiid *Euphausia crystallorophias*, polychaete larvae and tunicates all came into prominence.

It is to be concluded that these larger and more complex communities depended for the extent of their development largely upon the availability of a suitable supply of food, represented in the first instance by the phytoplankton. The limiting influence of water temperature must also be taken into consideration although the extent to which the slight summer rise may have affected the development of the community is not known. At temperatures close to freezing point, it is probable that a small increase could exert a far-reaching effect not only upon the metabolic activities of individual groups but also upon the number of groups capable of existence in the environment.

Both plankton production and the qualitative nature of the community were affected radically at the height of the thaw period by the chlorinity of the surface water. At this time, the normal phytoplankton population of the surface water was severely reduced and partly or completely replaced by Chlamydomonad algae and high concentrations of flagellate protozoa. Except for the poorly saline thaw water, the levels of dissolved phosphate were not found to constitute a factor limiting productivity.

The increase in complexity of the phytoplankton population with the advance of the summer season is of interest. In mid-September, only one species, the un-named diatom *Nitzschia* sp.A., was recorded. By early November, 12 species were present, the number increasing irregularly to 44 by the end of January and dropping back to 30 by 10 February when the programme was concluded. Given an adequate mechanism for the constant introduction of a diversity of viable cells and assuming the physico-chemical conditions to be suitable for their growth, it may be concluded that the number of species succeeding in the environment is related principally to the availability of radiant energy for autotrophic growth. This does not take into account the influence of the grazing activities of the zooplankton. However, it does help to explain the paucity of species compared with waters further to the north in the Antarctic Zone and may, in part, account for the relative lack of diversity in the zooplankton community.

Although it was not possible to carry the present study through the full twelve-month cycle and although observations were made at only two stations, it may be useful to include a brief statement regarding the possible magnitude of organic production in the area during the period covered by the programme.

Primary organic production by phytoplankton was limited to the summer season. The quantities of organic carbon present from time to time in the standing crop at Stations 1 and 2 in the surface 25 metres have been estimated on the assumption that 0.88 μg. chlorophyll is equivalent to 3.3×10^{-3} mg. organic carbon (Sverdrup, Johnson and Fleming, 1942). This information is shown in Table 17. It will be seen that the amounts of organic carbon present in the surface 25 metres of water lay between zero and nearly 15 mg./m^3. The higher values are comparable with those obtained by Cushing (1957) during spring in the North Sea.

Values for total organic carbon in the mixed crop of phyto- and zooplankton, based on depletion of available phosphates, were much higher. Because of the heterogeneity of the water, the results were obtained by measuring the depletion in the mean summer phosphate levels relative to the mean summer level present below 75 metres at Station 2, assumed to be largely unaffected by biological activity. The values obtained are presented in Table 18. Allowance was made in the calculations for variation in chlorinity.

TABLE 17

ESTIMATED AMOUNTS OF ORGANIC CARBON (mg./m.^{3}) IN THE STANDING CROP OF PHYTOPLANKTON AT STATIONS 1 AND 2

Station 1

Depth (m.)	12.11.56	27.11.56	10.12.56	23.12.56	1.1.57	9.1.57	21.1.57
0	1.28	0.83	1.43	12.08	0.00	1.24	5.63
5	1.28	0.83	1.43	14.80	10.88	2.63	5.44
10	0.71	0.26	2.36	12.68	6.38		9.08
15	0.71	0.26	2.36	12.38	10.13		6.45
20	0.94	0.41	2.66	5.36	5.36		8.06
25	0.94	0.41	2.66	5.25	5.25		5.25

Station 2

Depth (m.)	19.11.56	4.12.56	17.12.56	14.1.57	28.1.57
0	0.45	1.65	1.43	0.56	4.50
5					
10	0.45	1.65	2.74	1.13	3.75
15					
20					
25	0.26	0.71	0.53	1.58	4.76

TABLE 18

MEAN SUMMER STANDING CROP OF PLANKTON IN TERMS OF ORGANIC CARBON IN mg./m.^{2} AND BASED ON DEPLETION OF DISSOLVED PHOSPHATES

Depth	Station 1	Depth	Station 2
0	176	0	108
5	164		
10	164	10	81
15	135		
20	81		
25	68	25	68

Because of difficulties and deficiencies in the use of nets for plankton hauls under the conditions prevailing at Mawson, the measurement of yields cannot be considered reliable. Therefore, any discussion of plankton production in these terms has been excluded except to indicate the obvious increases in the volumes of zooplankton which were taken following large-scale phytoplankton blooms in the summer period.

FUTURE WORK

At the time the present programme was drawn up, its objectives, broadly, were to study the hydrological characteristics and plankton populations of the waters above the continental shelf in the vicinity of the Australian antarctic base, Mawson, at intervals throughout a period of twelve months. Since the investigation was of an exploratory nature carried out under unusual conditions, it may be worthwhile to consider the extent to which these objectives were realised and the practical difficulties that arose in the field as well as to suggest improvements in methodology and to indicate some of the main problems arising from the results which call for further investigation.

Various circumstances prevented full achievement of the planned objectives. The autumn and early winter period in the months February to June was not covered. Stations were not established at intervals over the continental shelf, being in fact restricted to the zone immediately against the coastline. The methods used for capturing zooplankton were seriously deficient.

Some of the factors that prevented full accomplishment of the original aims included: the time involved in setting up the laboratory and preparing the field equipment; the incidence of high winds during autumn which caused repeated disruption of the newly-formed sea ice; the amount of labour and time required to clear ice from the sample tubes to allow access to the water below the surface; the almost immediate freezing of water samples brought to the surface in Nansen bottles; difficulties associated with the handling of plankton nets, including the presence of large quantities of ice crystals unavoidably brought to the surface in hauls mainly in winter but also in surface tows in summer; the difficulty of handling all gear under adverse conditions; inadequate transport; lack of assistance; difficulties in traversing badly disintegrated, weak ice during the summer thaw.

Although no ready solution seems apparent for overcoming the last problem or for excluding ice from plankton nets without impairing their efficiency, it is considered that the remaining difficulties could be eliminated or greatly reduced in any future programme provided that resources were available for more elaborate equipment, a team larger than one man and a period of investigation extending over two and preferably more seasons. A note on the facilities and equipment envisaged in this connection may be of interest.

The laboratory, which should be situated as close as possible to the shoreline, should include an attached heated workroom for the maintenance of field equipment, sorting of samples, drying nets, etc. Transport should be designed to operate over as many conditions of sea surface as possible. An amphibious vehicle of suitable dimensions would be suitable on established sea ice, in very light pack and in open water. Such a vehicle should be equipped with a closed, heated cabin allowing Nansen bottles to be emptied and samples to be pre-treated in the field; a built-in power winch capable of raising equipment from a depth of two or three hundred meters and, if possible, a powered ice auger capable of penetrating six or seven feet of sea ice and boring a hole large enough to admit at least a net of the Clark-Bumpus type. Due consideration should be afforded the important factor of providing thorough maintenance and housing for transport of this description.

There are two periods of the year at Mawson when travel by normal methods any distance beyond the shoreline is either too dangerous to be undertaken or practically impossible. In the early winter, the developing sea ice is weak and unreliable for anything but light sleds, and in any case is liable to be blown out to sea with very little warning. During the latter part of the summer thaw when the sea ice is deteriorating, a stage is reached before any open water appears when travel, at first with anything but sledges and later even on foot, becomes impossible. At these times it would be found expedient to maintain continuity of observations by occupation of inshore stations, using sledge-mounted equipment light enough to be hauled by manpower alone. It is unfortunate that such obstacles exist at times when the investigator is most anxious to maintain observations, especially on the plankton populations.

The results discussed in the present paper raise many questions for future investigation and indicate clearly the need for more extensive observations. It is very questionable whether conditions recorded close inshore are representative of the waters and the plankton communities of the continental shelf as a whole. To determine this, stations should be established at greater distances from the coastline and it would be desirable at the same time to extend such activities to include other zones of the shelf. Concerning the hydrological characteristics of these waters, it would be interesting to determine the distribution of relatively low chlorinities during the winter period and, in particular, to investigate the reported existence of water of questionably low salt content such as appeared to exist at Station 2 in winter. It would be desirable also to examine the suggestion that conditions appear to exist which allow the formation of ice crystals in super-cooled water in depths down to 100 metres and the effect this phenomenon would have upon the remaining liquid phase. That incompletely mixed summer water appears to remain by the coast during the ensuing winter, and is not replaced until the introduction of more saline water from other zones; requires further study, here, observations extending further out over the shelf could be of great value. A continuation of observations during the autumn and early winter period would be particularly interesting, both in connection with hydrological conditions and the nature of the plankton communities.

Although it would seem that the incidence of submarine radiant energy in a region of pronounced summer-winter differences is chiefly responsible for increases in phytoplankton, this is by no means proven and would bear more extensive scrutiny. Here, more reliable measurements of incident submarine radiation would be of considerable value. The suggestion that the phytoplankton populations in these waters, at least in the early part of the summer season, are composed of large numbers of individuals, representing relatively few species, should be further examined and attempts should be made to trace the origin of the populations. There is a possibility that their appearance may follow release of viable individuals which are known to become entrapped often in large concentrations, in developing sea ice. It remains to be determined whether the phytoplankton taken beneath appreciable layers of sea ice is occupied in photosynthetic activity, although indirect evidence has been presented which indicates that this may be the case.

Little information was gained in the present programme regarding the zooplankton. Clearly, more efficient methods of collection are required. Whatever equipment may be used in future, some provision for the exclusion of ice from the collecting apparatus without impairing its trapping efficiency is essential. Particular attention should be paid to methods designed for capturing the larger forms of planktonic crustacea. Of these, only immature individuals of *Euphausia crystallorophias* were taken in any numbers in the nets. An examination, however, of the stomach contents of penguins and antarctic birds of flight, both groups of which occur in large numbers on the shores of Antarctica in summer, indicate the gap which must exist between the situation suggested by the results of net hauls and actual conditions in the sea.

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APPENDIX 1

OCEANOGRAPHICAL STATION LIST

NOTE.—The methods and units are those given by C.S.I.R.O. Aust. (1951) or as otherwise indicated in this report.

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 1 — DAILY SURFACE WATER TEMPERATURES

All values negative unless otherwise indicated. Temperatures lower than approximately −1.9°C are indicative of the sharp temperature gradient between air and rapidly freezing water under the artificial conditions arising from excavation of ice at the surface to allow sampling operations.

Date	*Temp.* (°C)	*Date*	*Temp.* (°C)	*Date*	*Temp.* (°C)	*Date*	*Temp.* (°C)	*Date*	*Temp.* (°C)
		17..	2.20	17..	2.40	17..	1.80	18..	1.95
1956		18..	2.20	18..	2.20	18..	2.00	19..	1.80
June		19..	2.20	19..	2.30	19..	1.95	20..	1.95
19..	1.95	20..	1.90	20..	1.80	20..	2.00	21..	1.93
20..	2.05	21..	1.95	21..	2.15	21..	1.97	22..	2.10
21..	1.80	22..	1.90	22..	2.40	22..	2.05	23..	2.03
22..	1.90	23..	1.90	23..	2.00	23..	2.00	24..	1.80
23..	2.20	24..	2.20	24..		24..	1.97	25..	1.82
24..	2.20	25..	1.95	25..	1.95	25..	2.20	26..	1.95
25..	1.80	26..	1.95	26..	2.10	26..	2.15	27..	1.77
26..	1.90	27..	1.90	27..	1.90	27..	2.15	28..	
27..	2.10	28..	1.95	28..	2.15	28..	1.95	29..	
28..	1.95	29..	2.10	29..	2.10	29..	1.93	30..	
29..	1.95	30..	2.20	30..	2.15	30..	2.03	31..	
30..	1.95	31..	2.15	31..	2.20				
						October		November	
July		August		September		1..	1.80	1..	
1..	1.90	1..	2.05	1..	2.15	2..	2.40	2..	
2..	2.80	2..	2.40	2..	2.25	3..	1.95	3..	1.70
3..	1.85	3..	1.90	3..	2.40	4..	1.90	4..	
4..	2.00	4..	1.95	4..	1.80	5..	1.95	5..	
5..	1.90	5..	2.00	5..	2.05	6..	1.90	6..	1.90
6..	1.90	6..	2.00	6..	2.00	7..		7..	1.82
7..	2.00	7..	2.40	7..	2.05	8..	1.90	8..	1.70
8..	2.30	8..	2.10	8..	2.10	9..	1.75	9..	1.75
9..	2.40	9..	2.20	9..	2.00	10..	1.85	10..	
10..	1.95	10..	2.20	10..	1.85	11..	1.90	11..	
11..	2.20	11..	2.40	11..	2.10	12..	1.93	12..	1.67
12..	2.50	12..	2.00	12..	2.20	13..	1.90	13..	1.73
13..	3.00	13..	2.25	13..	1.85	14..	1.95	14..	1.67
14..	2.80	14..	2.40	14..	1.90	15..	1.83	15..	1.57
15..	2.80	15..	2.20	15..	2.20	16..	1.83	16..	1.64
16..	2.00	16..	2.30	16..	2.00	17..	2.00		

Date	*Temp.* (°*C*)	*Date*	*Temp.* (°*C*)	*Date*	*Temp.* (°*C*)	*Date*	*Temp.* (°*C*)	*Fate*	*Temp.* (°*C*)
17..	1.47	3..		21..		5..	+0 77	23..	
18..	1.60	4..	0.82	22..	+1.43	6..		24..	
19..	1.62	5..	0.83	23..	+0.95	7..	+0.55	25..	
20..	1.45	6..	0 90	24..	0.24	8..		26..	
21..	1.48	7..	0.98	25..	+0.65	9..	0.45	27..	
22..	1.52	8..	0.80	26..	+0.70	10..		28..	1.27
23..		9..	0.85	27..	+0.40	11..	+0.90	29..	
24..	1.40	10..	0.63	28..		12..	+1.02	30..	
25..	1.47	11..	0.62	29..	+0.35	13..		31..	
26..		12..	0.57	30..	+0.80	14..			
27..	1.39	13..	0.52	31..	+0.37	15..	+1.25	February	
28..	1.25	14..	0.27			16..	+0.85	1..	
29..	1.10	15..	0.57	1957		17..		2..	0.35
30..	1.03	16..	0.39	January		18..	0.55	3..	0.62
		17..	0.60	1..	+0.47	19..	0.60	4..	
December		18..		2..	+0.58	20..	0.08	5..	
1..	0.75	19..	0.40	3..	+0.63	21..	+0.25	6..	
2..	0.65	20..		4..	+0 60	22..		7..	1.00

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 2 — DAILY SURFACE WATER TEMPERATURES

All values negative unless otherwise indicated.

Date	*Temp.* (°*C*)	*Date*	*Temp.* (°*C*)	*Date*	*Temp.* (°*C*)	*Date*	*Temp.* (°*C*)	*Date*	*Temp.* (°*C*)
		10..	1.95	19..	2.00	28..	1.95	4..	2.00
1956		11..	2.20	20..	1.95	29..	2.00	5..	2.00
July		12..	2.30	21..	1.90	30..	1.90	6..	2.20
4..	2.20	13..	2.40	22..	1.90	31..	1.95	7..	2.10
5..	1.90	14..	2.10	23..	2.00			8..	2.05
6..	2.00	15..	2.20	24..	2.20	August		9..	2.30
7..	2.20	16..	1.90	25..	1.90	1..	1.90	10..	2.05
8..	2.00	17..	1.90	26..	1.90	2..	1.90	11..	2.20
9..	2.00	18..	1.95	27..	1.85	3..	2.20	12..	1.95

Date	*Temp.* (°C)	*Date*	*Temp.* (°C)	*Date*	*Temp.* (°C)	*Date*	*Temp.* (°C)	*Date*	*Temp.* (°C)
		13..		15..	1.90	16..	1.63	18..	
13..	1.85	14..	1.90	16..	1.70	17..	1.50	19..	
14..	2.15	15..	1.95	17..	1.80	18..	1.60	20..	
15..	2.20	16..	1.90	18..	1.97	19..	1.55	21..	
16..	1.90	17..	1.85	19..	1.80	20..	1.52	22..	
17..	2.10	18..	1.90	20..	1.77	21..	1.50	23..	
18..	2.00	19..	1.90	21..		22..	1.52	24..	
19..	2.20	20..	1.95	22..	1.85	23..		25..	
20..	2.20	21..	1.95	23..	1.75	24..	1.50	26..	
21..		22..	1.90	24..	1.75	25..	1.45	27..	
22..	2.00	23..	1.75	25..	1.80	26..		28..	
23..		24..	1.70	26..	1.90	27..		29..	
24..		25..	1.95	27..		28..	1.30	30..	
25..	1.90	26..	2.00	28..	2.00	29..	1.19	31..	
26..	1.90	27..	1.95	29..	1.70	30..	0.99		
27..	1.85	28..	1.85	30..	2.00			1958	
28..	2.00	29..	1.85	31..	1.95	December		January	
29..	1.95	30..	1.90			1..	0.78	14..	+0.68
30..	2.00			November		2..	1.18	15..	
31..	1.95	October		1..	1.90	3..		16..	
		1..	1.75	2..	1.75	4..	1.10	17..	
September		2..	2.00	3..	1.70	5..	1.12	18..	
1..	2.00	3..	1.75	4..		6..		19..	
2..	2.05	4..	1.75	5..		7..	1.10	20..	
3..	2.20	5..	1.75	6..	1.66	8..	1.05	21..	
4..	2.40	6..	1.75	7..	1.67	9..	0.95	22..	
5..	1.90	7..		8..	1.70	10..	0.95	23..	
6..	1.90	8..	1.75	9..	1.70	11..	0.65	24..	
7..	1.90	9..	1.75	10..		12..	0.55	25..	
8..	1.95	10..	1.65	11..		13..	+0.05	26..	
9..	1.95	11..	1.70	12..	1.75	14..		27..	
10..	1.85	12..	1.73	13..	1.73	15..	0.15	28..	1.35
11..	1.97	13..	1.83	14..	1.67	16..	0.20		
12..	1.95	14..	1.73	15..		17..	+0.13		

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

STATION 1 — ISOLATED MEASUREMENTS OF DIURNAL VARIATIONS OF SURFACE WATER TEMPERATURE

15.11.56—Sea ice present		19.1.57—Sea ice absent	
Time	*Temp. (°C)*	*Time*	*Temp. (°C)*
1100	−1.60	1000	−0.60
1200	−1.57	1100	−0.55
1300	−1.60	1200	−0.50
1400	−1.57	1400	−0.33
1500	−1.62	1500	−0.20
1600	−1.58	1600	−0.15
1700	−1.60	1700	−0.05
1800	−1.60		
1900	−1.60		
2000	−1.62		

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

MEASUREMENTS OF SEA ICE THICKNESS

Station 1—27.11.57–8.1.57	
Date	*Ice Thickness (m.)*
27.11.56 ..	1.36
8.12.56 ..	1.23
13.12.56 ..	1.18
16.12.56 ..	1.16
18.12.56 ..	1.03
20.12.56 ..	0.96
21.12.56 ..	0.88
23.12.56 ..	0.74
25.12.56 ..	0.67
28.12.56 ..	0.60
1.1.57 ..	0.55
3.1.57 ..	0.52
4.1.57 ..	0.50
6.1.57 ..	0.47
8.1.57 ..	0.38
16.1.57 ..	Harbour free of ice

Station 2 — 14.3.56–16.12.56	
Date	*Ice Thickness (m.)*
14.3.56 ..	First formed
18.3.56 ..	Break out
29.3.56 ..	Break out
12.4.56 ..	Break out
29.4.56 ..	Break out
13.5.56 ..	Break out
22.5.56 ..	Break out
6.6.56 ..	0.38
20.6.56 ..	0.63
9.7.56 ..	0.70
22.7.56 ..	0.83
15.8.56 ..	0.98
5.9.56 ..	1.08
17.9.56 ..	1.16
12.10.56 ..	1.16
3.11.56 ..	1.07
17.11.56 ..	0.96
29.11.56 ..	0.91
8.12.56 ..	0.91
13.12.56 ..	0.91
16.12.56 ..	0.85 including surface crust
	0.60 excluding surface crust

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.
Station 1 — SEA ICE TEMPERATURES, 26.7.56–13.10.56
20 cm. below surface. All values negative.

Date	Temp. (°C)	Date	Temp. (°C)	Date	Temp. (°C)	Date	Temp. (°C)	Date	Temp. (°C)
		8..	19.0	26..	13.2	11..	16.0	29..	12.1
1956		9..	18.7	27..	13.0	12..	16.9	30..	10.8
July		10..	17.8	28..	15.2	13..	15.2		
26..	9.5	11..	20.0	29..	17.8	14..	12.3	October	
27..	11.2	12..	21.8	30..	19.0	15..	12.4	1..	10.2
28..	12.0	13..	22.2	31..	21.0	16..	14.2	2..	9.0
29..	11.8	14..	23.0			17..	16.4	3..	8.4
30..	14.2	15..	23.7	September		18..	16.3	4..	9.0
31..	13.1	16..	24.5	1..	21.8	19..	15.7	5..	9.2
		17..	25.0	2..	21.4	20..	14.3	6..	9.8
August		18..	26.5	3..	18.6	21..	15.0	7..	
1..	14.0	19..	23.0	4..	16.7	22..	12.5	8..	8.2
2..	17.2	20..	25.0	5..	14.0	23..	13.5	9..	8.6
3..	20.0	21..	18.0	6..	15.7	24..	15.0	10..	9.5
4..	18.7	22..	15.0	7..	13.2	25..	16.5	11..	10.0
5..	20.0	23..	14.0	8..	14.1	26..	17.9	12..	10.6
6..	22.0	24..		9..	15.7	27..	18.0	13..	11.2
7..	21.8	25..	11.8	10..	14.9	28..	16.1		

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.
Station 2 — SEA ICE TEMPERATURES, 26.7.56–10.3.56
20 cm. below surface. All values inclusive.

Date	Temp. (°C)	Date	Temp. (°C)	Date	Temp. (°C)	Date	Temp. (°C)	Date	Temp. (°C)
		8..	18.0	26..	12.3	11..	16.2	29..	13.4
1956		9..	17.8	27..	12.1	12..	16.8	30..	10.9
July		10..	16.5	28..	14.1	13..			
26..	8.6	11..	19.1	29..	16.7	14..	12.6	October	
27..	10.2	12..	20.8	30..	18.0	15..	12.8	1..	9.9
28..	11.2	13..		31..	20.2	16..	14.4	2..	9.0
29..	11.0	14..	22.0			17..	16.3	3..	8.4
30..	13.1	15..	22.3	September		18..	16.9	4..	8.5
31..	12.2	16..	23.8	1..	21.4	19..	15.7	5..	8.8
		17..	24.1	2..	21.1	20..	14.2	6..	9.3
August		18....	26.0	3..	18.3	21..	14.8	7..	
1..	13.5	19..	22.5	4..	16.5	22..	12.8	8..	8.2
2..	17.2	20..	20.7	5..	14.3	23..	13.3	9..	9.2
3..	19.5	21..		6..	15.5	24..	15.1	10..	9.9
4..	18.0	22..	14.5	7..	13.5	25..	16.7	11..	10.3
5..	19.5	23..		8..	14.2	26..	18.4	12..	11.0
6..	20.6	24..		9..	15.9	27..	18.6	13..	12.2
7..	20.5	25..	11.0	10..		28..	17.1		

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

MEASUREMENT OF THE CHLORINITY OF THE SURFACE 30 cm. OF SEA ICE

Station 1—26.7.56–24.12.56		Station 2—2.8.56–18.12.56	
Date 1956	*Chlorinity ‰*	*Date* 1956	*Chlorinity ‰*
26 July ..	3.19	2 August ..	4.22
9 August ..	3.25	17 August ..	4.65
26 August ..	2.98	29 August ..	4.40
6 September ..	2.55	13 September ..	4.17
19 September ..	2.75	26 September ..	3.95
3 October ..	2.68	11 October ..	3.80
17 October ..	2.97	24 October ..	3.58
14 November ..	2.67	8 November ..	4.07
29 November ..	2.13	21 November ..	3.75
11 December ..	1.05	6 December ..	2.60
24 December ..	0.05	18 December ..	0.40

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 1 — SOLAR RADIATION

Between 20.6.56, when programme commenced, and 5.10.56, the incidence of solar radiation was too low for the sensitivity of the recording instrument. All values given in gm.-cal./cm.$^{-2}$/min.$^{-1}$

5.10.56 — Light brash at surface of sampling tube. Thin but complete cloud cover; light snow falling.

Depth (*m.*)	*Time (hr.)*	
	1330	1410
0.01 ..	0.09	0.05
0.50 ..	0.02	0.01
1.00 ..	0.00	0.00

15.11.56 — Light brash at surface of sampling tube. 1100–1400 hrs. no cloud; 1500–1700 hrs. intermittent cloud.

Depth (*m.*)	*Time (hr.)*						
	1100	1200	1300	1400	1500	1600	1700
0.02 ..	0.01	0.03	0.03	0.07	0.03	0.03	0.01
0.10 ..	0.00	0.03	0.02	0.04	0.02	0.02	0.00
0.20 ..		0.02	0.02	0.02	0.02	0.02	
0.30 ..		0.01	0.02	0.02	0.02	0.01	
0.40 ..		0.01	0.01	0.02	0.01	0.01	
0.50 ..		0.01	0.01	0.02	0.01	0.01	
0.60 ..		0.00	0.00	0.01	0.01	0.01	
0.70 ..				0.01	0.01	0.01	
0.80 ..				0.01	0.00	0.01	
0.90 ..				0.00		0.01	
1.00 ..						0.00	

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 1 — SOLAR RADIATION

30.11.56 — Metal Tube removed from sampling hole in sea ice. Sun totally unobscured. First three sets readings taken beneath surface ice crust 5 cm. thick; last set beneath ice-free water surface. Sea ice 1.36 m. thick.

Depth (*m.*)	*Time* (*hr.*)			
	1205	1400	1440	1450
0.02 ..	0.28	0.34	0.33	0.47
0.10 ..	0.25	0.33	0.34	0.40
0.20 ..	0.24	0.30	0.30	0.35
0.30 ..	0.24	0.29	0.28	0.36
0.40 ..	0.26	0.29	0.26	0.37
0.50 ..	0.24	0.26	0.24	0.33
0.60 ..	0.21	0.24	0.22	0.32
0.70 ..	0.18	0.22	0.20	0.26
0.80 ..	0.16	0.20	0.18	0.17
0.90 ..	0.14	0.18	0.16	0.13
1.00 ..	0.15	0.17	0.15	0.12
2.00 ..	0.07	0.08	0.07	0.06
3.00 ..	0.03	0.04	0.03	0.03
4.00 ..	0.03	0.03	0.03	0.03

12.12.56 — Sun totally unobscured. Sea ice 1.18 m. thick. Very thin "black" ice at surface of sampling hole.

Depth (*m.*)	*Time* (*hr.*)										
	1210	1310	1410	1505	1610	1705	1745	1910	2010	2115	2210
0.02 ..	0.54	0.55	0.54	0.52	0.42	0.38	0.32	0.20	0.12	0.05	0.02
1.00 ..	0.34	0.36	0.36	0.33	0.18	0.17	0.09	0.05	0.04	0.03	0.01
2.00 ..	0.13	0.11	0.14	0.09	0.07	0.05	0.04	0.03	0.02	0.01	0.00
3.00 ..	0.05	0.08	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	
4.00 ..	0.04	0.07	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.01	
5.00 ..	0.03	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.01	
6.00 ..	0.02	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.01	
7.00 ..	0.02	0.04	0.03	0.02	0.03	0.02	0.02	0.02	0.01	0.01	
8.00 ..	0.02	0.03	0.02	0.01	0.03	0.02	0.02	0.01	0.01	0.01	
9.00 ..	0.02	0.03	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.00	
10.00 ..	0.01	0.03	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.00	

22.2.56 — Sun faintly obscured by very light cloud. Sea ice 0.88 m. thick. Water at surface sampling hole ice-free.

Depth (*m.*)	*Time* (*hr.*)
0.02 ..	0.49
1.00 ..	0.28
2.00 ..	0.06
3.00 ..	0.04
4.00 ..	0.03
5.00 ..	0.02
6.00 ..	0.01
7.00 ..	0.01
8.00 ..	0.01
9.00 ..	0 00
10.00 ..	0.00

Mawson, Antarctica — 67°36′S. lat.; 62°53′E. long.

Station 1 — SOLAR RADIATION

19.1.57 — Sun totally unobscured. Harbour completely free of ice; water surface strongly rippled.

Depth (m.)	Time (hr.)			
	1015	1115	1215	1355
0.02	0.40	0.46	0.49	0.48
1.00	0.15	0.19	0.22	0.23
2.00	0.13	0.15	0.17	0.14
3.00	0.10	0.11	0.13	0.12
4.00	0.08	0.09	0.09	0.10
5.00	0.06	0.06	0.07	0.07
6.00	0.04	0.05	0.05	0.05
7.00	0.03	0.04	0.04	0.05
8.00	0.03	0.03	0.03	0.03
9.00	0.03	0.03	0.03	0.03
10.00	0.02	0.03	0.02	0.02

Mawson, Antarctica — 67°36′S. lat.; 62°53′E. long.

Station 2 — SOLAR RADIATION

28.9.56 — No cloud. Sea ice 1.16 m. thick; light brash at surface of sampling tube.

Depth (m.)	*Time (hr.)*
	1350
0.02 ..	0.05
0.50 ..	0.01
1.00 ..	0.00

12.10.56 — No cloud. Sea ice 1.16 m. thick; light brash at surface of sampling tube.

Depth (m.)	*Time (hr.)* 1340
0.02 ..	0.05
0.50 ..	0.00

25.10.56 — No cloud. Sea ice 1.10 m. thick; light brash at surface of sampling tube.

Depth (m.)	*Time (hr.)* 1340
0.02 ..	0.06
0.50 ..	0.01

25.11.56 — No cloud. Sea ice 0.92 m. thick; metal tube removed from sampling hole; no ice surface.

Depth (m.)	*Time (hr.)* 1405
0.02 ..	0.46
0.50 ..	0.38
1.00 ..	0.17
2.00 ..	0.07
3.00 ..	0.05
4.00 ..	0.05
5.00 ..	0.04

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 2 — SOLAR RADIATION

9.12.56 — Sky completely overcast. Sea ice 0.91 m. thick; surface water in sampling hole free of ice.

Depth (m.)	*Time (hr.)* 1650
0.02 ..	0.25
0.10 ..	0.22
0.20 ..	0.19
0.30 ..	0.17
0.40 ..	0.15
0.50 ..	0.15
0.60 ..	0.13
0.70 ..	0.11
0.80 ..	0.09
0.90 ..	0.09
1.00 ..	0.08
2.00 ..	0.05
3.00 ..	0.04
4.00 ..	0.03
4.50 ..	0.03

Station 1

Mawson, Antarctica — 67°36′S. lat.; 62°53′E. long.

Date	Depth (*m.*)	Temp. (°*C*)	Cl (‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (μg. at./L.)	Eh (mv.)
1956											
19 June ..	0	−2.00	16.06	29.02	23.39	9.74	113	7.60	2.069	0.97	394
	5	−1.99	17.80	32.16	25.90	8.96	106	7.74	2.225	1.23	379
	10	−1.90	17.95	32.43	26.12	8.74	104	7.89	2.294	1.13	359
	15	−2.01	18.07	32.65	26.29	8.62	102	7.91	2.297	1.26	356
	20	−1.80	19.02	34.36	27.67			8.13	2.347		
27 June ..	0	−2.10	16.95	30.62	24.65	9.30	109	7.70	2.137	0.65	398
	5	−2.12	18.18	32.84	26.45	7.95	94	7.86	2.275	0.97	331
	10	−1.72	18.44	33.31	26.83	7.84	94	8.50	2.322	0.68	317
	15	−1.86	18.38	33.21	26.74	7.73	92	8.62	2.320	0.77	352
	20	−1.83	18.67	33.73	27.16	7.50	90	8.62	2.339	1.06	361
	24										
10 July ..	0	−1.95	18.28	33.03	26.60	8.45	101	7.30	2.297	1.48	412
	5	−2.22	18.88	34.11	27.48	8.31	99	7.56	2.314	1.35	408
	10	−2.04	18.67	33.73	27.17	7.88	94	7.70	2.314	1.39	404
	15	−1.99	18.72	33.82	27.25	8.05	97	7.75	2.319	1.45	403
	20	−1.84	18.72	33.82	27.24	7.73	93	7.64	2.316	1.68	400
	24										
23 July ..	0	−1.90	19.12	34.54	27.83	7.42	90	7.60	2.330	1.71	384
	5	−1.84	18.78	33.93	27.32	7.74	93	8.70	2.316	1.55	376
	10	−1.83	18.77	33.91	27.31	7.67	92	7.92	2.324	1.48	372
	15	−1.80	18.77	33.91	27.31	7.61	92	7.95	2.322	1.48	372
	20	−1.80						7.98			368
	24										
6 August ..	0	−2.00	18.89	34.13	27.49	7.73	93	7.62	2.328	1.61	401
	5	−1.95	18.99	34.31	27.64	7.62	92	7.81	2.328	1.58	394
	10	−1.91	18.79	33.95	27.34	7.62	92	7.89	2.328	1.55	374
	15	−1.91	18.60	33.60	27.06	7.46	89	7.95	2.324	1.52	368
	20	−1.87	18.73	33.84	27.25	6.99	84	8.06	2.334	1.65	376
	24	−1.85	18.74	33.86	27.26	7.29	88	8,02	2.330	1.58	384

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 1

Date	Depth (m.)	Temp. (°C)	Cl (‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (μg. at./L)	Eh (mv.)
1956 20 August ..	0	−1.80	18.83	34.02	27.40	7.50	90	7.73	2.328	1.65	437
	5	−1.80	18.74	33.86	27.26	7.54	91	7.84	2.316	1.65	430
	10	−1.80	18.73	33.84	27.25	7.53	91	7.95	2.329	1.65	426
	15	−1.91	18.70	33.78	27.21	7.49	90	7.99	2.327	1.65	425
	20	−1.74	18.98	34.29	27.61	7.08	86	8.07	2.336	1.65	421
	24	−1.78	18.82	34.00	27.38	7.42	90	8.06	2.330	1.52	423
4 September..	0	−1.80	18.61	33.62	27.08	6.81	82	7.74	2.322	1.48	433
	5	−1.87	18.62	33.64	27.09	7.32	88	7.84	2.316	1.48	427
	10	−1.75	18.70	33.78	27.21	7.25	87	7.91	2.330	1.45	426
	15	−1.75	18.87	34.09	27.45			7.92	2.331	1.35	424
	20		18.78	33.93	27.32	6.60		8.00	2.334	1.52	418
	24	−1.77	18.82	34.00	27.38	6.76	82	8.02	2.337	1.45	418
17 September..	0	−1.80	18.70	33.78	27.21	7.60	91	7.76	2.328	1.48	429
	5	−1.79	18.75	33.87	27.28	7.10	86	8.03	2.331	1.48	410
	10	−1.79	18.81	33.98	27.37	7.09	86	8.10	2.336	1.55	395
	15	−1.82	18.83	34.02	27.40	7.09	86	8.13	2.336	1.55	393
	20	−1.79	18.77	33.91	27.31	6.71	81	8.24	2.341	1.55	384
	24	−1.78	18.87	34.09	27.45	6.75	81	8.23	2.339	1.58	387
1 October ..	0	−1.80	18.11	32.72	26.35	7.59	92	7.67	2.280	1.61	401
	5	−1.71	18.48	33.39	26.89	6.53	79	7.87	2.306	1.71	396
	10	−1.72	18.45	33.33	26.84	7.35	88	7.94	2.314	1.74	403
	15	−1.73	18.44	33.31	26.83	7.39	89	7.97	2.319	1.68	408
	20	−1.71	18.51	33.44	26.93	7.07	85	8.01	2.322	1.81	406
	24	−1.74	18.58	33.57	27.03	7.25	87	8.02	2.322	1.74	409
15 October ..	0	−1.83	17.49	31.60	25.44	9.12	108	7.70	2.255	1.45	383
	5	−1.70	17.98	32.48	26.15	8.07	96	7.91	2.311	1.52	374
	10	−1.70	18.23	32.94	26.51	7.63	91	7.98	2.316	1.45	372
	15	−1.73	18.22	32.92	26.51	7.60	91	8.00	2.325	1.61	380
	20	−1.73	18.15	32.79	26.40	7.27	87	8.08	2.328	1.48	379
	24	−1.68	18.31	33.08	26.63	7.26	87	8.11	2.331	1.61	380

Station 1

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Date	Depth (*m*).	Temp. (°*C*)	Cl.(‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (μg. at./L.)	Eh (mv.)
1956											
12 November . .	0	−1.67	18.97	34.27	27.60	7.84	95	7.80	2.329	1.45	368
	5	−1.54	18.97	34.27	27.60	7.47	91	7.98	2.336	1.45	360
	10	−1.64	18.98	34.29	27.61	7.41	90	8.04	2.337	1.42	359
	15	−1.65	18.98	34.29	27.61	7.34	89	8.05	2.339	1.55	361
	20	−1.60	18.98	34.29	27.61	6.90	84	8.10	2.341	1.55	358
	24	−1.60	18.98	34.29	27.61	6.87	83	8.09	2.340	1.68	360
27 November . .	0	−1.39	18.61	33.62	27.07	12.22	148	8.50	2.330	0.74	333
	5	−1.36	18.96	34.25	27.57	7.97	97	8.10	2.336	1.35	354
	10	−1.51	18.96	34.25	27.57	7.75	94	8.06	2.339	1.42	355
	15	−1.54	18.99	34.31	27.63	7.29	89	8.02	2.338	1.45	361
	20		18.96	34.25	27.58	7.02		8.02	2.339	1.55	360
	24	−1.53	18.98	34.29	27.61	7.08	86	8.01	2.338	1.55	362
10 December . .	0	−0.63	8.99	16.26	27.60	8.94	98	8.14	1.600	0.35	333
	5	−1.09	18.85	34.05	27.40	8.61	106	7.94	2.330	1.10	353
	10	−1.33	18.96	34.25	27.57	8.02	98	7.96	2.337	1.13	354
	15	−1.42	18.97	34.27	27.59	7.74	94	7.96	2.337	1.26	357
	20	−1.46	18.97	34.27	27.59	7.36	90	7.97	2.338	1.39	358
	24	−1.47	18.97	34.27	27.59	7.44	91	7.97	2.337	1.32	360
23 December . .	0	+0.95	2.55	4.63	3.73	7.82	83	7.51	0.475	0.00	334
	5	−1.32	18.87	34.09	27.44	8.86	108	8.02	2.339	1.16	346
	10	−1.38	18.93	34.20	27.53	8.45	103	8.06	2.340	1.29	347
	15	−1.41	18.94	34.22	27.54	8.03	98	8.05	2.341	1.32	359
	20	−1.53	18.94	34.22	27.54	6.76	82	8.08	2.342	1.48	361
	24	−1.52	18.94	34.22	27.54	7.30	89	8.06	2.338	1.48	362
1957											
1 January . .	0	+0.47	0.62	1.15	<1.43	7.33	75	6.87	0.475	0.00	412
	5	−0.89	18.86	34.07	27.42	8.08	100	7.94	2.340	1.48	357
	10	−1.47	18.94	34.22	27.54	7.55	92	7.97	2.341	1.42	357
	15	−1.50	18.96	34.25	27.57	7.62	93	8.01	2.341	1.42	355
	20	−1.58	18.96	34.25	27.58	7.08	86	8.02	2.342	1.55	356
	24	−1.58	18.98	34.29	27.61	7.02	85	8.01	2.342	1.65	359

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 1

Date	Depth (*m*).	Temp. (°*C*)	Cl. (‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (μg. at./L.)	Eh (mv.)
1957											
9 January ..	0	−0.45	17.82	32.20	25.89	9.11	112	7.92	2.316	0.97	351
	5	−0.37	18.71	33.80	27.17	9.68	121	7.98	2.339	1.16	352
21 January ..	0	+0.25	18.47	33.37	26.79	9.09	115	7.98	2.336	0.94	368
	5	−0.07	18.63	33.66	27.04	8.89	112	8.10	2.342	0.84	366
	10	−0.57	18.73	33.84	27.21	8.76	109	8.12	2.343	0.71	368
	15	−0.59	18.77	33.91	27.27	8.64	107	8.12	2.343	0.74	370
	20	−0.95	18.79	33.95	27.32	8.18	101	8.16	2.344	0.97	367
	24	−1.17	18.85	34.05	27.40	8.18	101	8.14	2.343	1.10	369
7 February ..	0	−1.00	18.08	32.66							

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 2

Date	Depth (*m*).	Temp. (°*C*)	Cl. (‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (μg. at./L.)	Eh (mv.)
1956											
5 July ..	0	−1.90	13.55	24.49	19.68	11.92	134	7.42	2.175	0.87	429
	10	−1.87	13.45	24.31	19.53	11.23	126	7.54	1.487	0.81	385
	25		14.65	26.47		10.26		7.62	1.887	0.58	376
	50	−1.63	9.00	16.28	13.04	8.48	90	7.68	1.787	0.00	370
	75	−1.57				8.33					376
	100	−1.65	15.25	27.56	22.16	10.29	119	7.74	1.787	1.03	370
16 July ..	0	−1.90	9.60	17.36	13.91	6.79	73	7.44	1.637	1.03	405
	10	−1.88	15.62	28.22	22.70	7.58	87	7.56	2.006	1.42	405
	15	−1.83	15.32	27.68	22.26	7.49	86	7.68	2.000	1.19	394
	50	−1.69	15.28	27.61	22.20	7.66	88	7.75	1.962	0.97	392
	75	−1.64	16.78	30.32	24.40	6.73	79	7.74	2.131	1.65	393
	100	−1.65	15.13	27.34	21.98	8.89	104	7.79	2.006	1.52	382

Station 2

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Date	Depth (*m*).	Temp. (°*C*)	Cl. (‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (μg. at./L.)	Eh (mv.)
1956											
30 July ..	0	−1.90	16.00	28.91	23.25	10.57	122	7.70	2.132	1.29	403
	10	−1.84	16.11	29.11	23.41	10.27	119	7.84	2.131	1.32	397
	25	−1.71	16.59	29.97	24.12	9.37	110	7.92	2.187	1.39	394
	50	−1.73	16.95	30.62	24.64	9.09	107	7.96	2.187	1.35	395
	75	−1.67	13.50	24.40	19.61	7.78	88	8.02	1.975	1.23	393
	100	−1.57	17.25	31.17	25.08	8.58	102	7.98	2.241	1.68	395
13 August ..	0	−1.85	18.22	32.92	26.51	8.40	100	7.67	2.306	1.26	441
	10	−1.86	17.97	32.47	26.14	8.60	102	7.82	2.284	1.42	431
	25	−1.67	17.64	31.87	25.66	8.50	101	7.91	2.280	1.35	422
	50	−1.62	17.76	32.09	25.83	7.96	95	7.94	2.287	1.48	417
	75	−1.58	17.92	32.38	26.06	7.78	93	7.96	2.287	1.61	416
	100	−1.61	18.17	32.83	26.43	7.89	95	7.99	2.301	1.48	414
27 August ..	0	−1.85	17.70	31.98	25.74	8.50	101	7.69	2.271	1.32	421
	10	−1.78	17.05	30.81	24.79	9.20	108	7.85	2.212	1.35	413
	25	−1.66	16.75	30.26	24.35	8.90	105	7.95	2.212	1.26	395
	50	−1.66	16.97	30.66	24.67	8.86	105	7.95	2.225	1.19	395
	75	−1.64	17.05	30.81	24.79	8.62	102	8.00	2.233	1.39	395
	100	−1.72	17.71	32.00	25.76	8.29	99	8.03	2.281	1.39	394
10 September..	0	−1.85	16.37	29.58	23.82	9.75	113	7.79	2.225	1.32	429
	10	−1.80	17.15	30.99	24.93	8.99	106	7.95	2.256	1.35	422
	25	−1.74	17.37	31.38	25.26	8.74	103	8.01	2.272	1.52	413
	50	−1.62	17.23	31.13	25.05	8.57	101	8.06	2.272	1.48	413
	75	−1.60	16.97	30.66	24.67	7.73	91	8.10	2.259	1.61	409
	100	−1.62	17.85	32.25	25.96	7.81	93	8.12	2.302	1.52	409
24 September..	0	−1.70	17.85	32.25	25.96	8.12	97	7.71	2.287	1.35	411
	10	−1.74	17.49	31.60	25.44	8.36	99	7.84	2.266	1.55	404
	25	−1.70	17.46	31.55	25.39	8.17	97	7.94	2.281	1.52	395
	50	−1.57	17.82	32.20	25.92	7.78	93	7.94	2.302	1.52	401
	75	−1.59	18.01	32.54	26.19	7.55	91	8.00	2.309	1.71	399
	100	−1.63	18.21	32.90	26.48	7.60	91	8.01	2.316	1.65	399

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 2

Date	Depth (*m*).	Temp. (°*C*)	Cl. (‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (µg. at./L.)	Eh (mv.)
1956 9 October ..	0	−1.75	18.35	33.15	26.69	7.51	90	7.74	2.309	1.32	406
	10	−1.73	18.53	33.48	26.96	7.09	85	7.86	2.320	1.45	390
	25	−1.67	18.70	33.78	27.21	6.36	77	7.96	2.330	1.45	385
	50	−1.66	18.68	33.75	27.18	6.27	76	7.96	2.330	1.42	388
	75	−1.59	18.69	33.77	27.19	6.45	78	8.02	2.336	1.55	384
	100	−1.61	18.80	33.96	27.35	6.62	80	7.97	2.330	1.52	390
22 October ..	0	−1.85	16.06	29.02	23.34	10.37	120	7.70	2.137	1.10	400
	10	−1.75	16.79	30.34	24.41	9.79	115	7.88	2.212	1.26	394
	25	−1.69	17.45	31.53	25.37	8.96	106	7.94	2.279	1.42	397
	50	−1.63	17.20	31.08	25.01	8.60	102	7.94	2.269	1.42	404
	75	−1.58	17.31	31.27	25.17	8.09	96	7.99	2.277	1.55	403
	100	−1.59	17.27	31.20	25.11	8.34	99	7.98	2.272	1.48	398
9 November ..	0	−1.66	17.70	31.98	25.74	8.79	105	7.75	2.271	1.32	363
	10	−1.64	18.00	32.52	26.18	8.33	100	7.88	2.295	1.39	357
	25	−1.60	18.26	32.99	26.56	7.62	92	7.94	2.316	1.55	357
	50	−1.60	18.30	33.06	26.61	7.41	89	7.94	2.317	1.55	360
	75		18.23	32.94	26.51	7.26		8.00	2.321	1.61	359
	100	−1.56	18.39	33.22	26.75	7.15	87	8.01	2.327	1.61	360
19 November ..	0	−1.55	18.93	34.20	27.54	8.06	98	7.76	2.330	1.32	361
	10	−1.51	18.97	34.27	27.59	7.56	92	7.89	2.334	1.32	359
	25	−1.60	19.00	34.33	27.64	7.19	87	7.96	2.337	1.45	359
	50	−1.56	19.00	34.33	27.64	6.98	85	7.97	2.337	1.61	364
	75	−1.54	18.99	34.31	27.63	6.73	82	7.99	2.338	1.55	364
	100	−1.53	19.00	34.33	27.64	6.86	83	7.98	2.337	1.55	367
4 December ..	0	−1.10	15.90	28.73	23.10	14.45	171	8.86	2.087	0.71	310
	10	−1.37	18.94	34.22	27.54	7.64	93	8.06	2.334	1.35	356
	25	−1.51	18.98	34.29	27.60	7.29	89	7.97	2.337	1.42	357
	50	−1.58	18.98	34.29	27.60	7.06	86	7.97	2.336	1.48	360
	75	−1.56	18.99	34.31	27.62	6.79	83	7.97	2.337	1.61	360
	100	−1.51	18.99	34.31	27.62	6.79	83	7.97	2.337	1.61	362

Station 2

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Date	Depth (*m*).	Temp. (°*C*)	Cl. (‰)	S (‰)	σt	O_2 (ml./L.)	O_2 (%)	pH	B.C.	Dissolved PO_4 (μg. at./L.)	Eh (mv.)
1956											
17 December ..	0	+0.13	4.72	8.55	6.85	10.06	107	8.28	1.250	0.71	319
	10	−1.08	18.86	34.07	27.42	8.48	104	7.93	2.334	1.16	353
	25	−1.58	18.97	34.27	27.59	6.87	84	7.90	2.338	1.55	356
	50	−1.56	18.98	34.29	27.60	6.82	83	7.90	2.339	1.52	360
	75	−1.54	18.99	34.31	27.62	6.65	81	7.90	2.338	1.61	360
	100	−1.54	19.00	34.33	27.63	6.71	82	7.90	2.338	1.61	360
1957											
14 January ..	0	+0.68	13.23	23.91	19.19	9.48	114	8.02	1.912	0.65	351
	10	−1.14	18.87	34.09	27.43	8.54	105	7.99	2.340	1.48	363
	25		18.96	34.25	27.57	7.47		8.00	2.342	1.48	368
	50	−1.60	19.00	34.33	27.63	7.39	90	8.02	2.342	1.68	370
	75	−1.63	19.00	34.33	27.64	6.99	85	8.04	2.342	1.74	371
	100	−1.58	19.02	34.36	27.67	7.06	86	8.02	2.342	1.71	372
28 January ..	0	−1.35	18.48	33.39	26.88	8.05	98	7.76	2.341	1.26	370
	10	−1.41	18.55	33.51	26.98	8.18	100	7.86	2.340	1.39	371
	25	−1.53	18.62	33.64	27.08	7.98	97	7.92	2.341	1.32	374
	50	−1.50	18.68	33.75	27.17	7.99	97	7.95	2.341	1.45	376
	75	−1.35	18.75	33.87	27.12	7.99	97	7.96	2.341	1.45	376
	100	−1.26	18.82	34.00	27.37	7.99	98	7.98	2.341	1.45	373

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

CHLOROPHYLL CONCENTRATIONS IN THE SEA WATER (mgm./m.^{3})

Station 1

<table>
<tr><th rowspan="2">Depth (m.)</th><th colspan="7">Date</th></tr>
<tr><th>12.11.56</th><th>28.11.56</th><th>10.12.56</th><th>23.12.56</th><th>1.1.57</th><th>10.1.57</th><th>21.1.57</th></tr>
<tr><td>0 .. ..</td><td rowspan="2">0.67</td><td rowspan="2">0.43</td><td rowspan="2">0.75</td><td>3.22</td><td>0.00</td><td>0.33</td><td>1.50</td></tr>
<tr><td>5 .. ..</td><td>3.92</td><td>2.90</td><td>0.70</td><td>1.45</td></tr>
<tr><td>10 .. ..</td><td rowspan="2">0.38</td><td rowspan="2">0.13</td><td rowspan="2">1 25</td><td>3.38</td><td>1.70</td><td></td><td>2.42</td></tr>
<tr><td>15 .. ..</td><td>3.30</td><td>2.70</td><td></td><td>1.72</td></tr>
<tr><td>20 .. ..</td><td rowspan="2">0.50</td><td rowspan="2">0.22</td><td rowspan="2">1.42</td><td>1.43</td><td>1.43</td><td></td><td>2.15</td></tr>
<tr><td>24 .. ..</td><td>1.40</td><td>1.40</td><td></td><td>1.40</td></tr>
</table>

Station 2

<table>
<tr><th rowspan="2">Depth (m.)</th><th colspan="5">Date</th></tr>
<tr><th>20.11.56</th><th>5.12.56</th><th>17.12.56</th><th>15.1.57</th><th>29.1.57</th></tr>
<tr><td>0 .. ..</td><td rowspan="2">0.23</td><td rowspan="2">0.88</td><td>0.38</td><td>0.15</td><td>1.20</td></tr>
<tr><td>10 .. ..</td><td>0.73</td><td>0.30</td><td>1.00</td></tr>
<tr><td>25 .. ..</td><td rowspan="2">0.13</td><td rowspan="2">0.38</td><td>0.14</td><td>0.42</td><td>1.27</td></tr>
<tr><td>50 .. ..</td><td>0.00</td><td>0.30</td><td>1.30</td></tr>
<tr><td>75 .. ..</td><td rowspan="2">0.06</td><td rowspan="2">0.13</td><td>0.00</td><td>0.14</td><td>2.15</td></tr>
<tr><td>100 .. ..</td><td>0.00</td><td>0.00</td><td>1.95</td></tr>
</table>

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

PHYTOPLANKTON*

Station 1 — Numbers of phytoplankton or organisms/litre of sea water (× 10^{-6})

Depth (m.)	3.11.56	12.11.56	22.11.56	10.12.56	10.12.56	23.12.56	1.1.57	9.1.57	9.1.57	21.1.57	21.1.57	21.1.57
	Diatoms	Diatoms	Diatoms	Diatoms	*Chlamydomonas* sp. ?	Diatoms	Diatoms	Diatoms	Dino-flagellates	Diatoms	Dino-flagellates	Silico-flagellates
0 ..	0.096	0.117	0.086	0.089	0.240	0.118	0.000	0.510	0.009	0.883	0.004	
5 ..		0.163	0.097	0.394	0.009	5.120	10.493	1.421	0.020	1.188	0.008	0.001
10 ..		0.229	0.130	0.791		3.979	6.408			0.864	0.043	
15 ..		0.394	0.191	0.852		2.771	8.216			1.348	0.004	
20 ..		0.216	0.156	0.705		1.368	2.790			1.191	0.003	0.001
24 ..		0.206	0.130	0.497		1.075	1.660			1.547	0.001	

* Phytoplankton first observed in very small numbers in mid-September.

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

PHYTOPLANKTON

Station 2 — Numbers of phytoplankton organisms/litre of sea water (× 10^{-6})

Depth (m.)	22.10.56	6.11.56	19.11.56	4.12.56	17.12.56	14.1.57	14.1.57	14.1.57	28.1.57	28.1.57	28.1.57
	Diatoms	Diatoms	Diatoms	Diatoms	Diatoms	Diatoms	Green flagellates	Dino-flagellates	Diatoms	Dino-flagellates	Silico-flagellates
0	0.048	0.064	0.103	0.654	0.066	0.007	0.118		2.086		
10	0.064	0.079	0.130	0.193	0.852	0.956		0.003	2.465		0.003
25	0.068	0.052	0.109	0.139	0.400	0.600			1.639	0.003	0.003
50	0.043	0.021	0.077	0.217	0.137	0.634			1.502	0.001	0.004
75	0.057	0.013	0.043	0.137	0.061	0.257			1.455		0.003
100	0.004		0.004	0.022	0.035	0.106			1.195	0.001	0.003

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

PROTOZOA INCLUDING COLOURLESS FLAGELLATES (Counts × 10^{-6}/L.)

Station 1

(X — Numbers not counted but presence noted)

Date	Depth (*m.*)	Flagellata				Coccolithophoridae	Ciliata
		Types a & b	Type c	Type d	Type e		
22 August ..	0		X			—	
	5		X			X	
	10		X			—	
	15		X			X	
	20		X			X	
	24		X			—	
5 September ..	0		—				
	5		X				
	10		—				
	15		—				
	20		—				
	24		—				
17 September ..	0		X				
	5		X				
	10		—				
	15		—				
	20		—				
	24		—				
2 October ..	0		X				
	5		X				
	10		X				
	15		X				
	20		X				
	24		X				
16 October ..	0		X	—			X
	5		—	X			—
	10		—	—			X
	15		X	—			—
	20		X	—			—
	24		X	—			—
3 November ..	0		0.004				X
	5		—				—
	10		—				—
	15		—				—
	20		—				—
	24		—				—
12 November ..	0		0.009				X
	5		0.017				—
	10		0.004				—
	15		0.009				—
	20		0.022				—
	24		0.021				—
27 November ..	0		0.004	X			0.334
	5		0.008	—			0.025
	10		0.004	—			0.013
	15		—	—			—
	20		0.009	—			—
	24		—	—			—

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.
PROTOZOA INCLUDING COLOURLESS FLAGELLATES (Counts × 10^{-6}/L.)

(X — Numbers not counted but presence noted)

Date	Depth (*m.*)	Flagellata				Coccolithophoridae	Ciliata
		Types a & b	Type c	Type d	Type e		
1956							
10 December ..	0	21.444	—				
	5	—	—				
	10	—	—				
	15	—	—				
	20	—	0.004				
	24	—	0.004				
23 December ..	0	7.826	—				
	5	—	—				
	10	—	—				
	15	—	—				
	20	—	—				
	24	—	X				
1957							
1 January ..	0		—				
	5		X				
	10		—				
	15		X				
	20		X				
	24		X				
9 January ..	0		0.010	0.102			
21 January ..	0		0.063		—		
	5		0.018		—		
	10		—		17.311		
	15		—		22.534		
	20		—		13.433		
	24		—		15.828		

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.
PROTOZOA INCLUDING COLOURLESS FLAGELLATES (Counts × 10^{-6}/L.)

Station 2

(X — Numbers not counted but presence noted)

Date	Depth (*m.*)	Flagellata				Coccolithophoridae	Ciliata
		Types a & b	Type c	Type d	Type e		
1956							
6 July.. ..	0					—	
	10					—	
	25					X	
	50					X	
	75					—	
	100					—	
17 July.. ..	0					—	
	10					—	
	25					X	
	50					X	
	75					—	
	100					—	

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

PROTOZOA INCLUDING COLOURLESS FLAGELLATES (Counts × 10^{-6}/L.)

Station 2

(X — Numbers not counted but presence noted)

Date	Depth (*m.*)	Flagellata				Coccolithophoridae	Ciliata
		Types a & b	Type c	Type d	Type e		
1956							
31 July	0					—	
	10					—	
	25					X	
	50					X	
	75					—	
	100					—	
14 August . .	0						
	10						
	25						
	50						
	75						
	100						
28 August . .	0		—				
	10		X				
	25		—				
	50		X				
	75		—				
	100		—				
11 September . .	0					—	
	10					—	
	25					X	
	50					X	
	75					—	
	100					—	
25 September . .	0		X				
	10		X				
	25		X				
	50		X				
	75		X				
	100		X				
9 October . .	0		—				
	10		—				
	25		—				
	50		X				
	75		—				
	100		X				
22 October . .	0		0.022				
	10		0.026				
	25		0.009				
	50		0.004				
	75		0.039				
	100		0.004				
6 November . .	0		0.076				
	10		0.129				
	25		0.004				
	50		—				
	75		—				
	100		—				

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

PROTOZOA INCLUDING COLOURLESS FLAGELLATES (Counts × 10^{-6}/L.)

Station 2

(X — Numbers not counted but presence noted)

Date	Depth (*m.*)	Flagellata				Coccolithophoridae	Ciliata
		Types a & b	Type c	Type d	Type e		
1956							
19 November ..	0		0.023				
	10		0.004				
	25		—				
	50		—				
	75		—				
	100		0.009				
4 December ..	0		—	0.008			
	10		0.013	0.004			
	25		—	—			
	50		—	—			
	75		0.009	—			
	100		0.013	—			
17 December ..	0	21.964	—				—
	10	—	—				X
	25	—	0.009				—
	50	—	—				—
	75	—	0.004				—
	100	—	0.009				—
1957							
14 January ..	0	0.128	—				
	10	—	—				
	25	—	0.009				
	50	—	—				
	75	—	—				
	100	—	—				
28 January ..	0		0.055		1.083		
	10		0.088		1.083		
	25		0.039		0.633		
	50		0.030		0.422		
	75		0.065		0.428		
	100		0.016		—		

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.

Station 1 — ZOOPLANKTON

Date	Time (*hr.*)	Number of Organisms*							
		Siphonophora	*Ctenophora*	*Chaetognatha*	*Polychaeta*	*Copepoda*	*Amphipoda*	*Euphausidacea*	*Tunicata*
1956									
1 May	1400					—	1		1
27 June	1330					1,650			
9 July	1330					56			
6 August	1415					—			
17 September	1400					34	72		
1 October	1430					4			
15 October	1415					6			
12 November	1415					60	4		
27 November	1630					42	4		
10 December	1345					19	28		
23 December	1100					155	15		
1957									
1 January	1430	1				112	9		
†**8 January**	**1910**					**18,200**	**10**		
8 January	1920					8,250	3		
19 January	**1315**					**135**			
19 January	1330				80	370	3	320	
21 January	1445				40	310		80	
21 January	**1915**				**30**	**660**	**10**	**240**	
28 January	1335				20	130			
7 February	1910	1			100	4,460		1,090	80
10 February	1345		X		50	5,600	2	2,600	80

*Numbers not recorded (X). † Horizontal hauls of five min. duration at surface are in bold type.

MAWSON, ANTARCTICA — 67°36′S. lat.; 62°53′E. long.
Station 2 — ZOOPLANKTON

Date	Time (*hr.*)	Number of Organisms*							
		Siphonophora	*Ctenophora*	*Chaetognatha*	*Polychaeta*	*Copepoda*	*Amphipoda*	*Euphausidacea*	*Tunicata*
1956									
4 July	1430					3,360			
16 July	1400					114			
30 July	1400					16			
13 August	1200	1				88	4		
10 September	1130	1				236	2		
24 September	1130					—			
9 October	1200					—			
22 October	1430					232			
6 November	1430	1				78	10		
19 November	1445					26			
4 December	1445	1	X	2		245			
1957									
†8 January	**2000**					**50,900**			
14 January	**2030**					**1,150**			
29 January	**1925**		**X**		**45**	**280**		**35**	

* Numbers not recorded (X). † Horizontal hauls of five min. duration at surface are in bold type.

APPENDIX 2

GRAPHICAL ILLUSTRATIONS

APPENDIX 2: FIGURES 2-45, GRAPHICAL ILLUSTRATIONS.

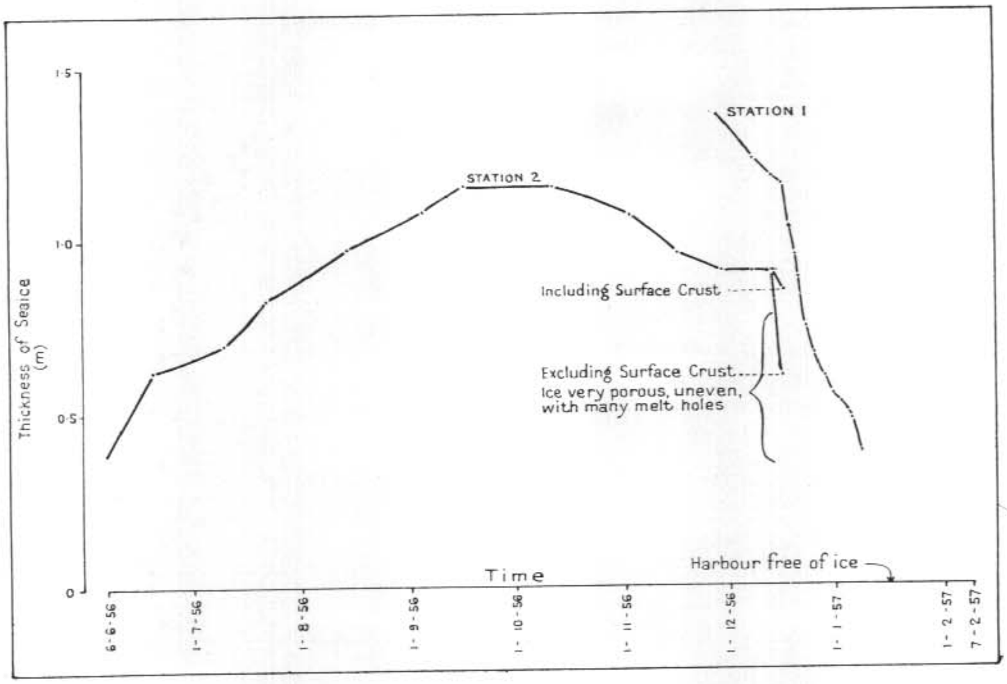


FIG. 2—Changes in thickness of the sea ice at Mawson, 1956-7.

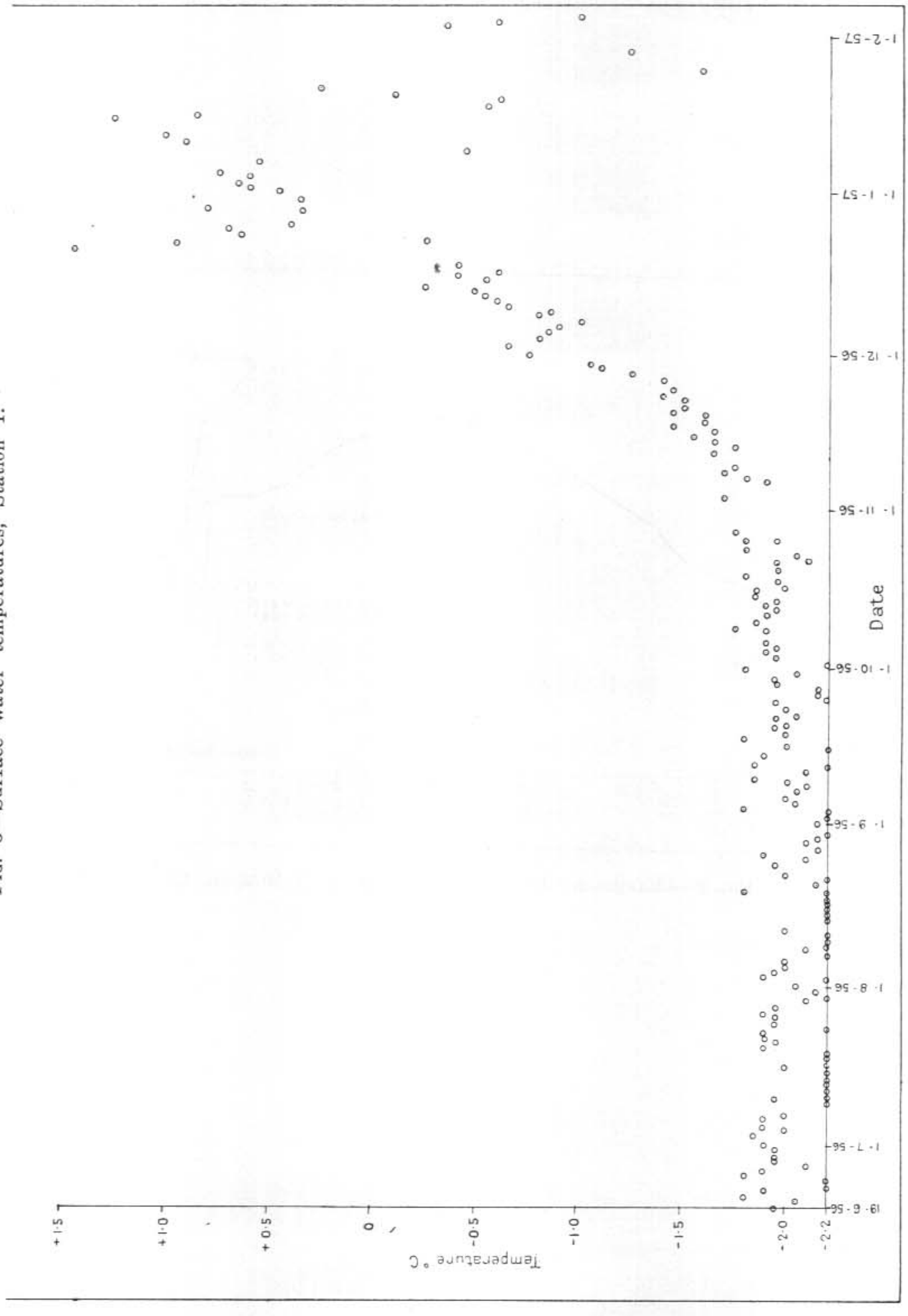


FIG. 3—Surface water temperatures, Station 1.

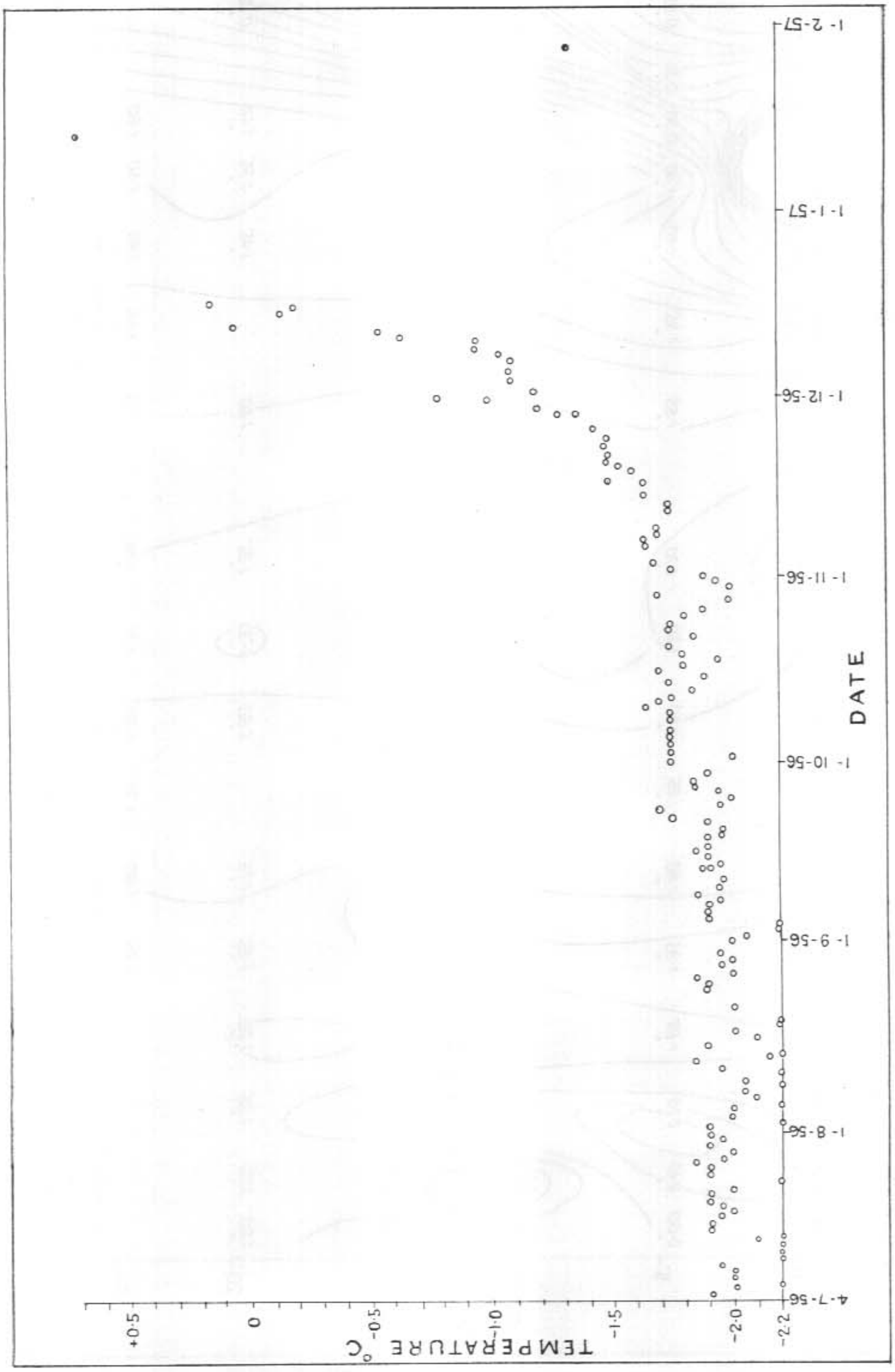


Fig. 4—Surface water temperatures, Station 2.

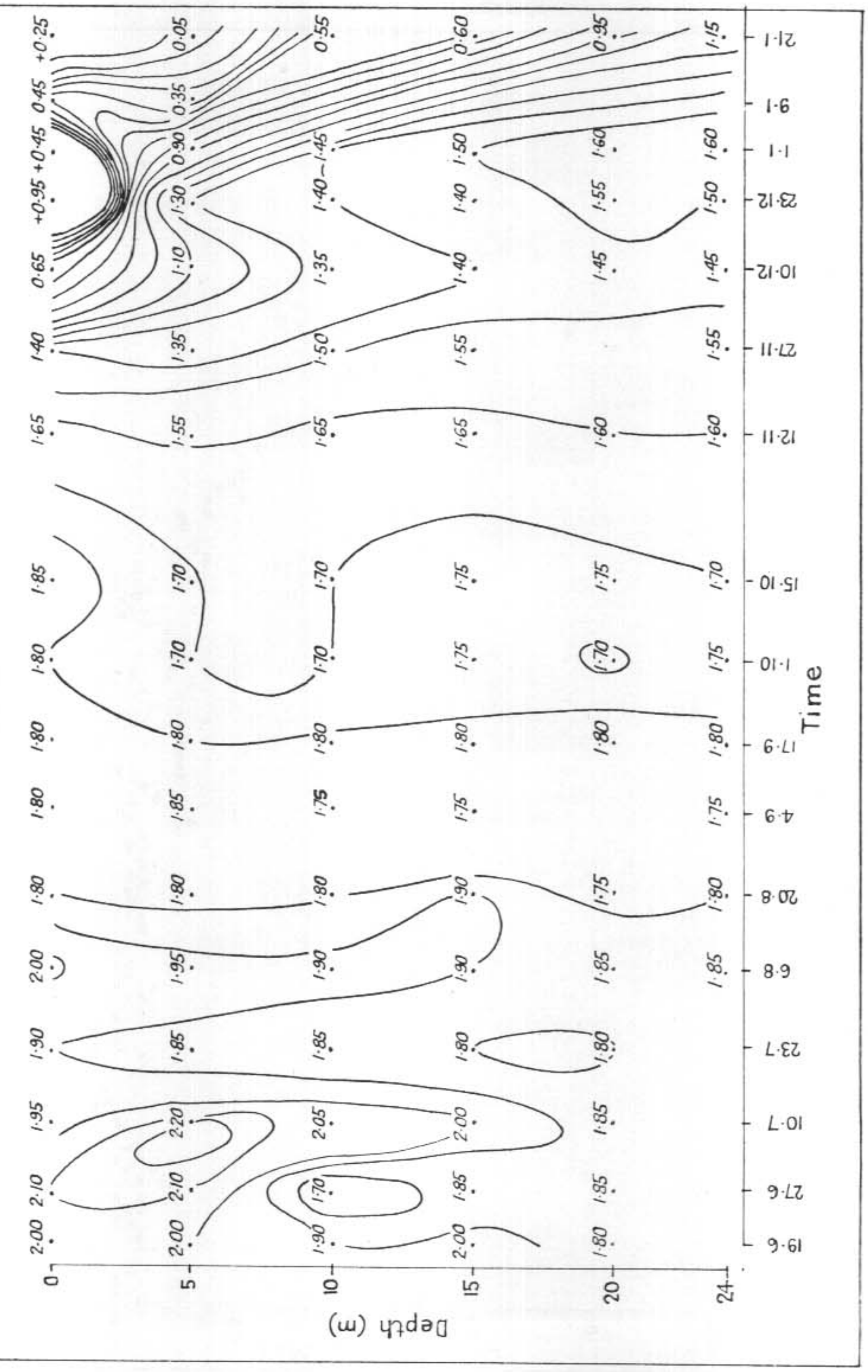


FIG. 5—Isopleths of temperature (°C) at Station 1. (Unless otherwise indicated, all temperatures are below 0°C.)

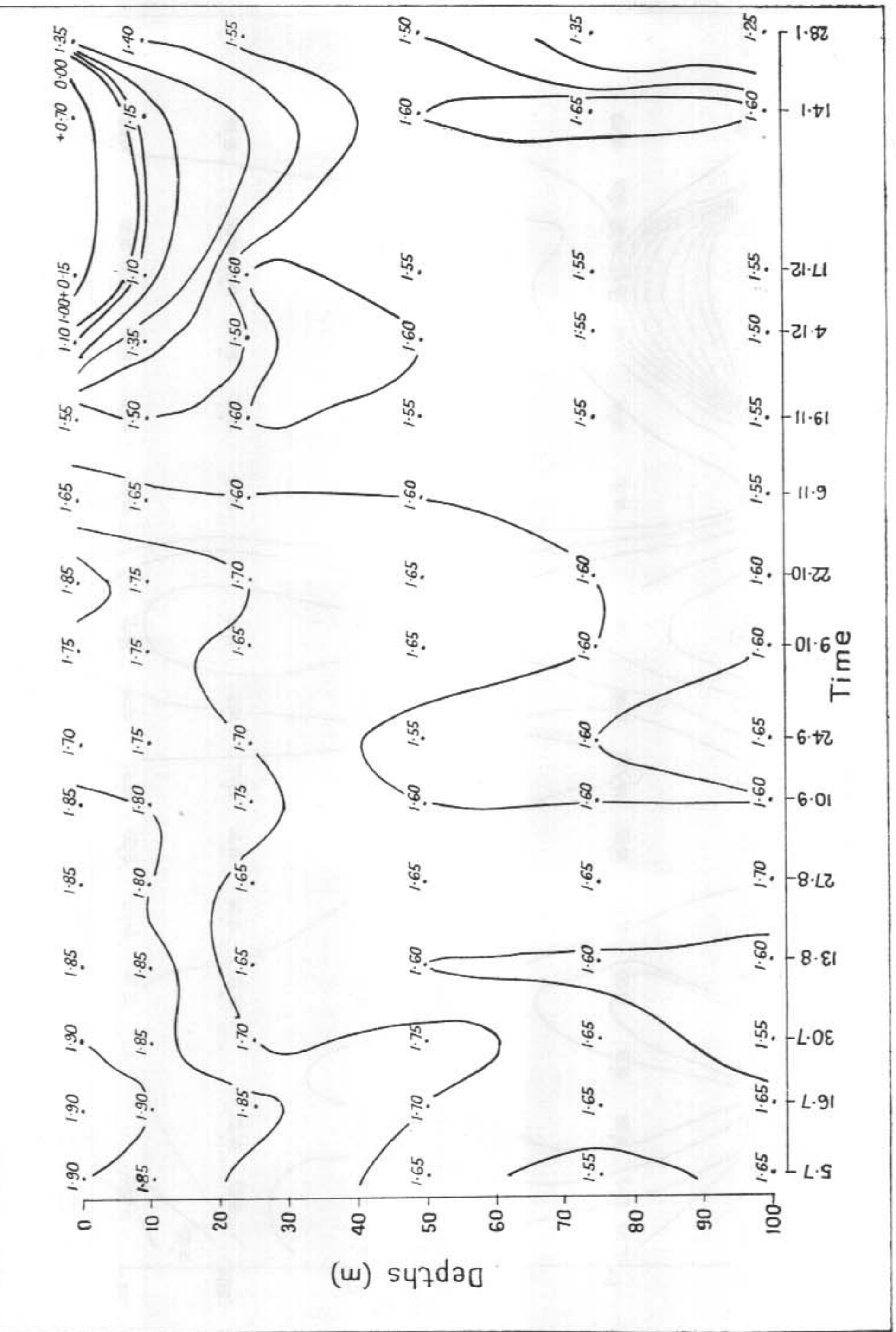


FIG. 6—Isopleths of temperature (0°C) at Station 2. (Unless otherwise indicated, all temperatures are below 0°C.)

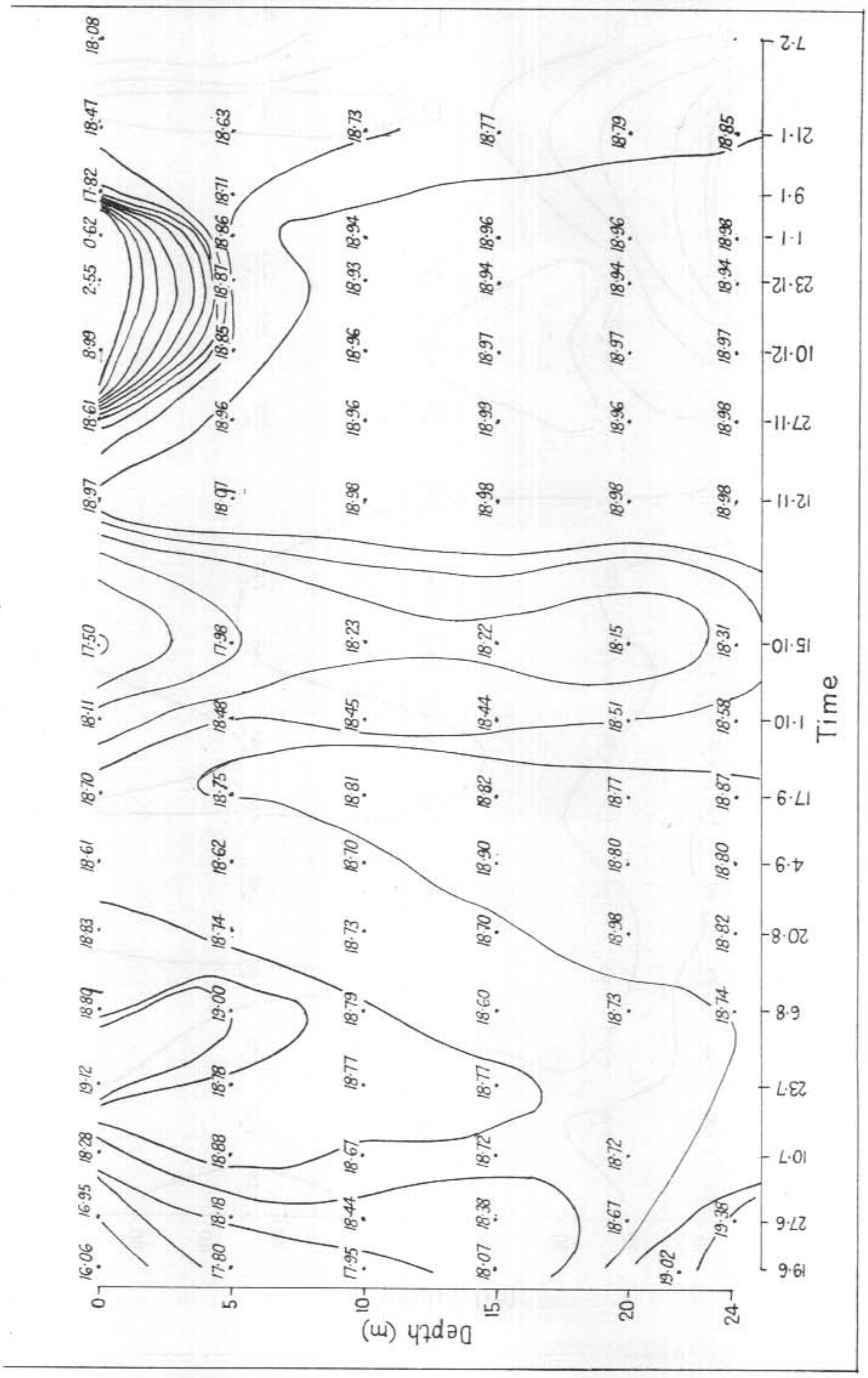


FIG. 7—Isopleths of chlorinity at Station 1.

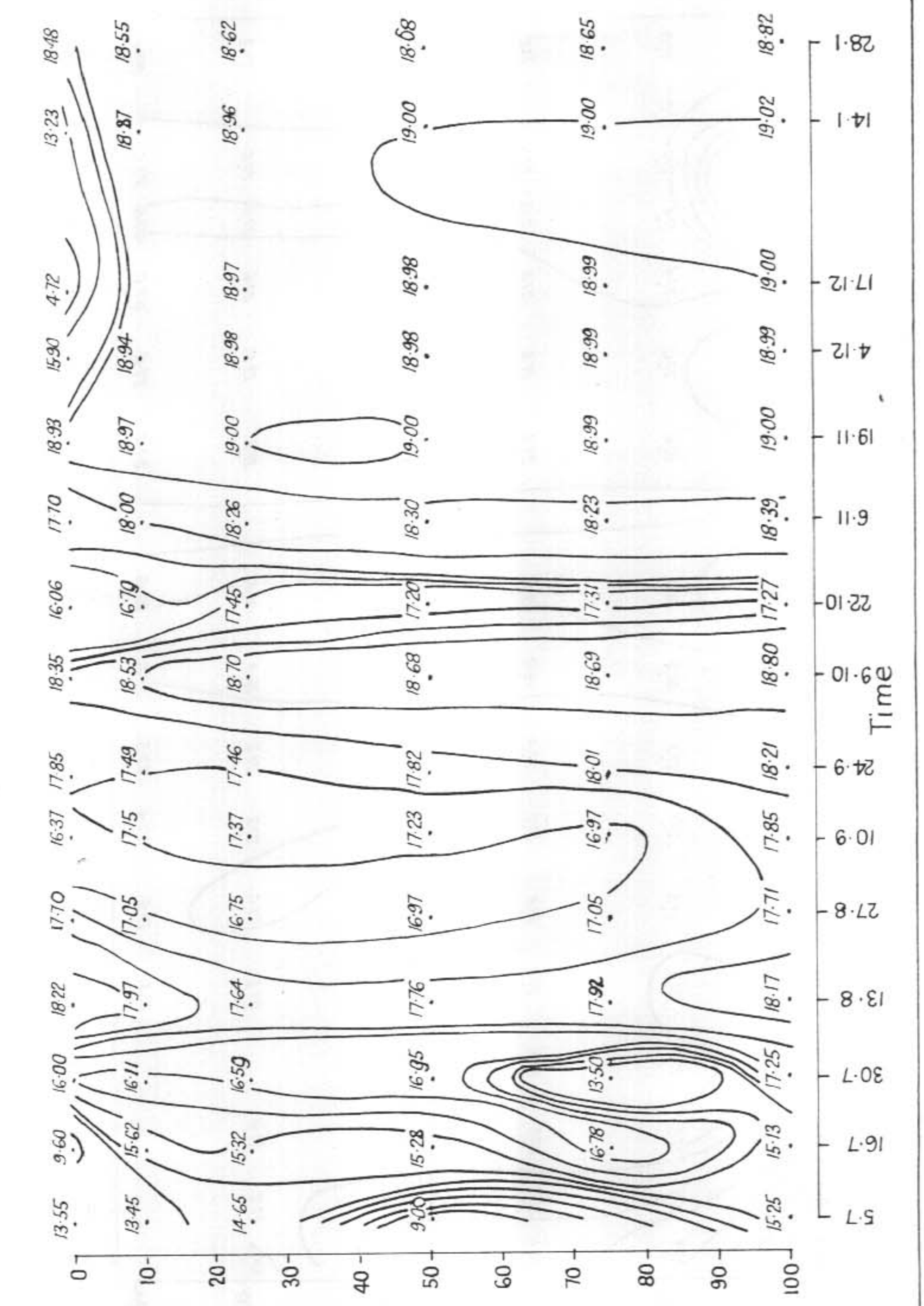


FIG. 8.—Isopleths of chlorinity at Station 2.

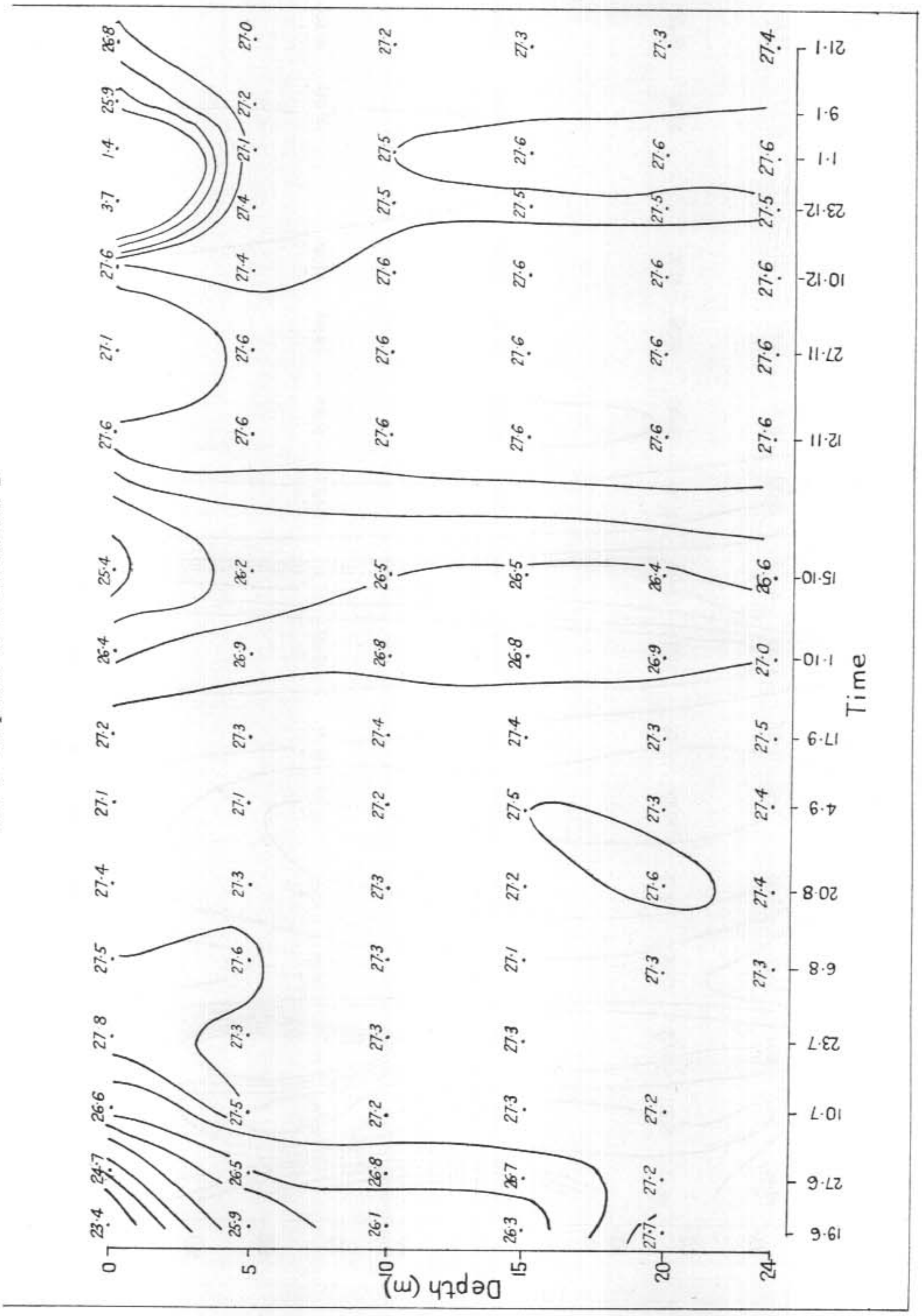


FIG. 9—Isopleths of σt at Station 1.

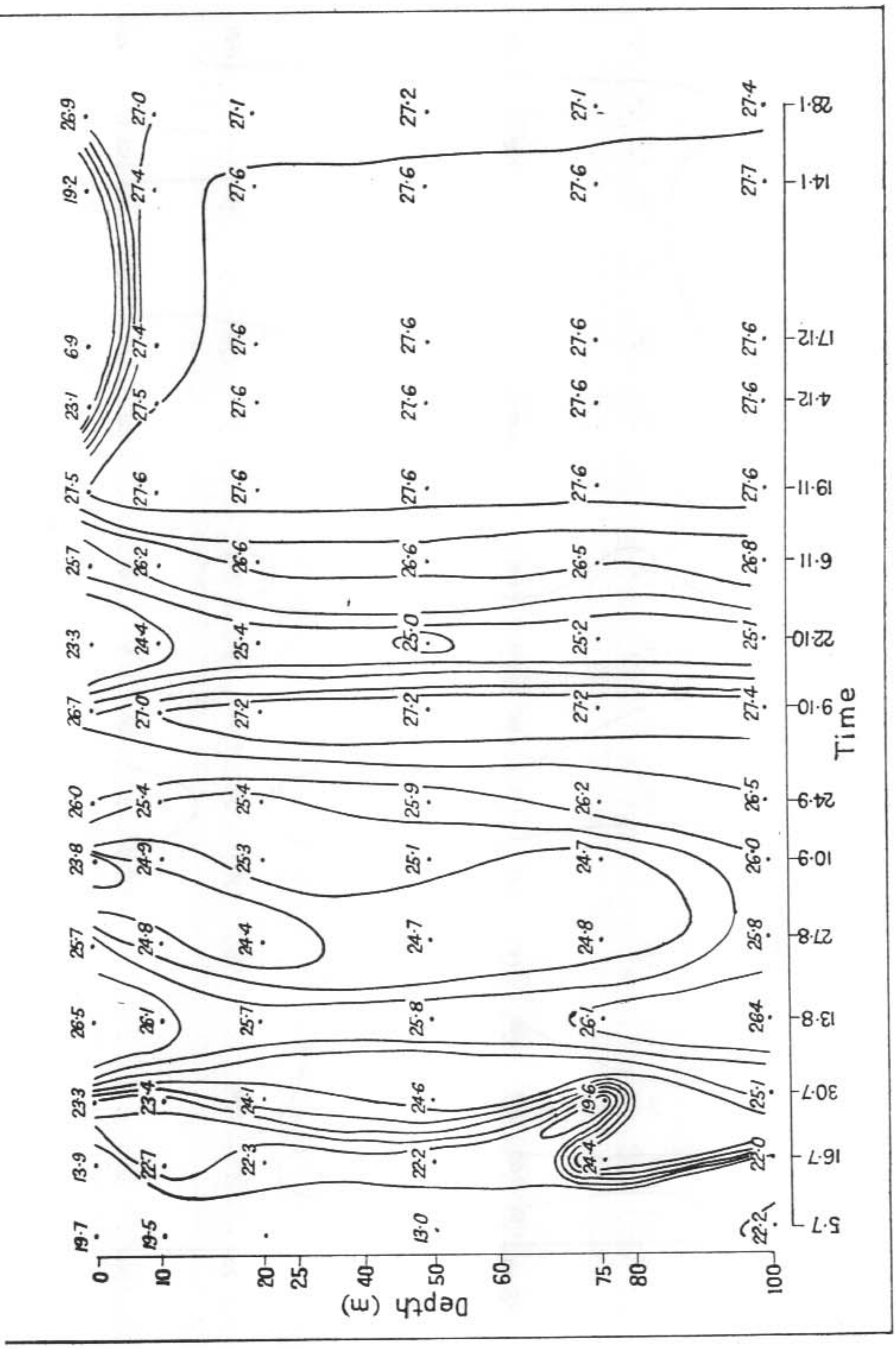


FIG. 10—Isopleths of σt at Station 2.

FIG. 11—Isopleths of dissolved phosphate (μg at./L) at Station 1.

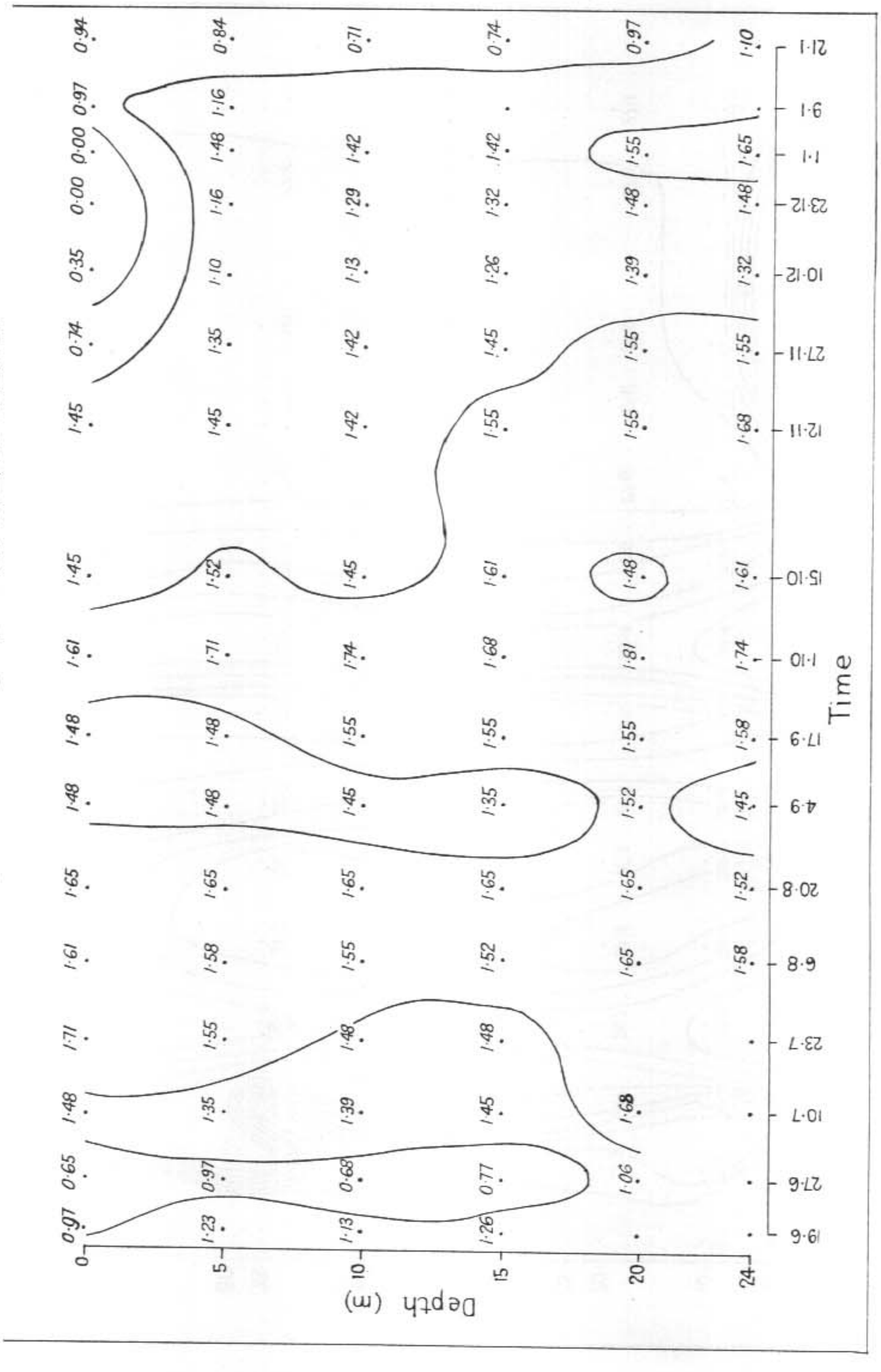


FIG. 12—Isopleths of dissolved phosphate (μg at./L) at Station 2.

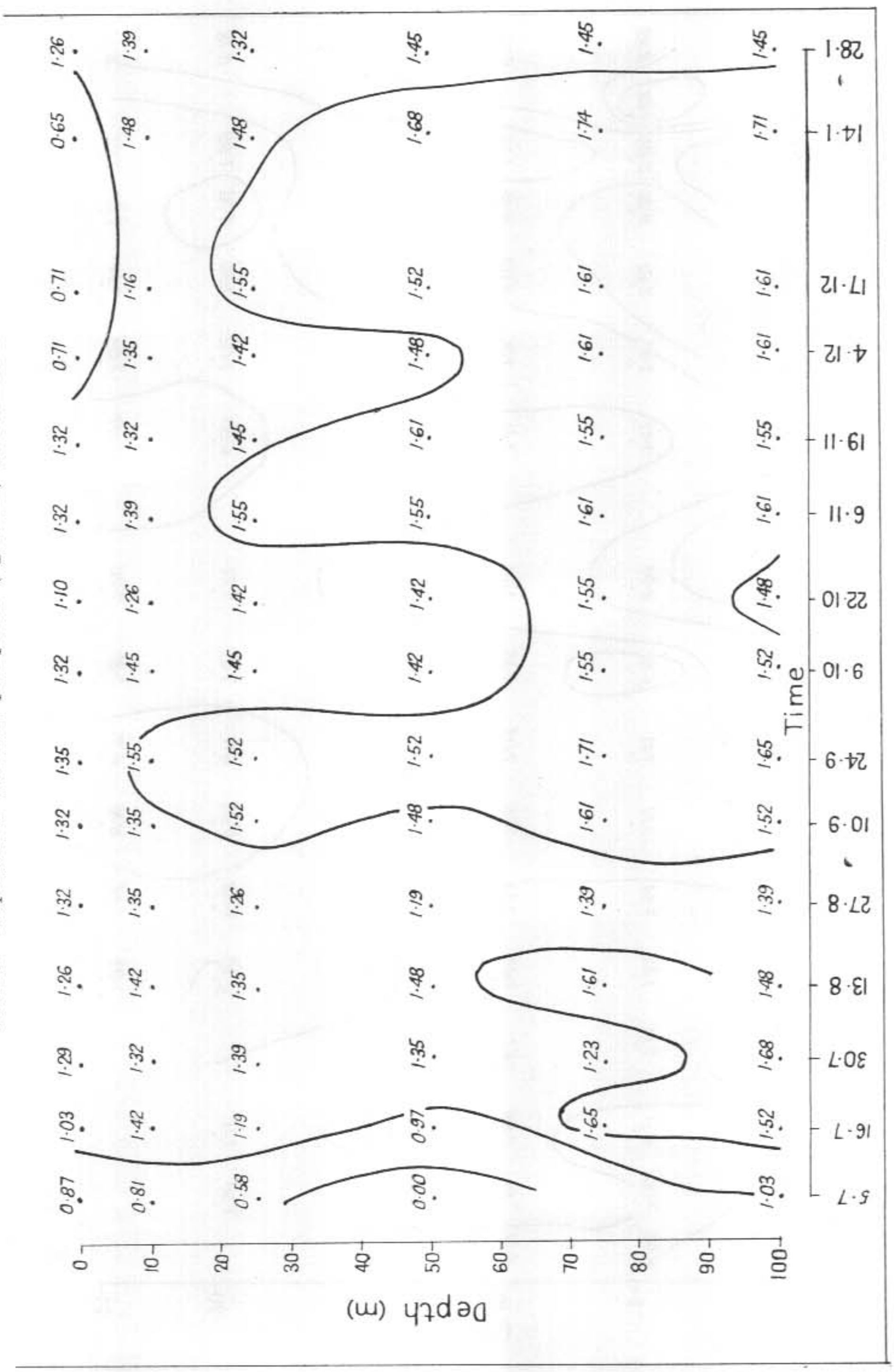


FIG. 13—Isopleths of dissolved oxygen (ml/L) at Station 1.

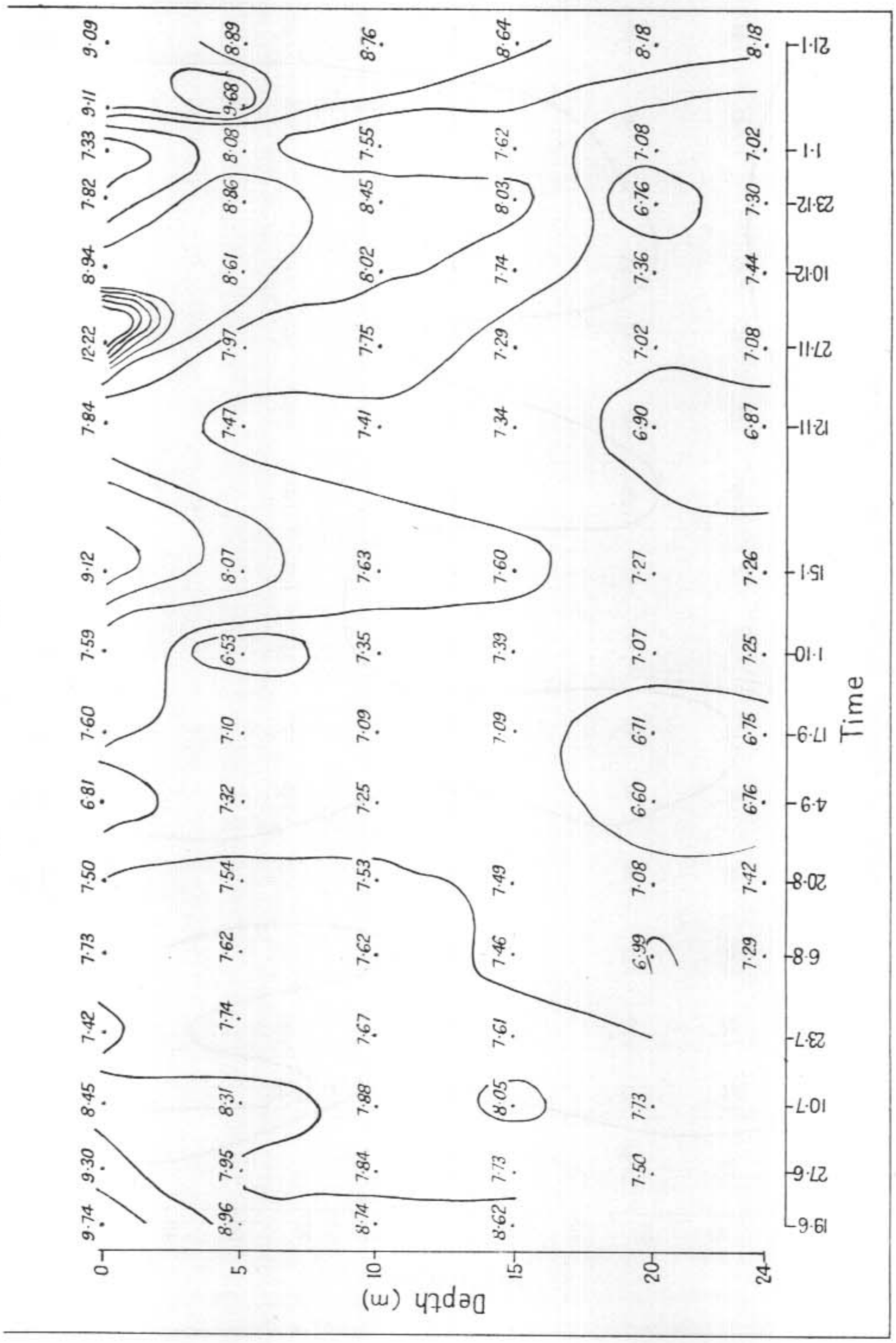


Fig. 14—Isopleths of dissolved oxygen (ml/L) at Station 2.

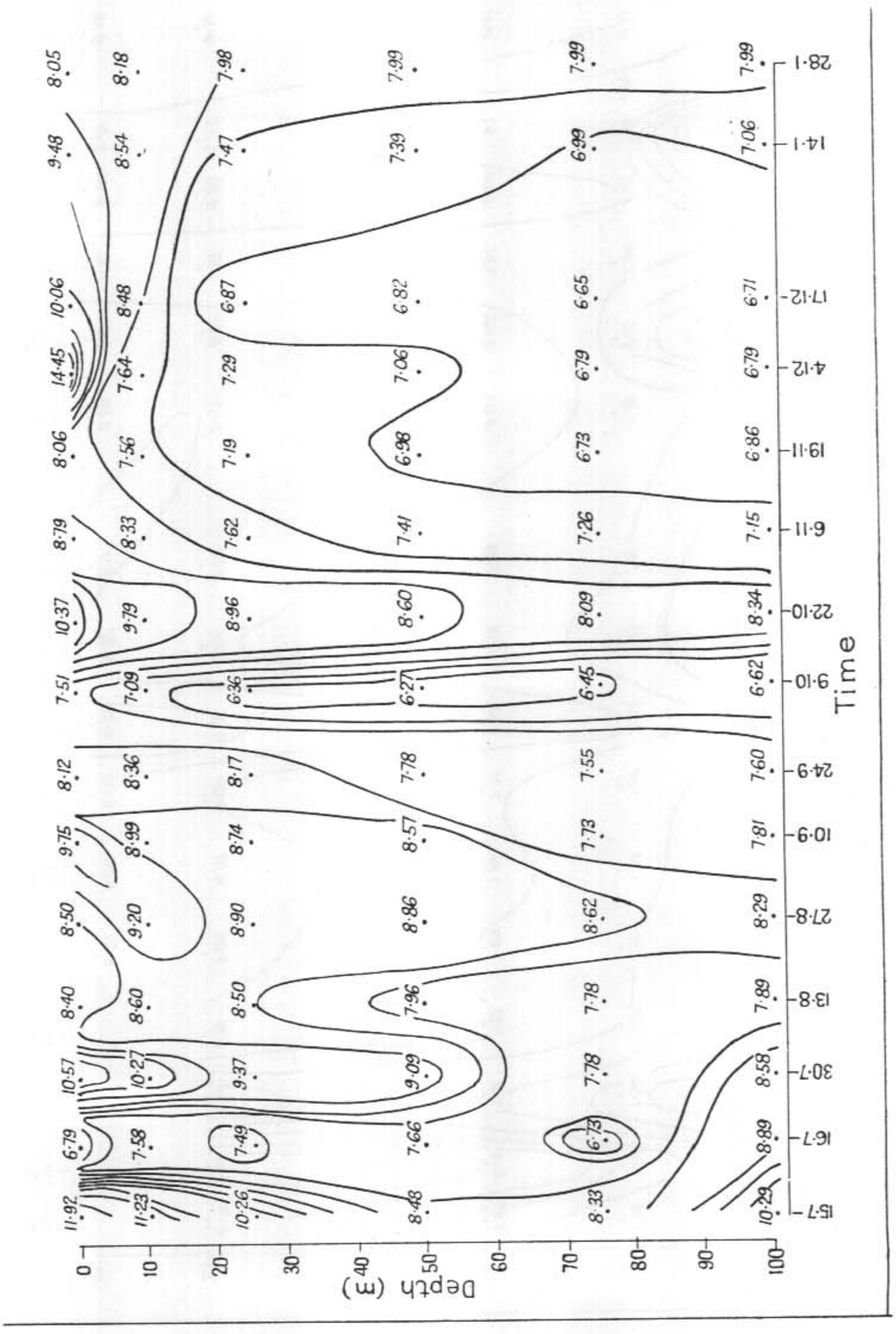
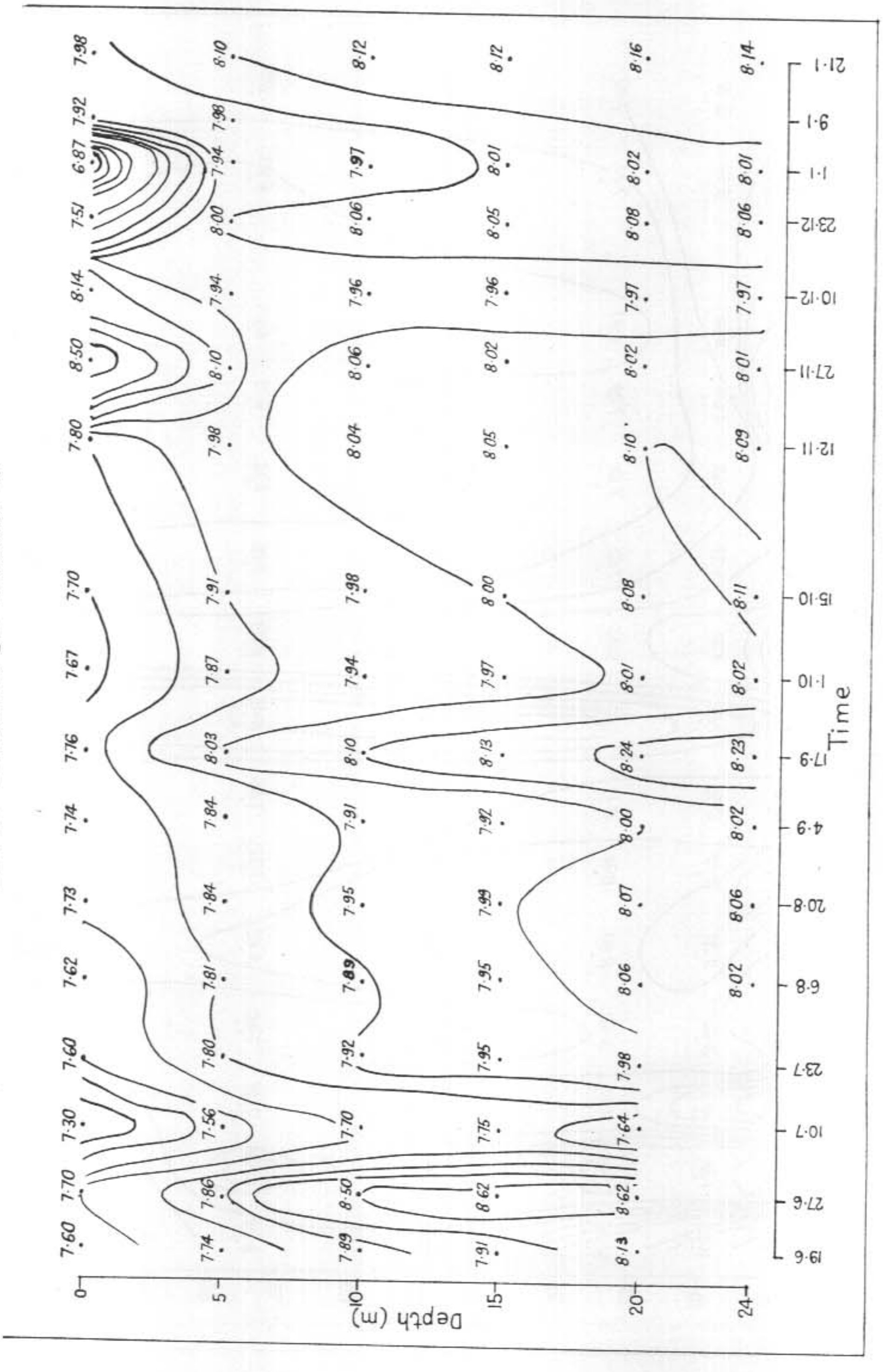


FIG. 15—Isopleths of pH at Station 1.



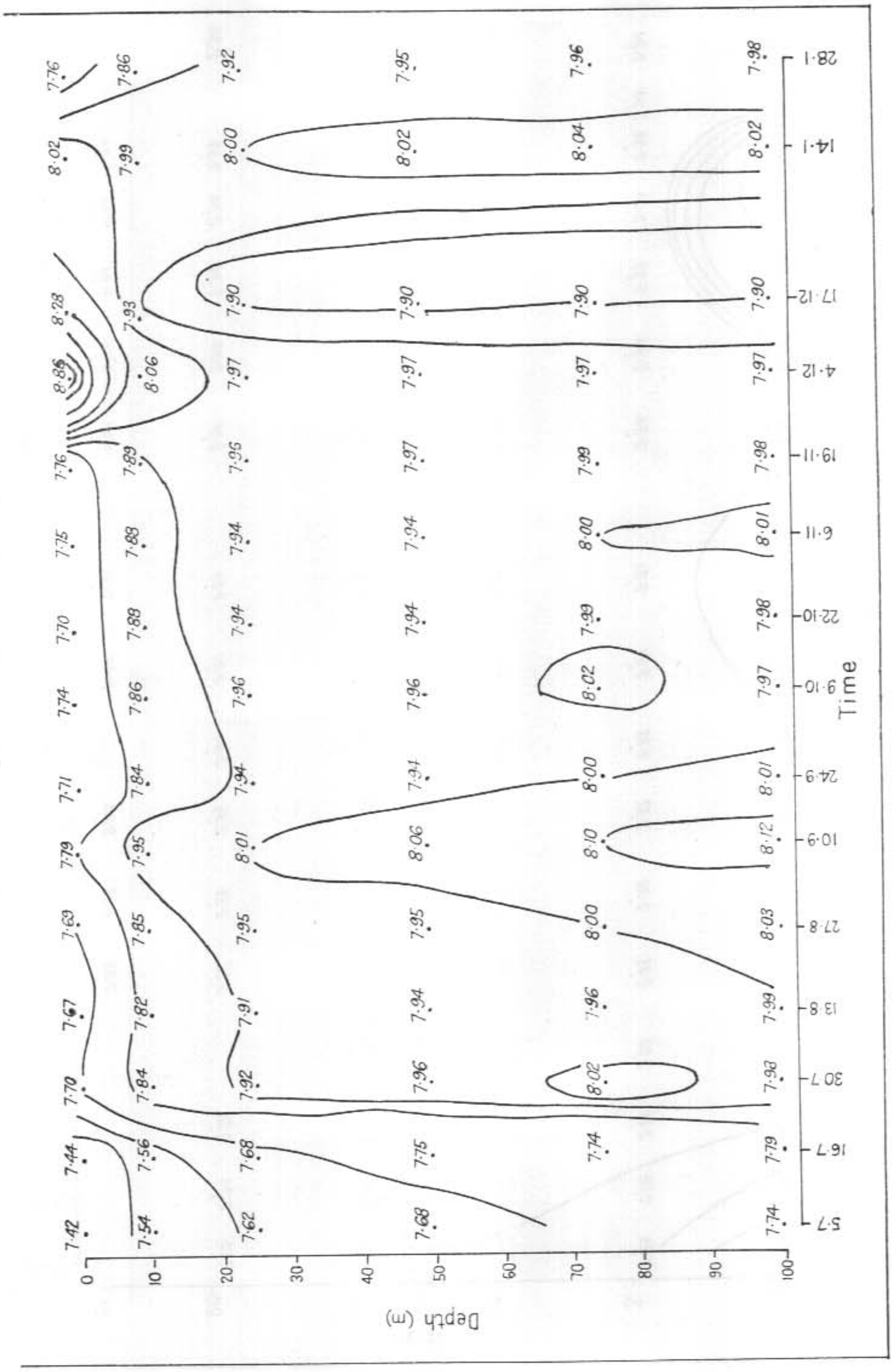


FIG. 16—Isopleths of pH at Station 2.

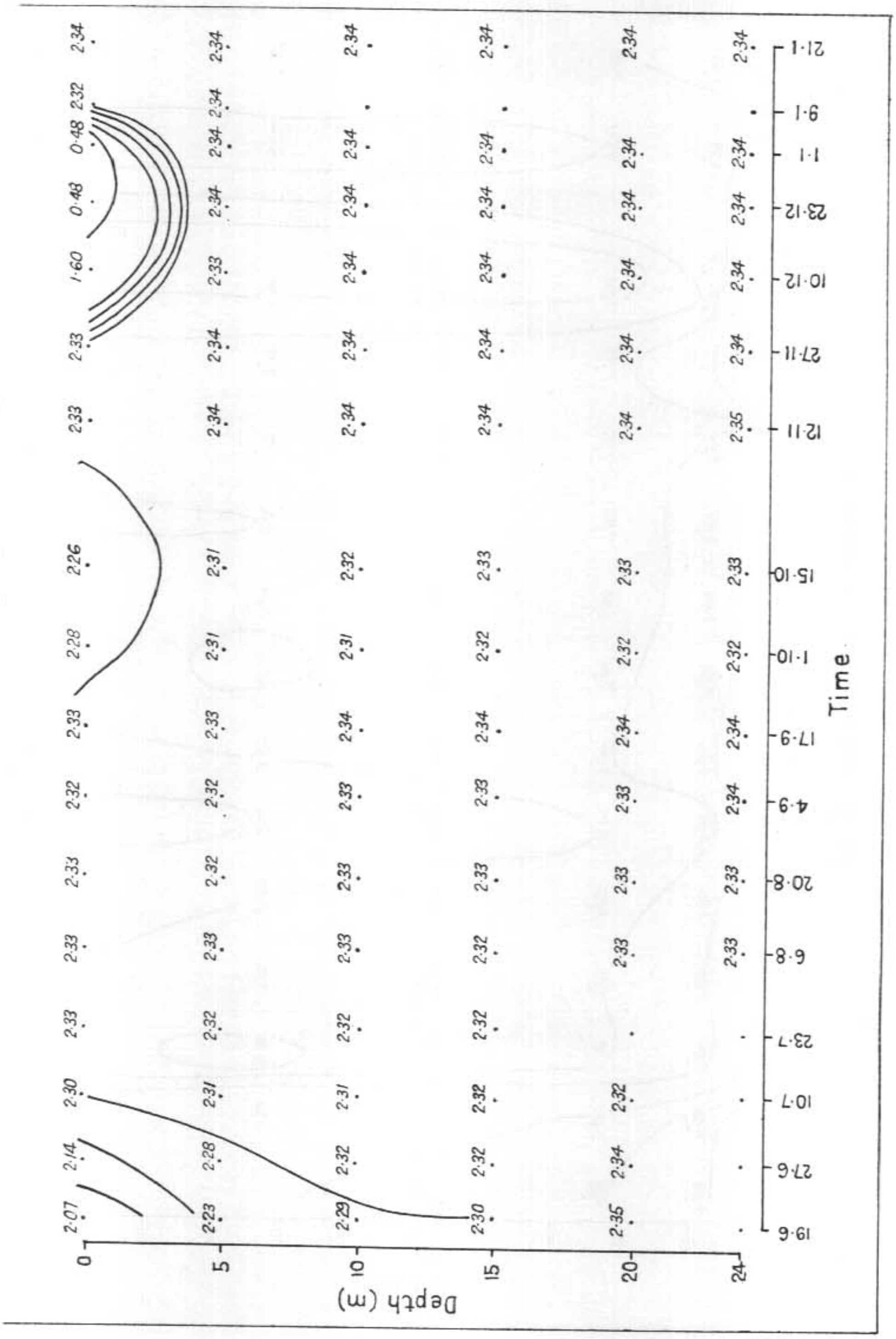


FIG. 17—Isopleths of buffer capacity at Station 1.

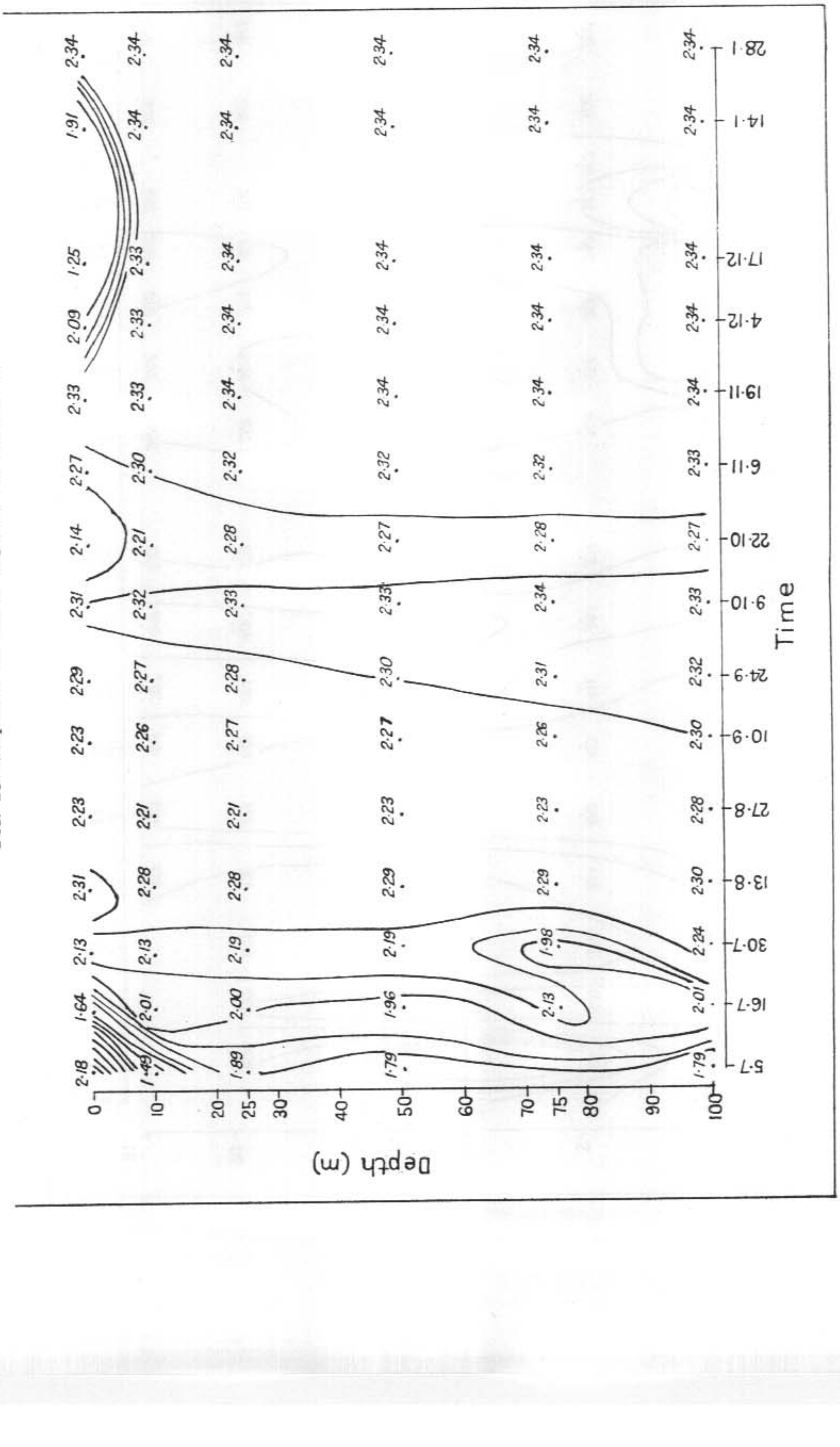


FIG. 18—Isopleths of buffer capacity at Station 2.

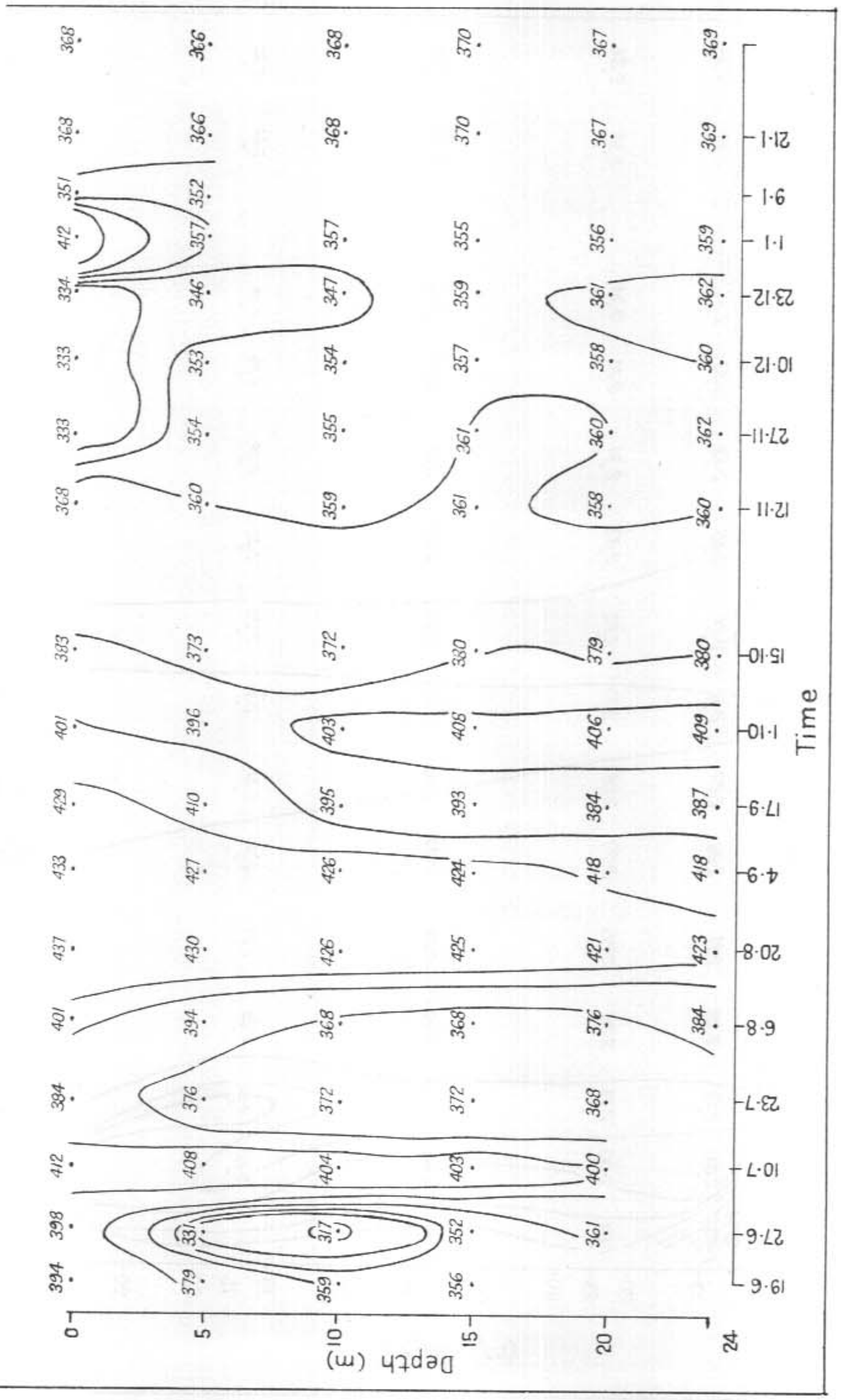


Fig. 19—Isopleths of Eh (m.v.) at Station 1.

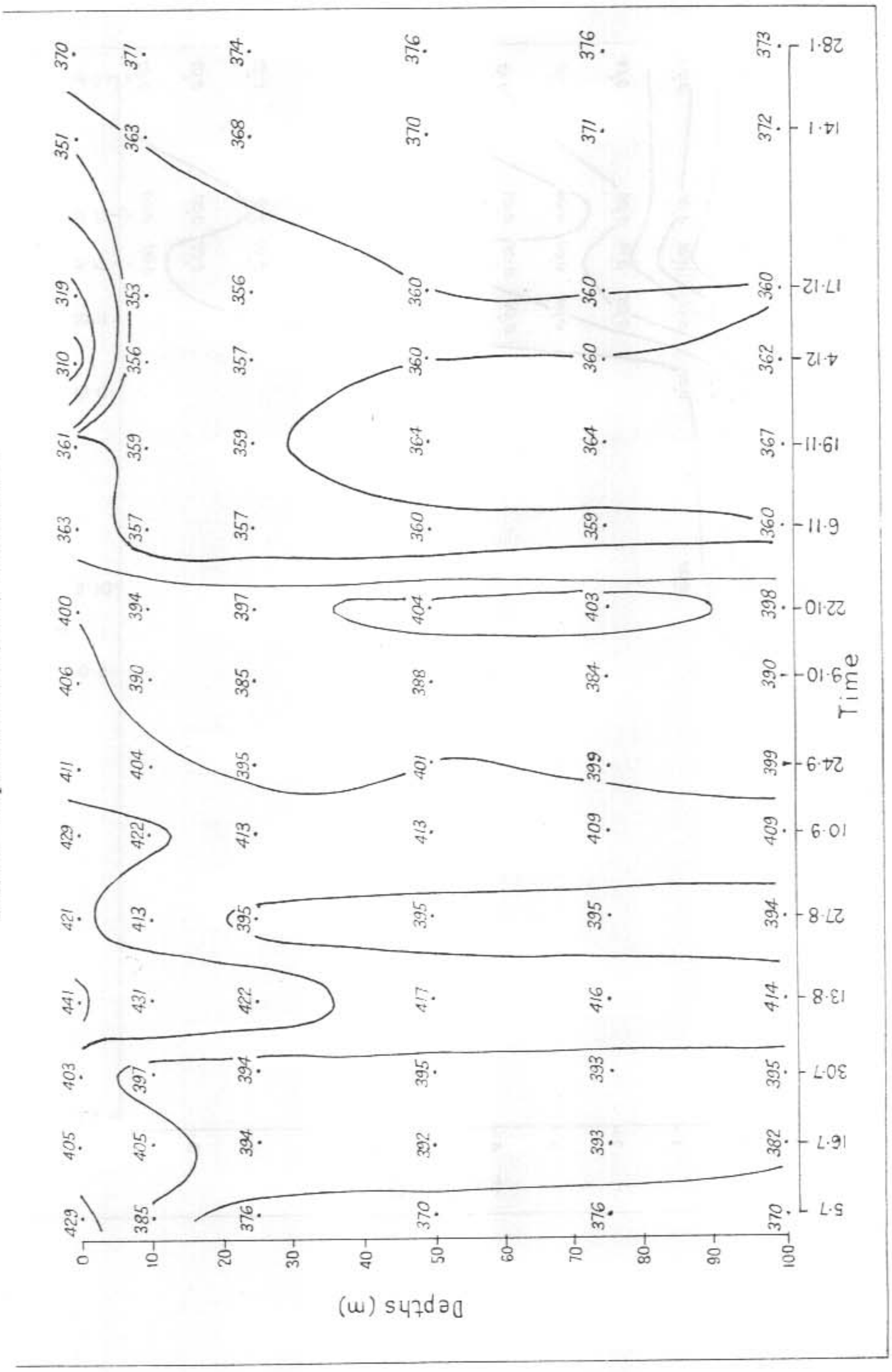


FIG. 20—Isopleths of Eh (m.v.) at Station 2.

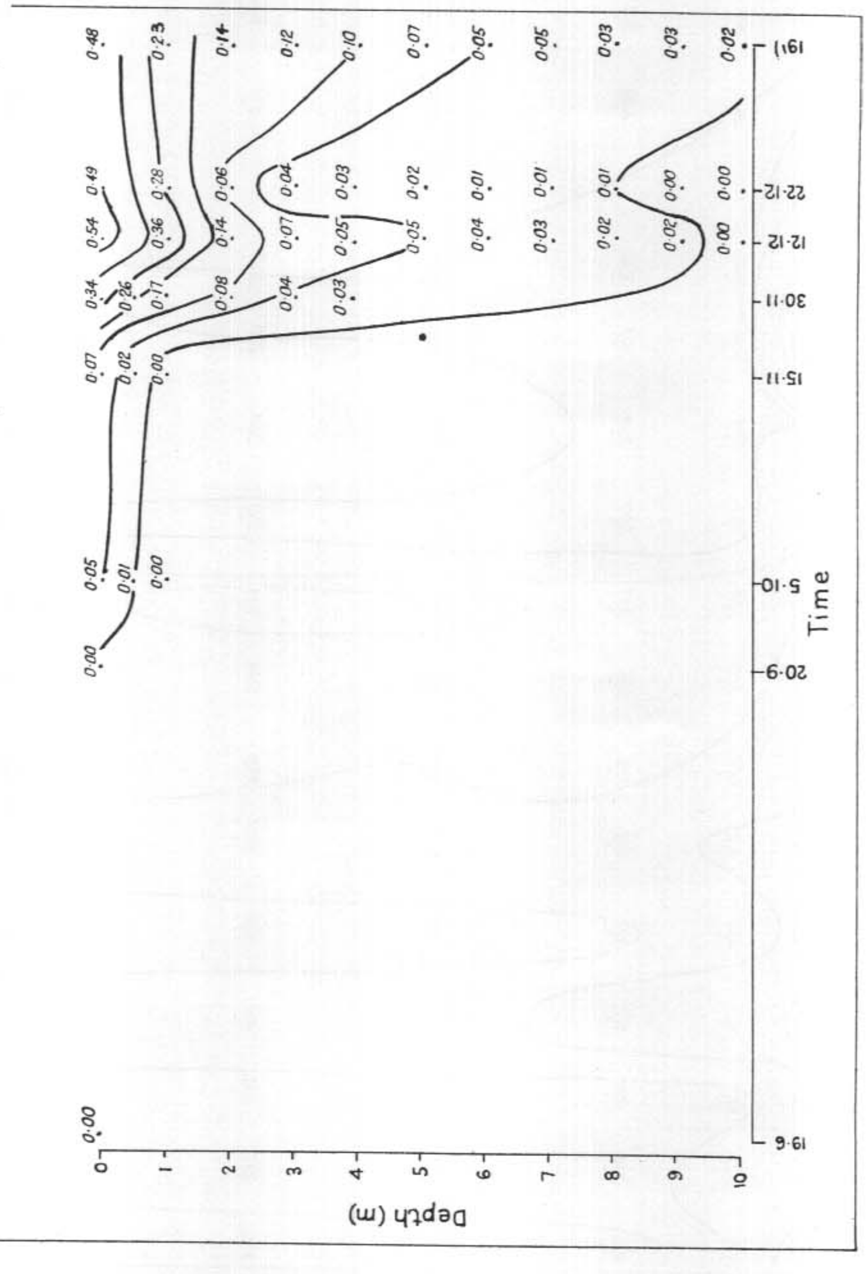


FIG. 21—Isopleths of radiant energy (cals cm^{-2} $min.^{-1}$) at Station 1.

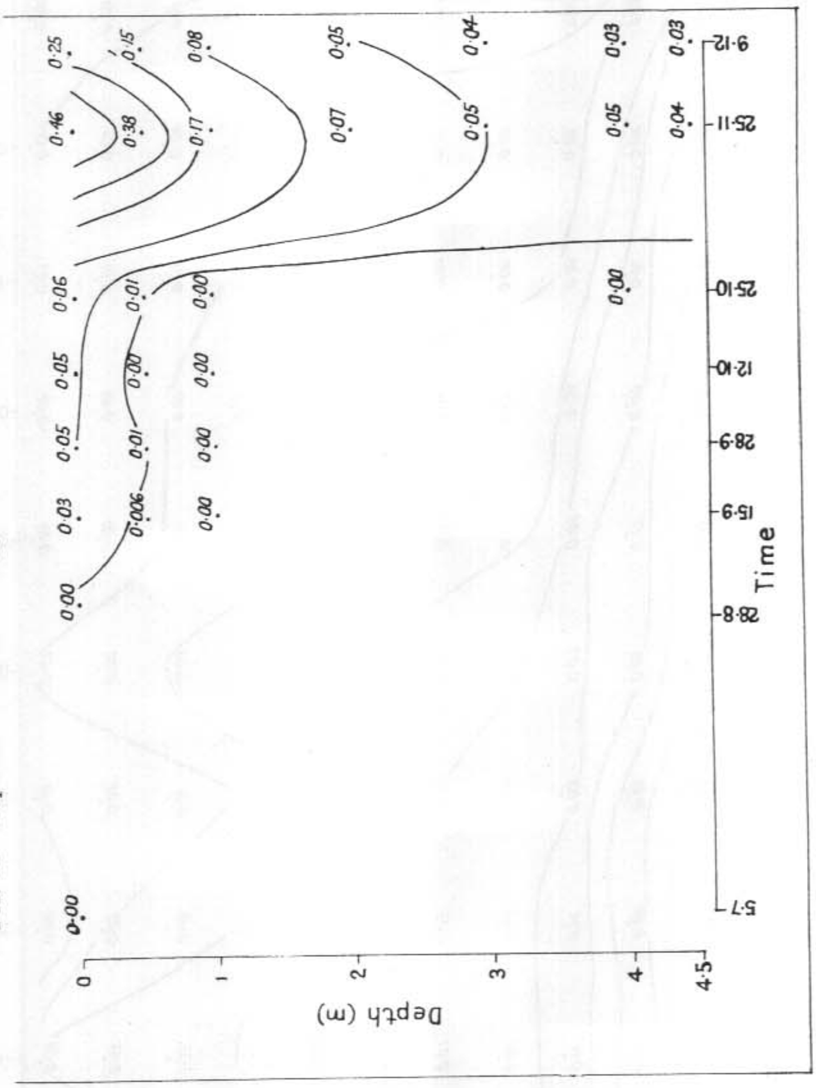


FIG. 22—Isopleths of radiant energy (cals cm^{-2} min.$^{-1}$) at Station 2.

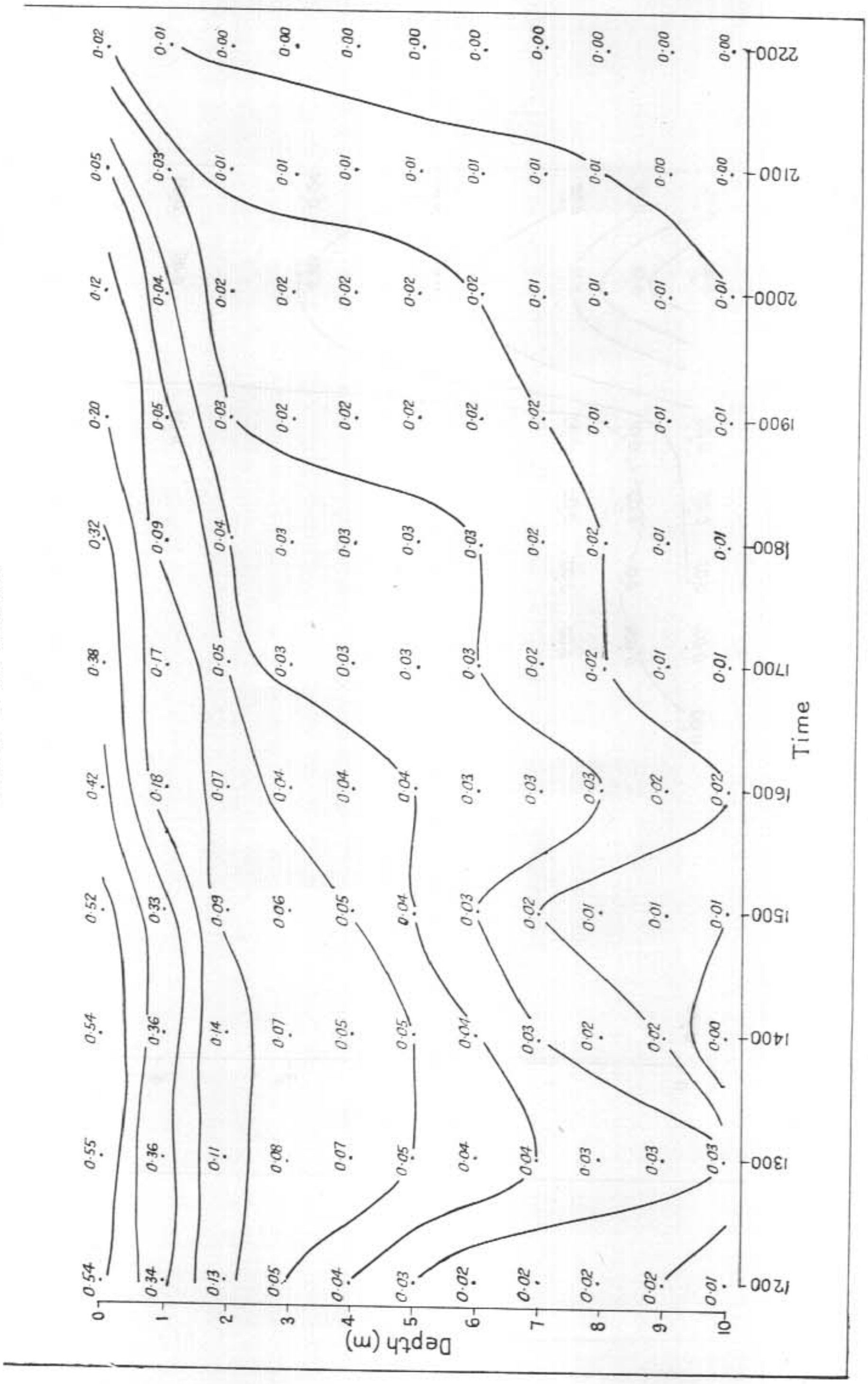


FIG. 23—Measurements of radiant energy (cals cm^{-2} min.$^{-1}$) penetrating the surface 10 metres of water at Station 1 on 12.12.56.

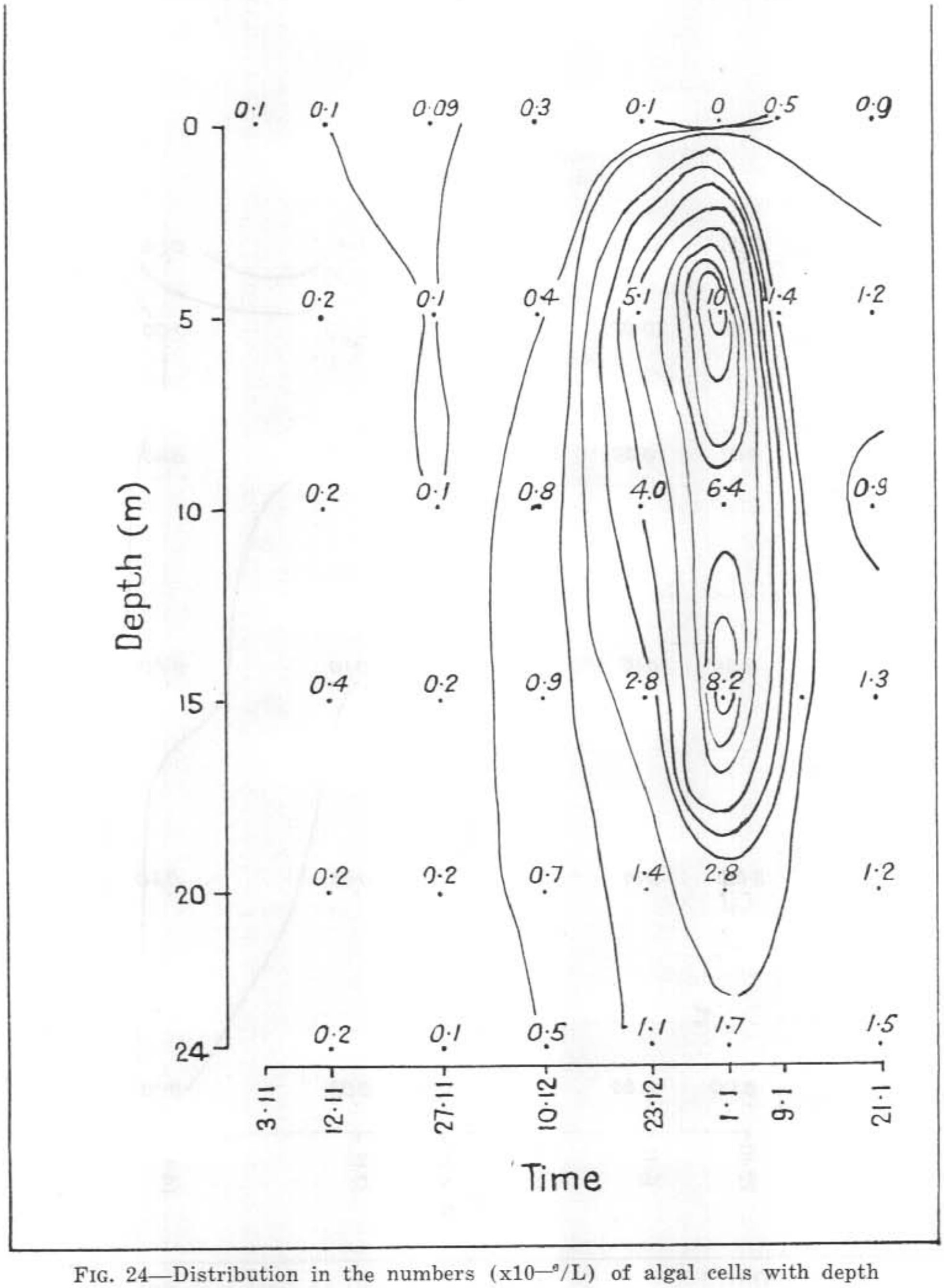


FIG. 24—Distribution in the numbers $(x10^{-6}/L)$ of algal cells with depth and time at Station 1.

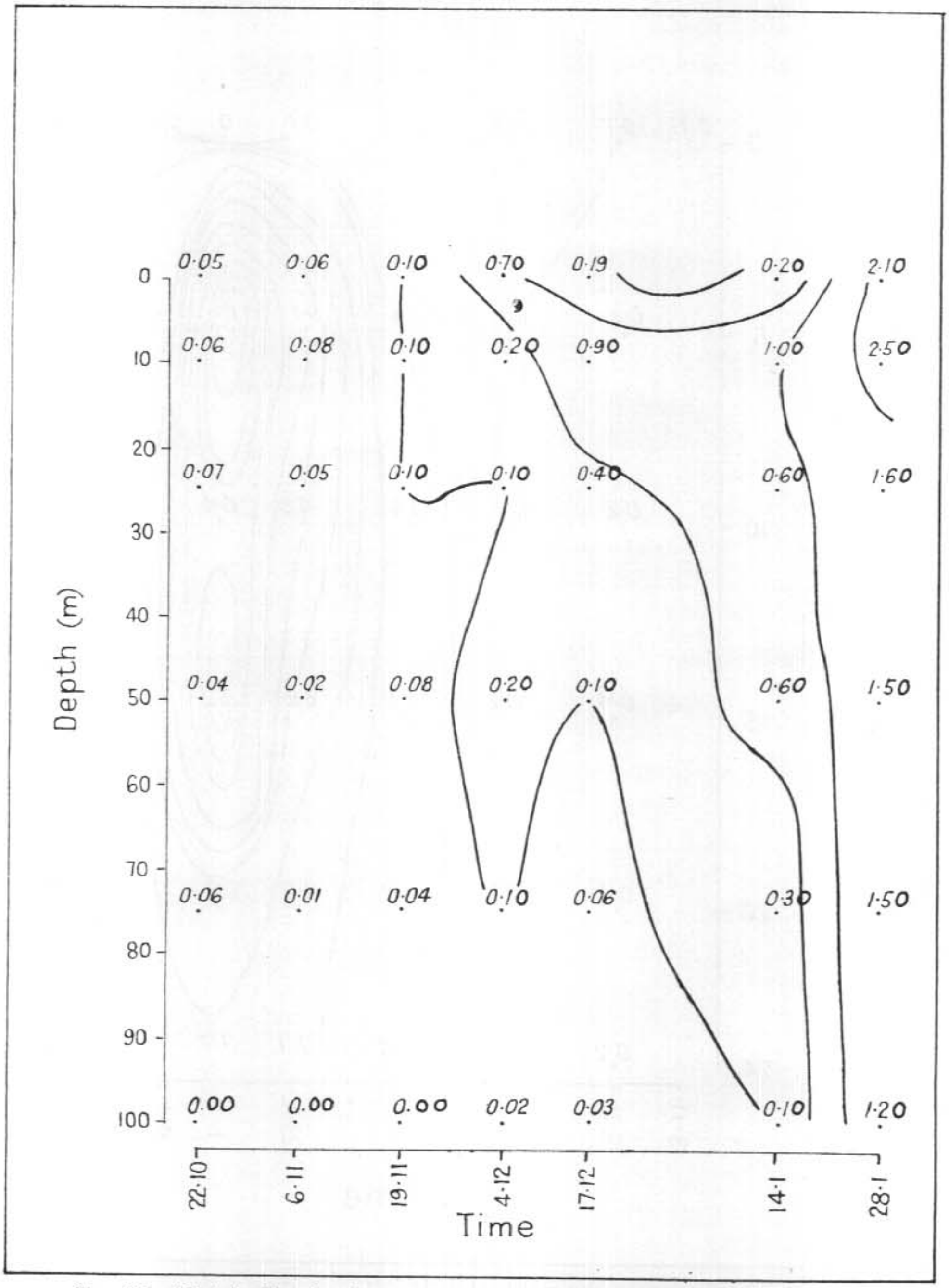


FIG. 25—Distribution in the numbers (x10^{-6}/L) of algal cells with depth and time at Station 2.

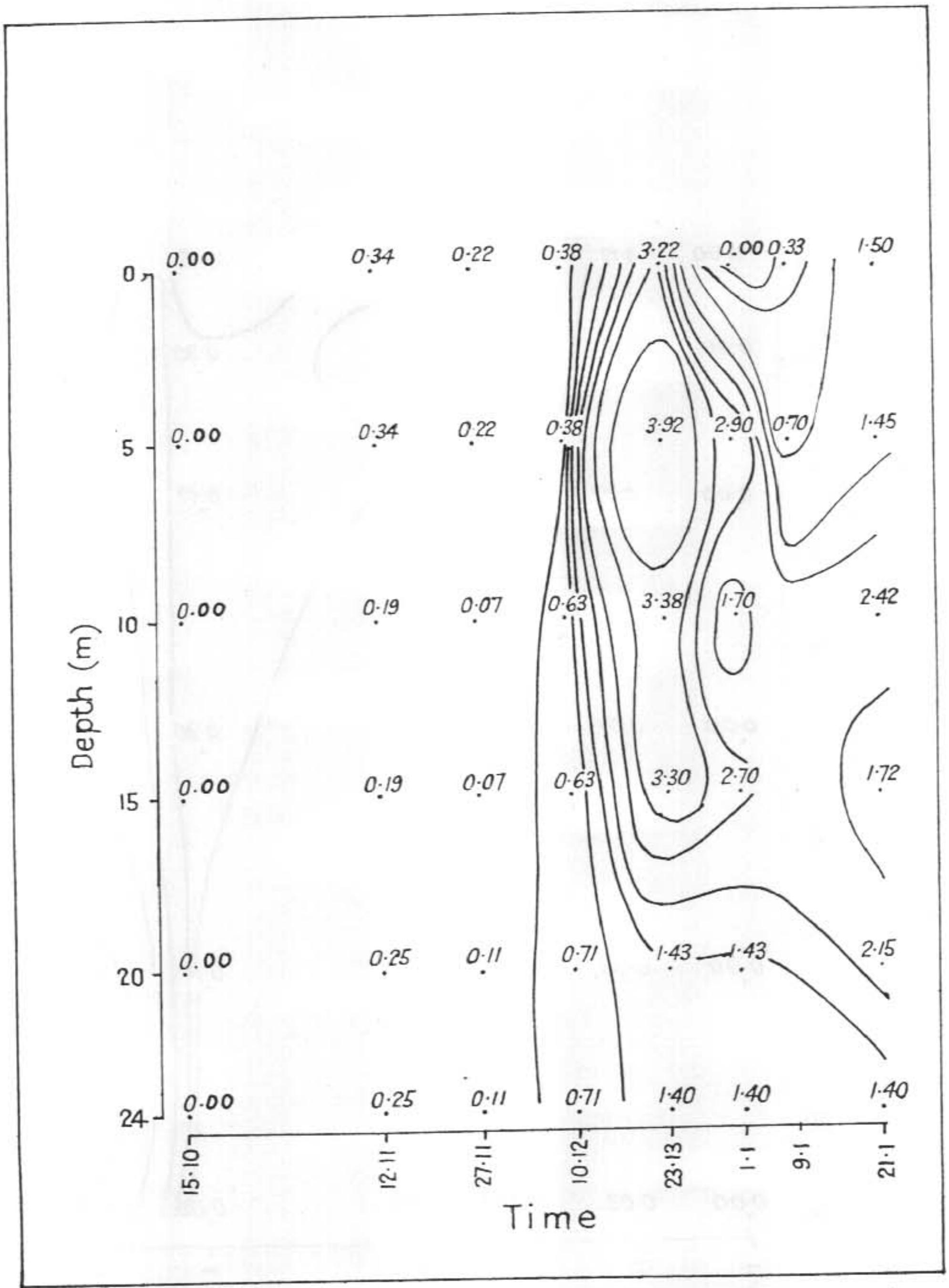


FIG. 26—Distribution in the level of chlorophyll (mg/m³) with depth and time at Station 1.

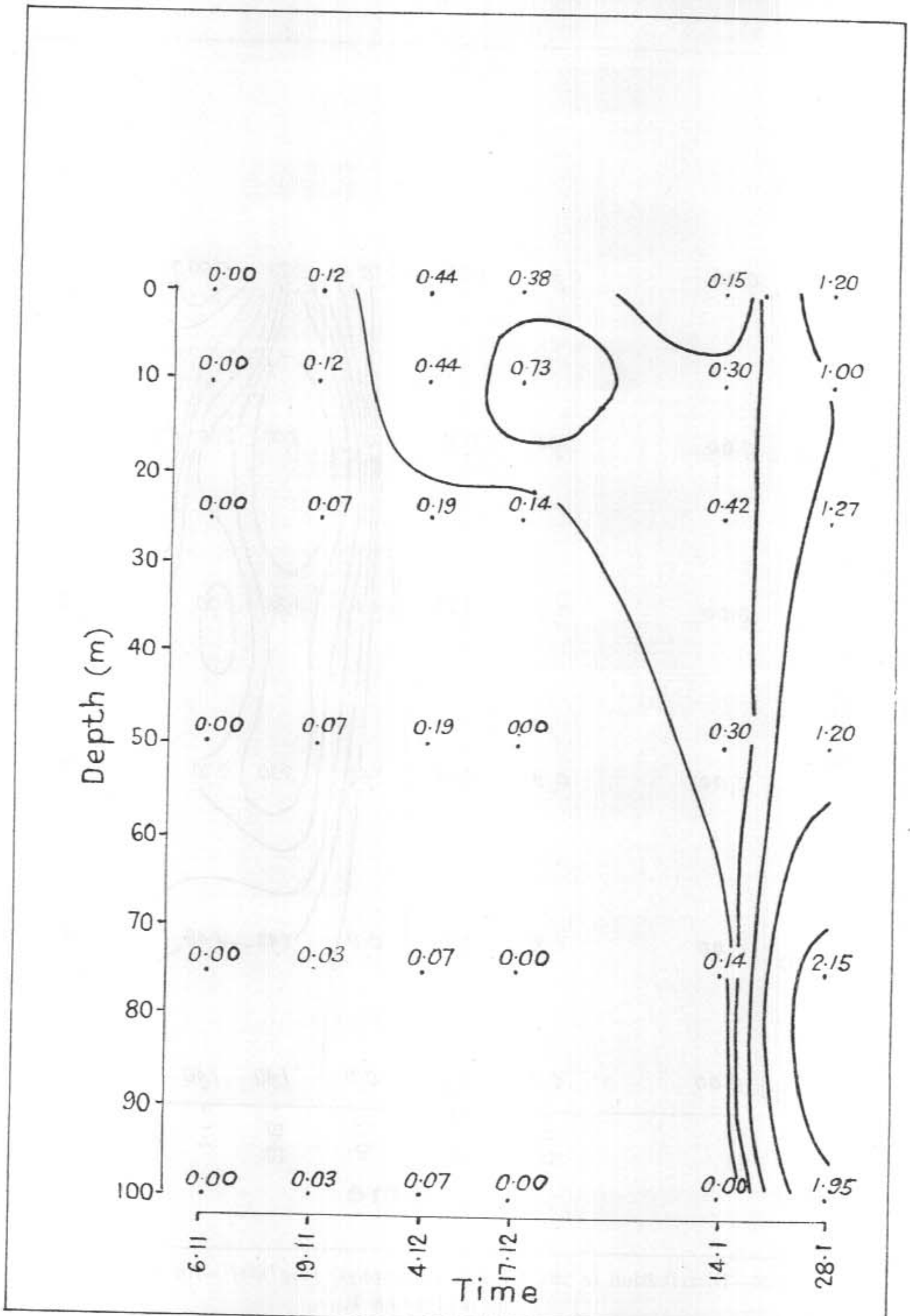


FIG. 27—Distribution in the level of chlorophyll (mg/m³) with depth and time at Station 2.

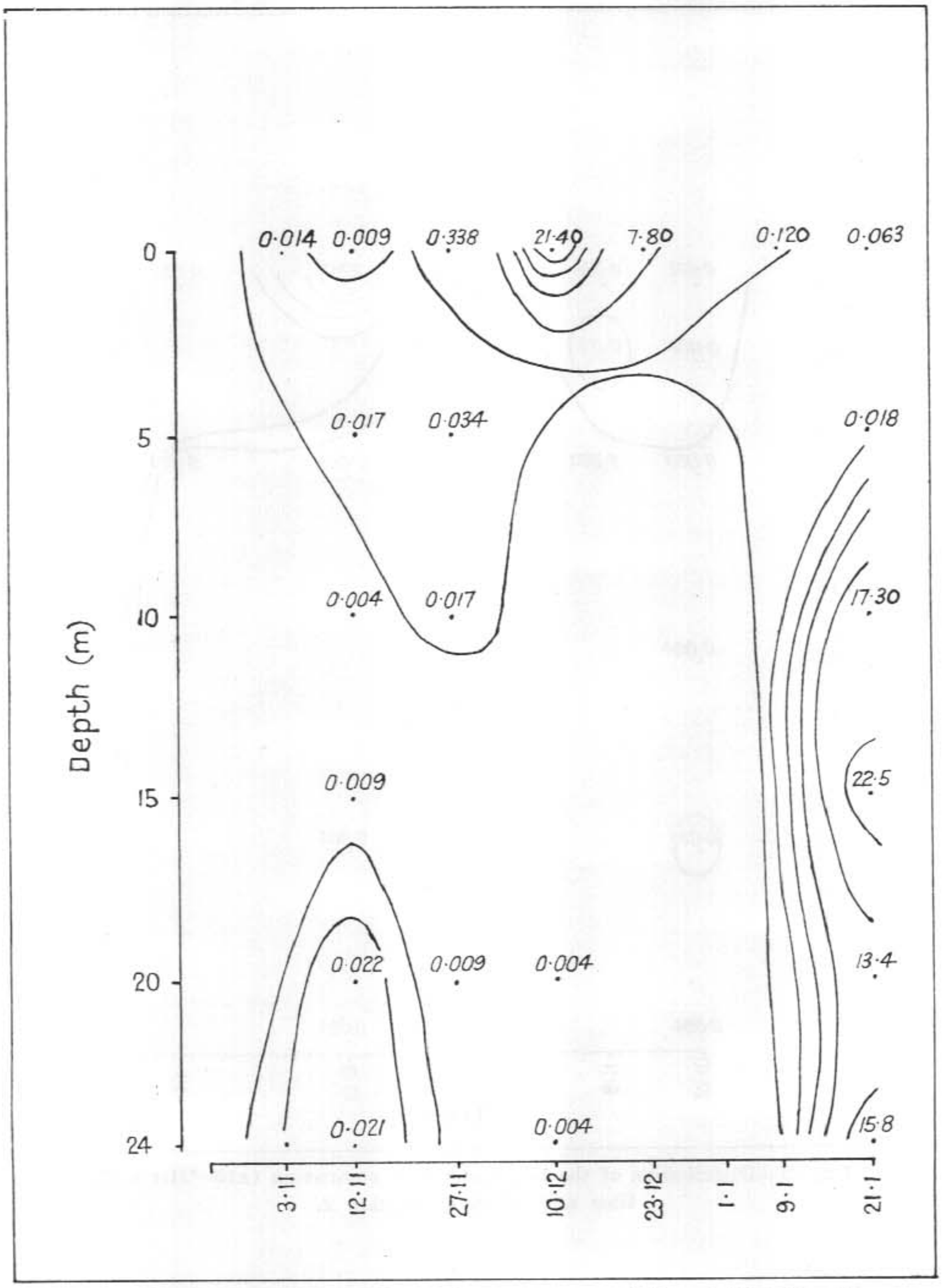


FIG. 28—Distribution of the total protozoan population (x10^{-6}/L) with time and depth at Station 1.

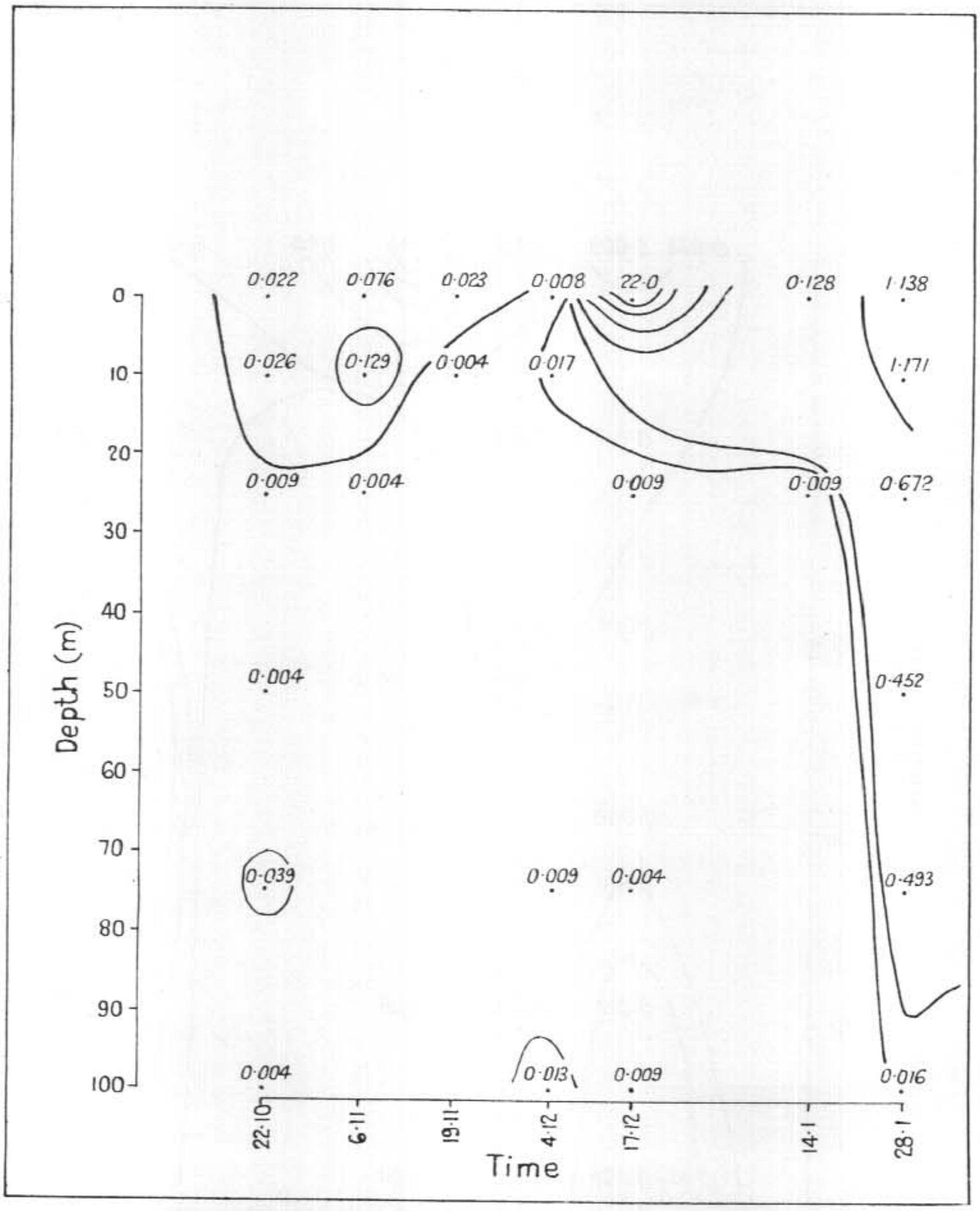


FIG. 29—Distribution of the total protozoan population ($x10^{-6}$/L) with time and depth at Station 2.

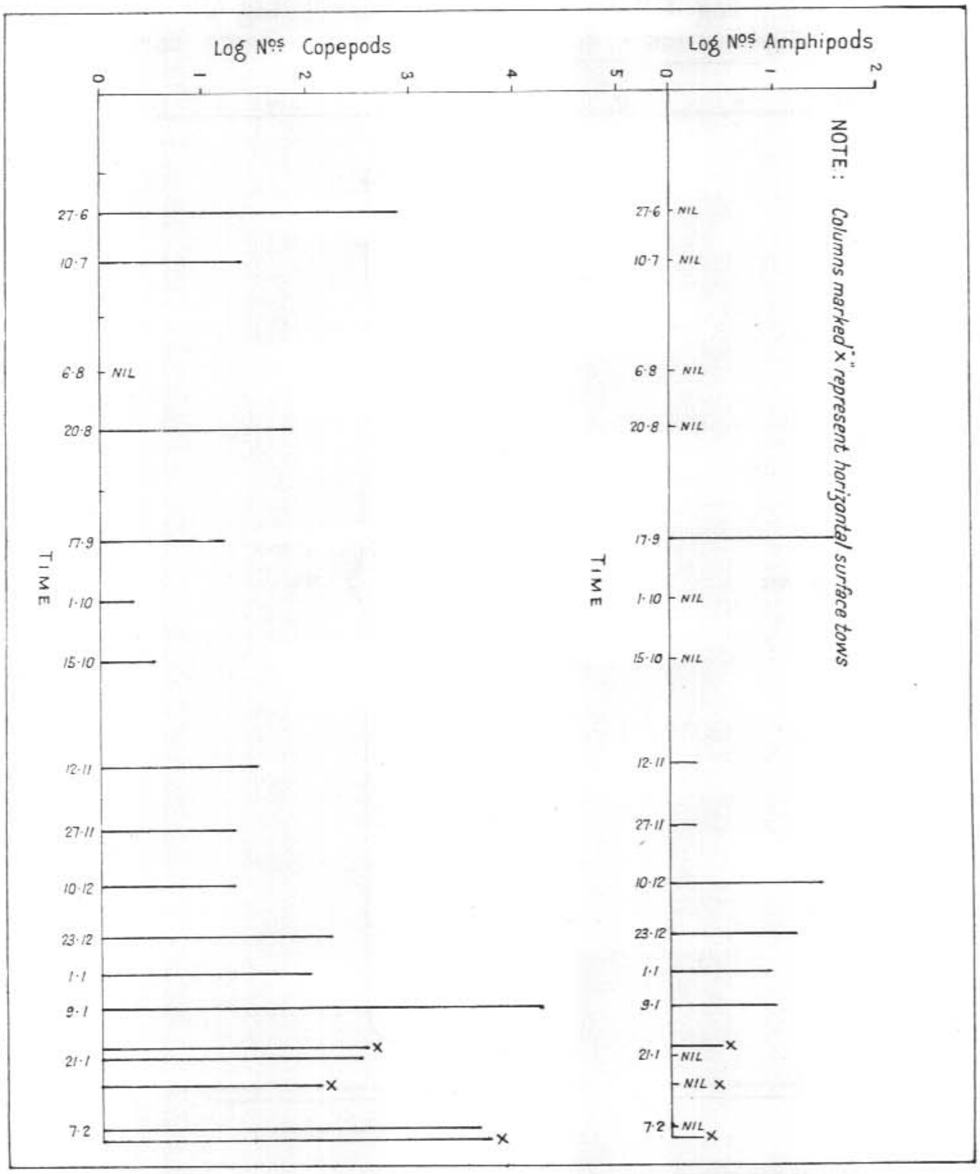


FIG. 30—Log. numbers of copepods and amphipods taken in 25 metre vertical hauls at Station 1.

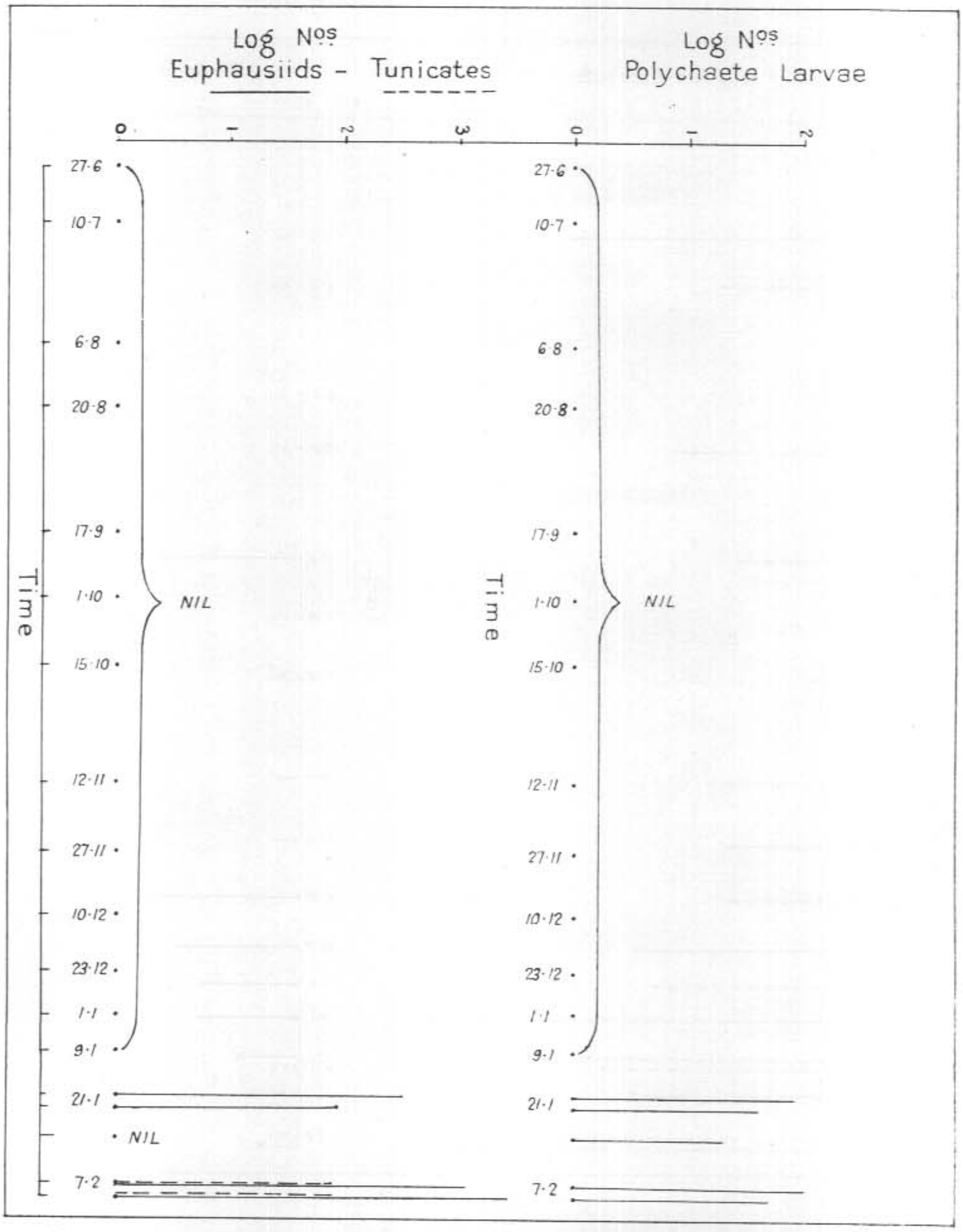


FIG. 31—Log. numbers of polychaete larvae, euphausiids and tunicates taken in 25 metre vertical hauls at Station 1.

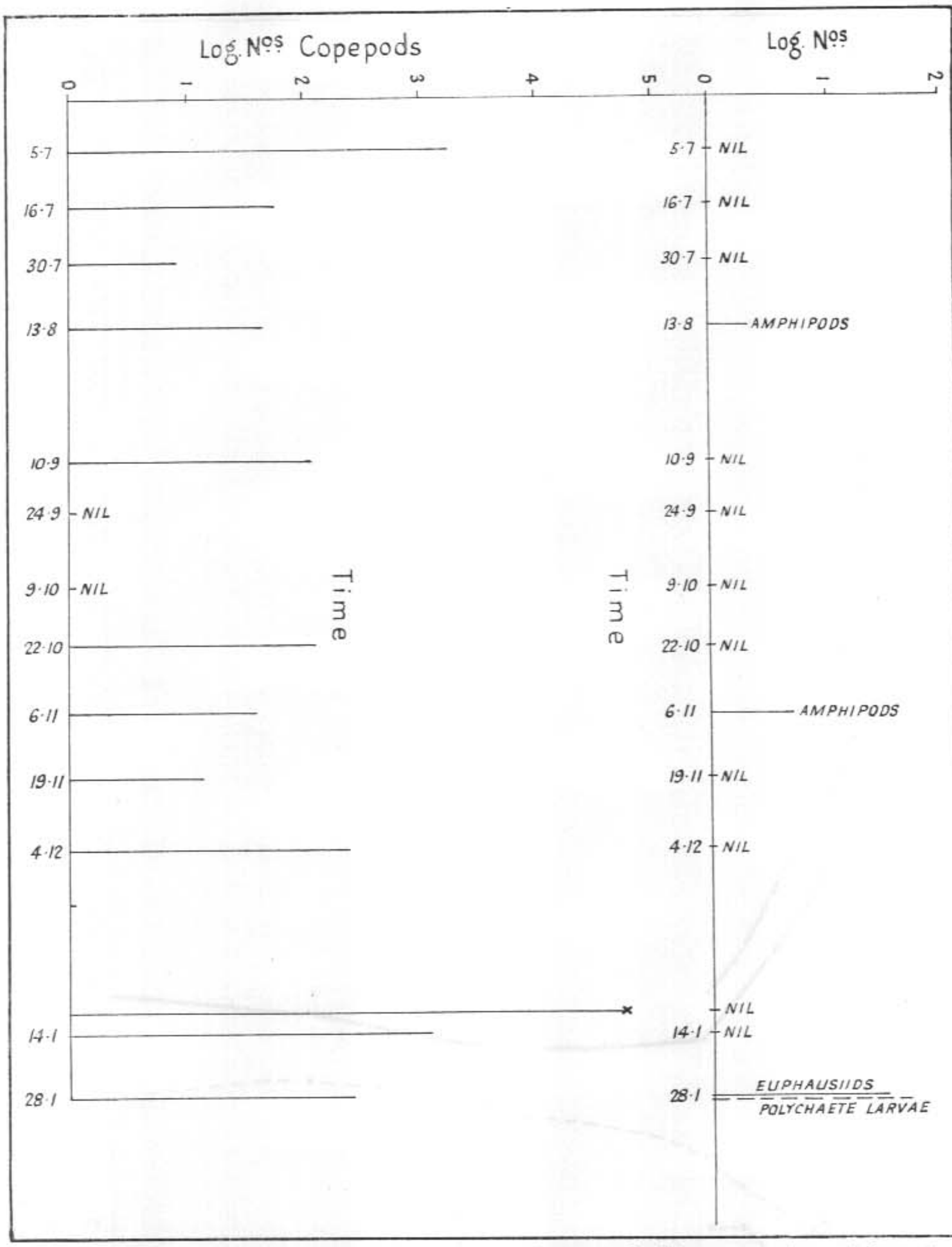
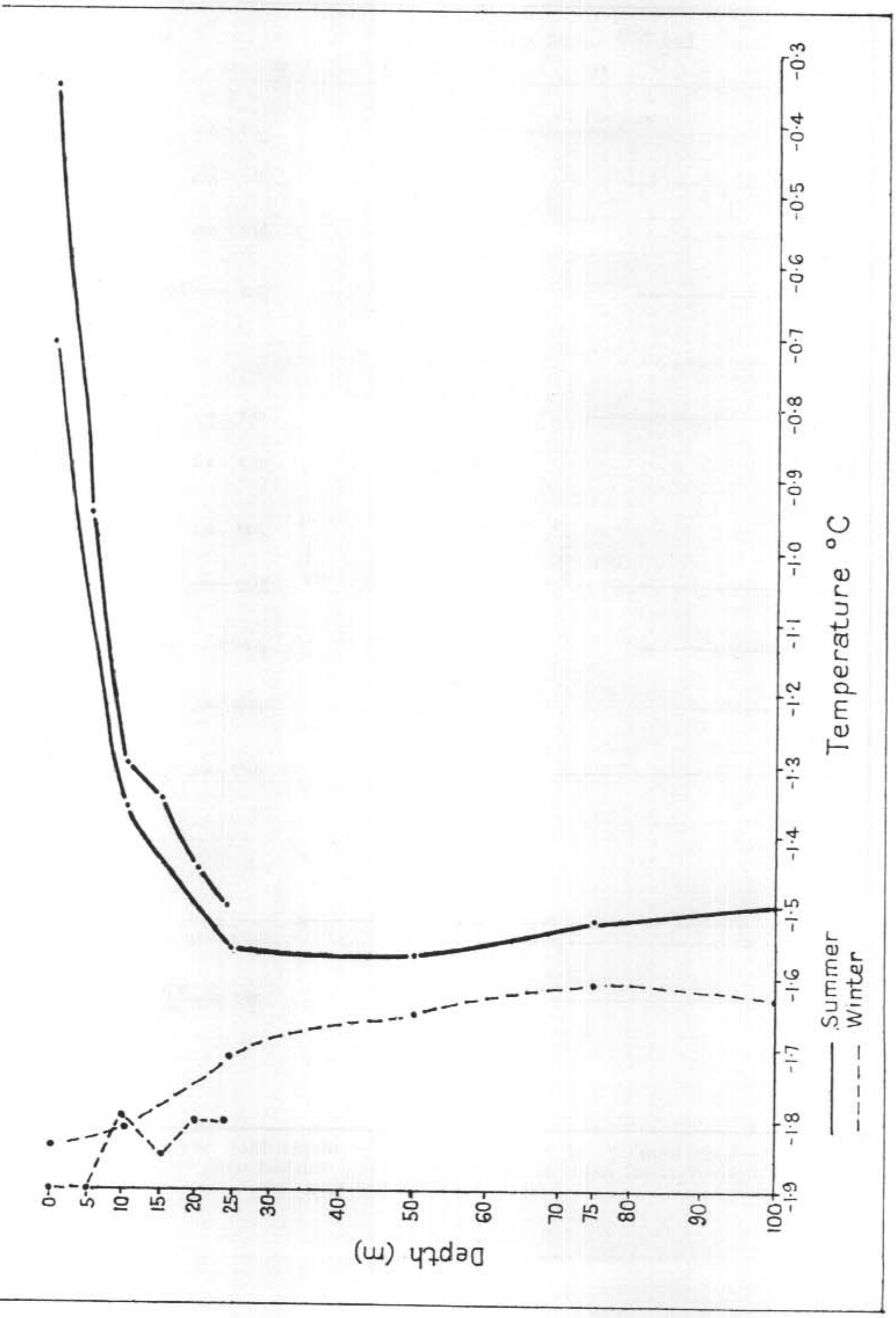


FIG. 32—Log. numbers of copepods and other zooplankton organisms taken in 100 metre vertical hauls at Station 2. Column marked with " x " represents horizontal surface tow.

FIG. 33—Changes in temperature with depth in the Summer and Winter waters at Stations 1 (25m.) and 2 (100m.).



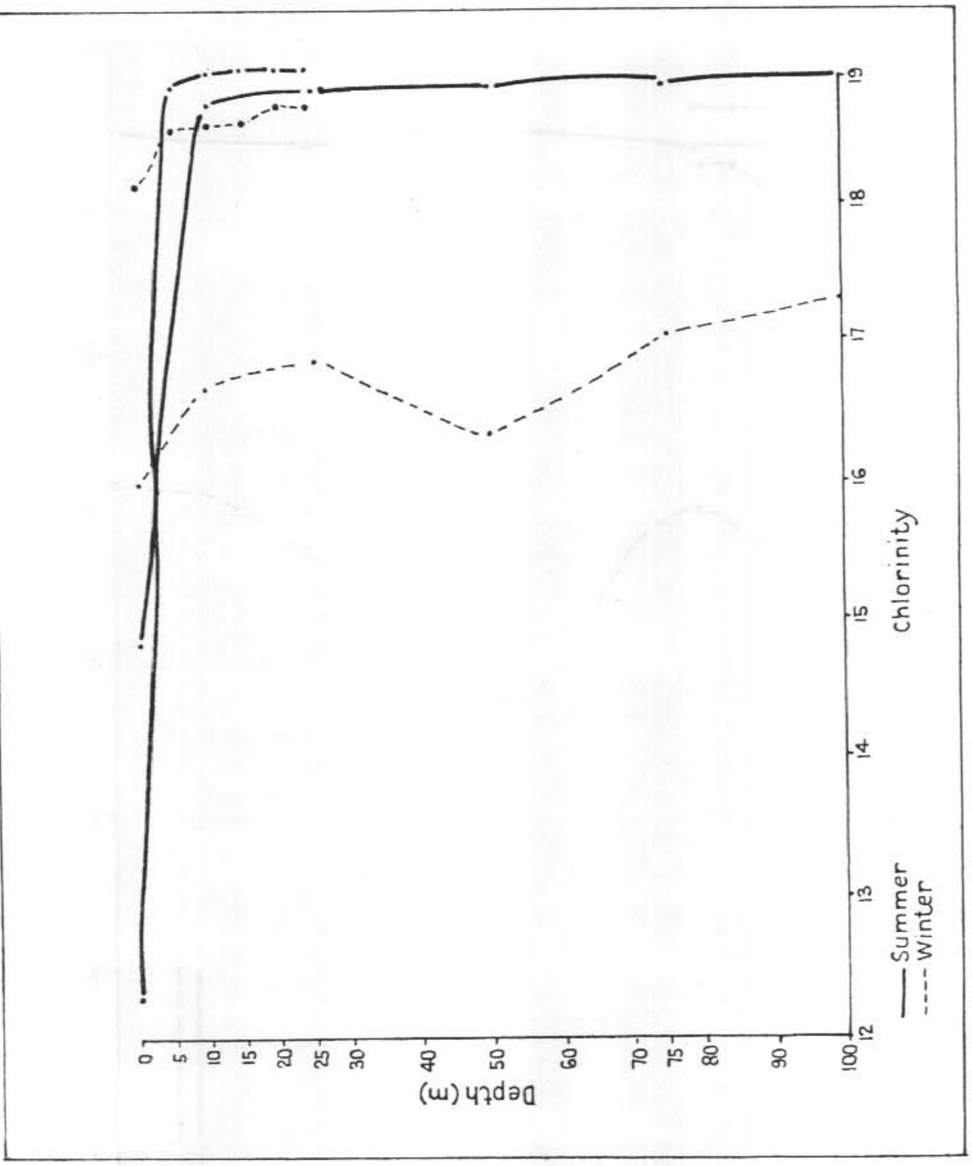


FIG. 34—Changes in chlorinity with depth in Summer and Winter waters at Stations 1 (25m.) and 2 (100m.).

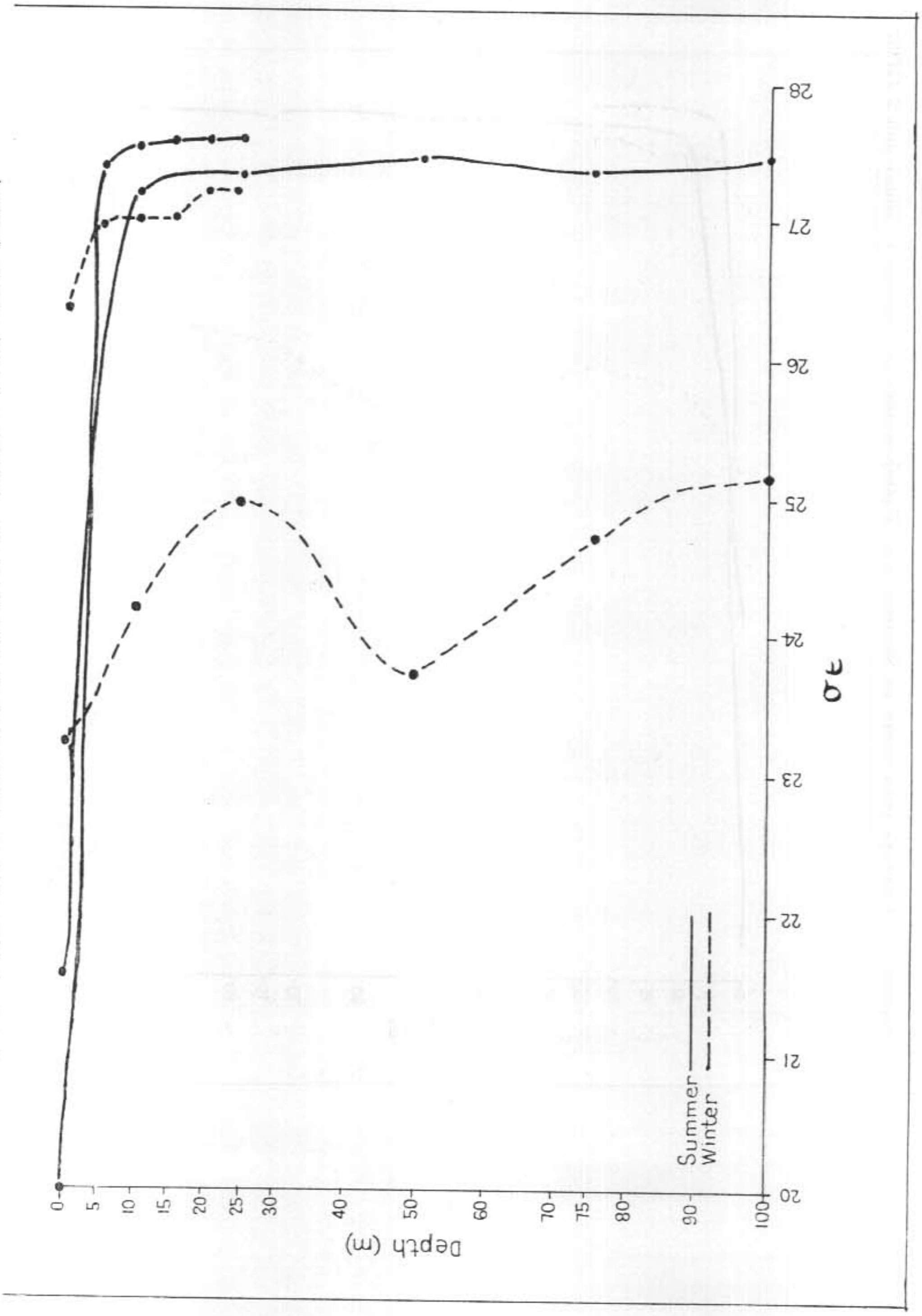


FIG. 35—Changes in σt with depth in Summer and Winter waters at Stations 1 (25m.) and 2 (100m.)

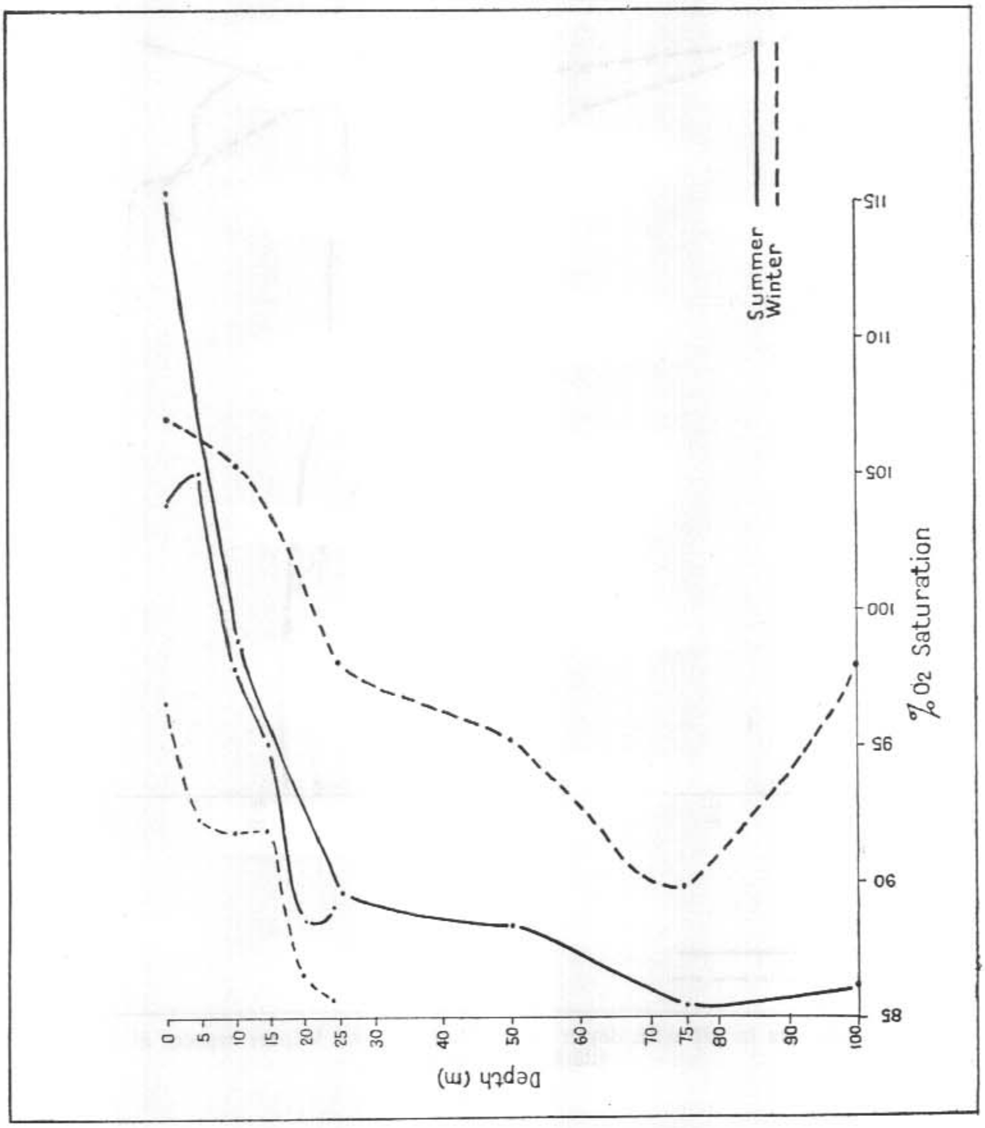


FIG. 36—Changes in per cent oxygen saturation with depth in Summer and Winter waters at Stations 1 (25m.) and 2 (100m.).

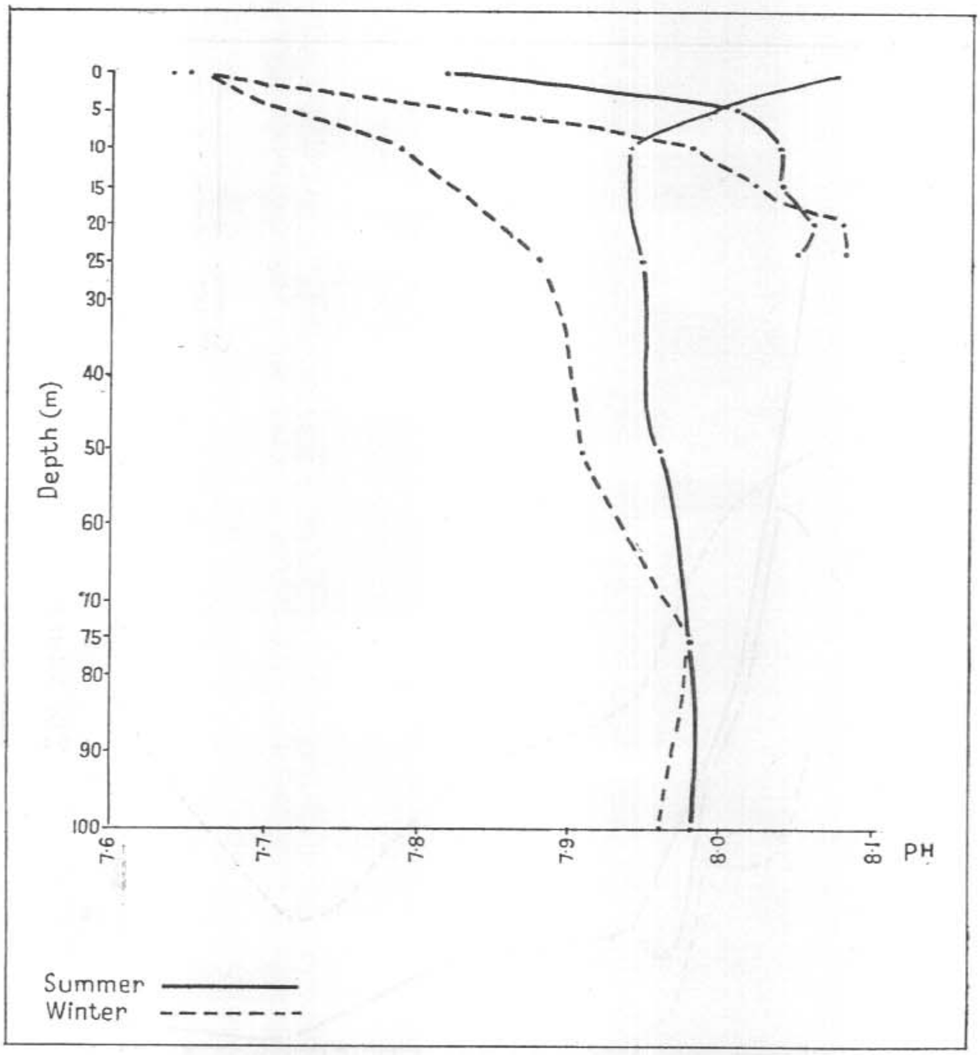


FIG. 37—Changes in pH with depth in the Summer and Winter waters at Stations 1 (25m.) and 2 (100m.).

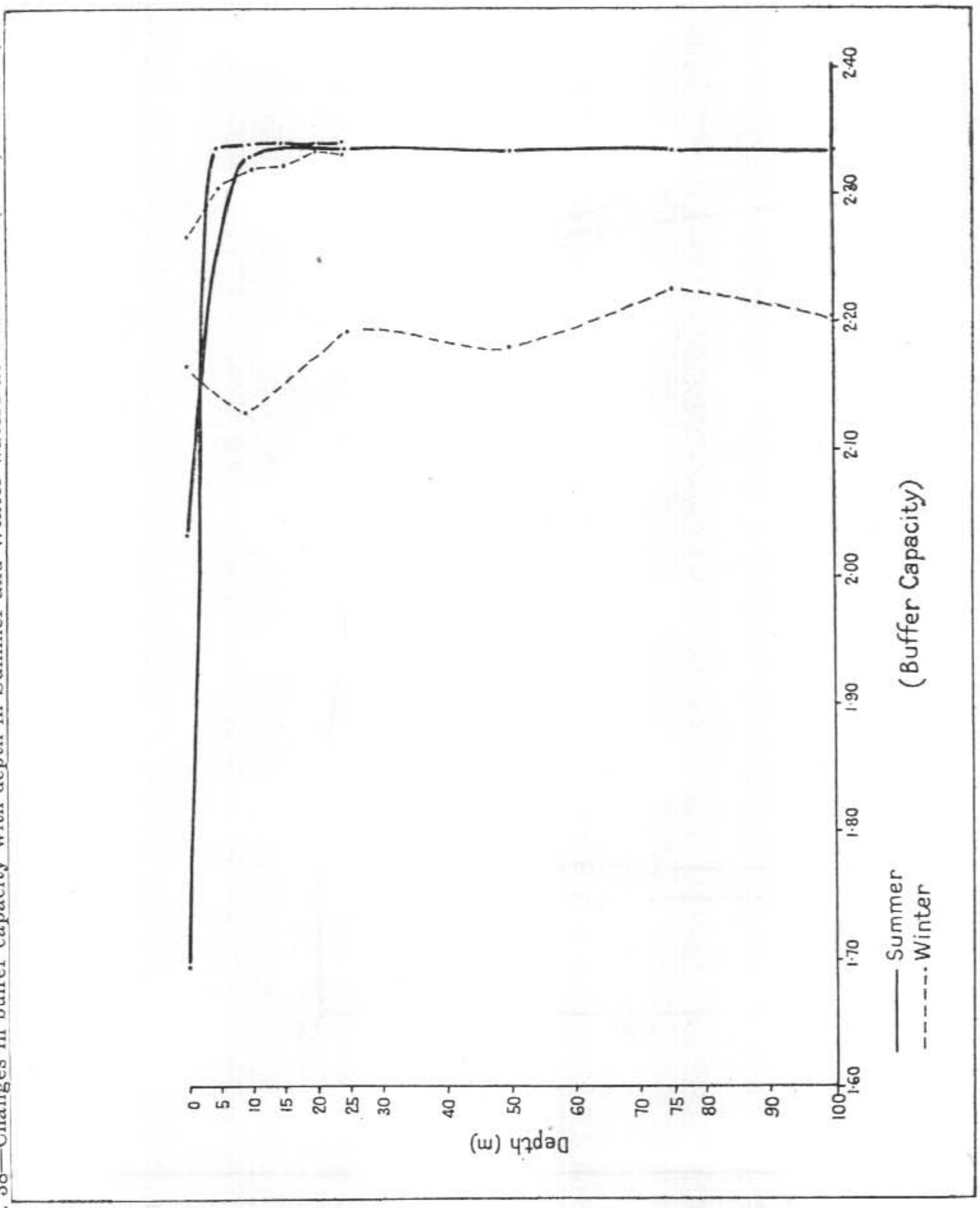


FIG. 38—Changes in buffer capacity with depth in Summer and Winter waters at Stations 1 (25m.) and 2 (100m.).

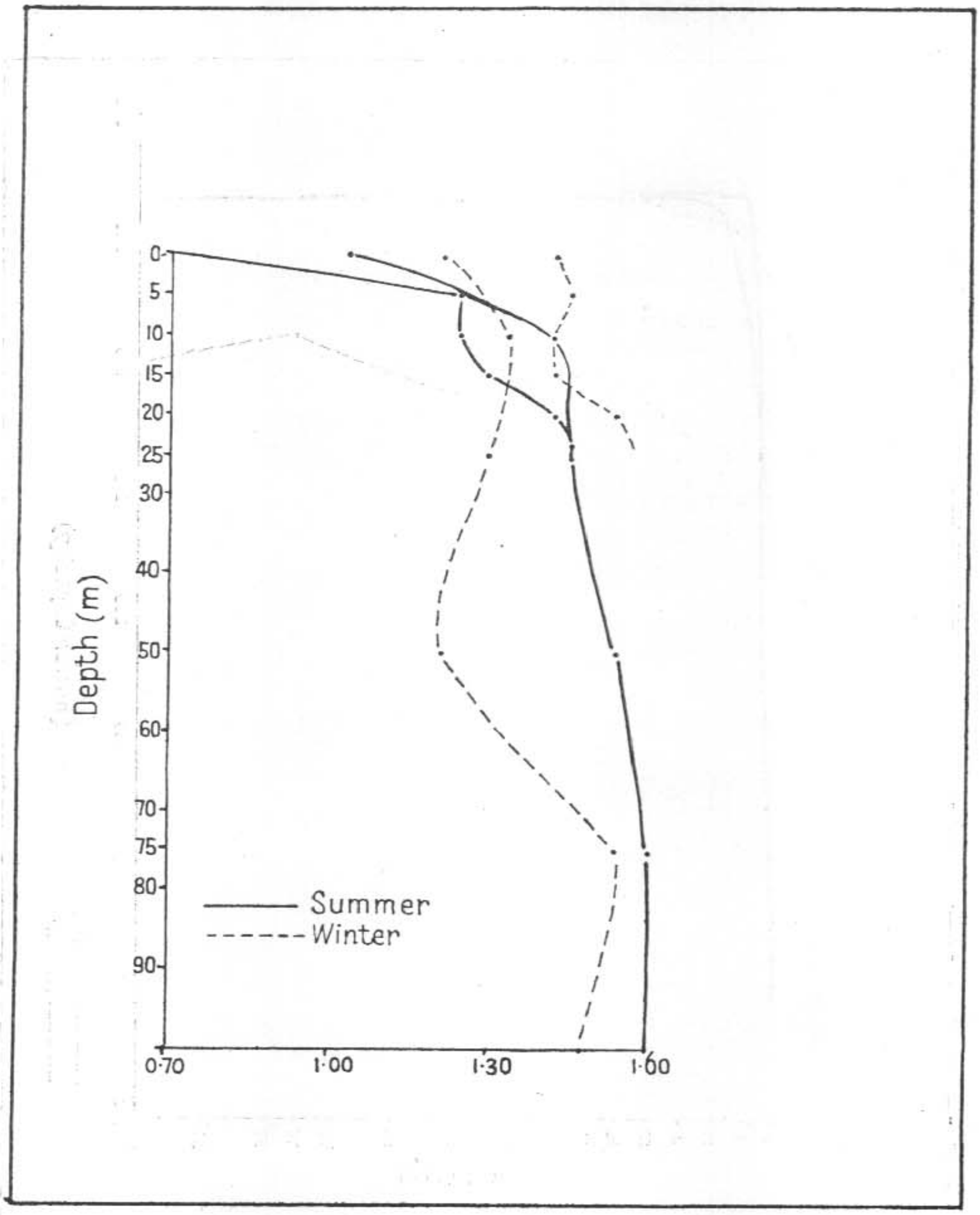


FIG. 39—Changes in dissolved phosphate (μg at./L) with depth in Summer and Winter waters at Stations 1 (25m.) and 2 (100m.).

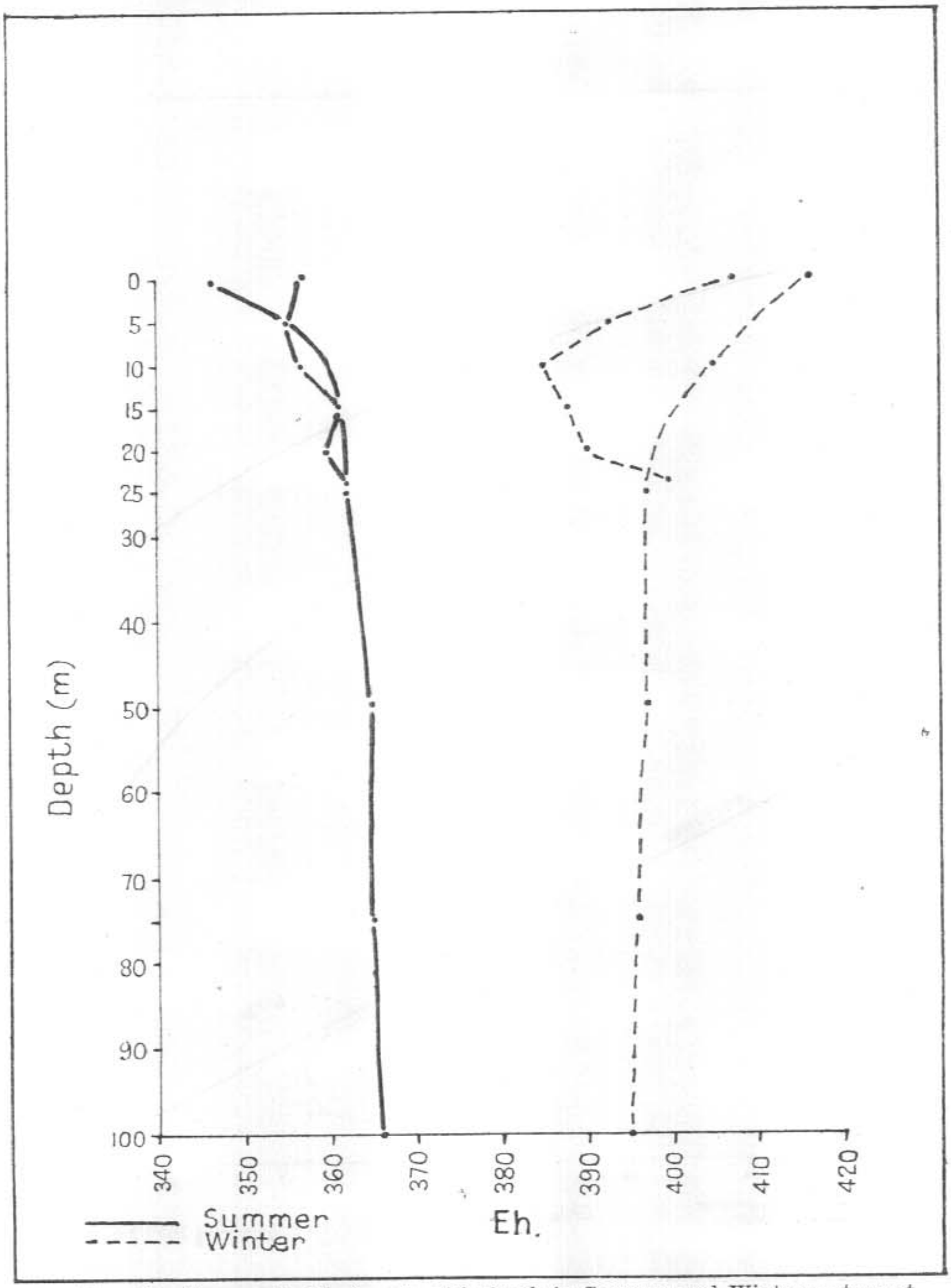


FIG. 40—Changes in Eh (m.v.) with depth in Summer and Winter waters at Stations 1 (25m.) and 2 (100m.).

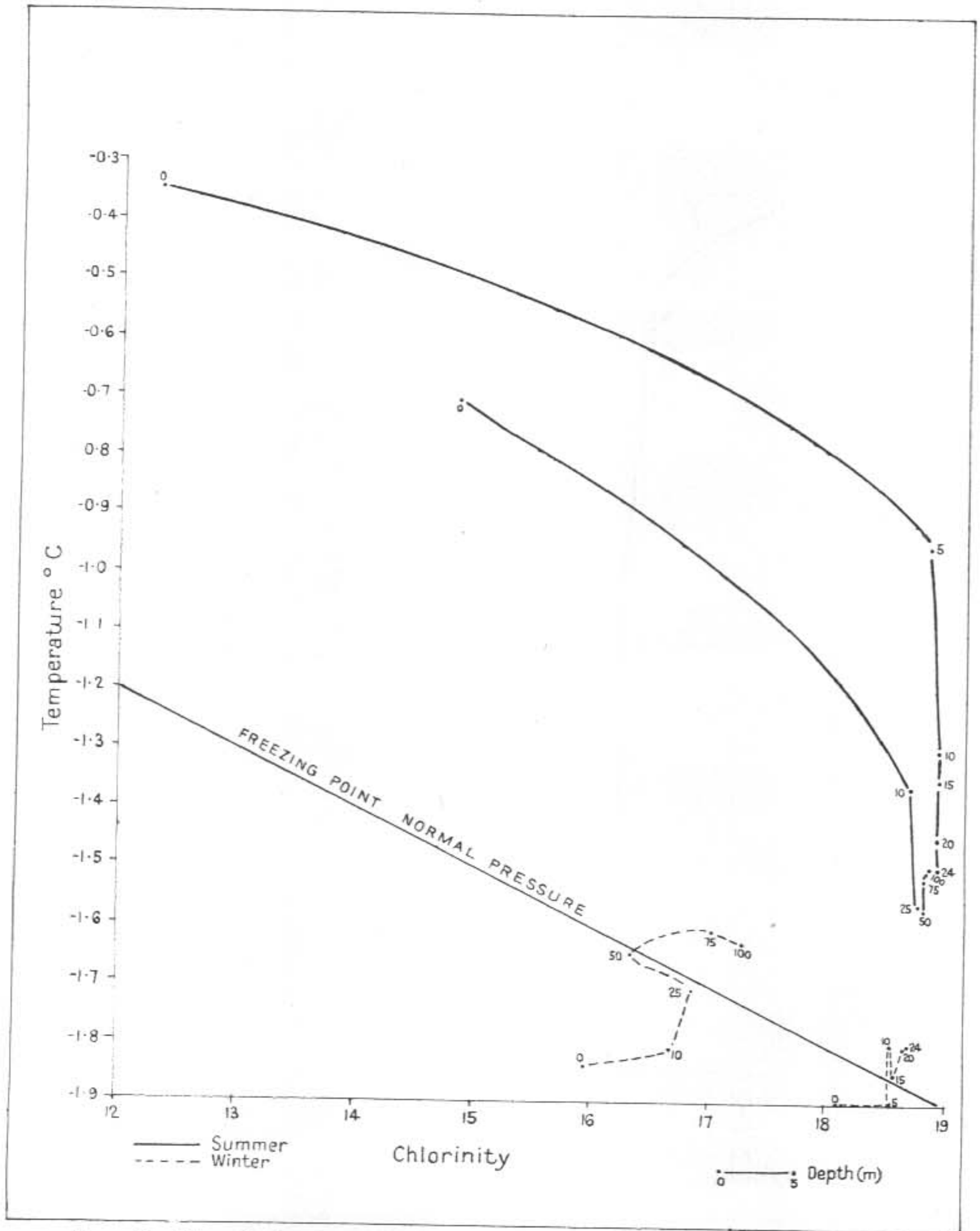


FIG. 41—The relationship between temperature and chlorinity in Summer and Winter waters at Stations 1 and 2. Freezing curve included for reference.

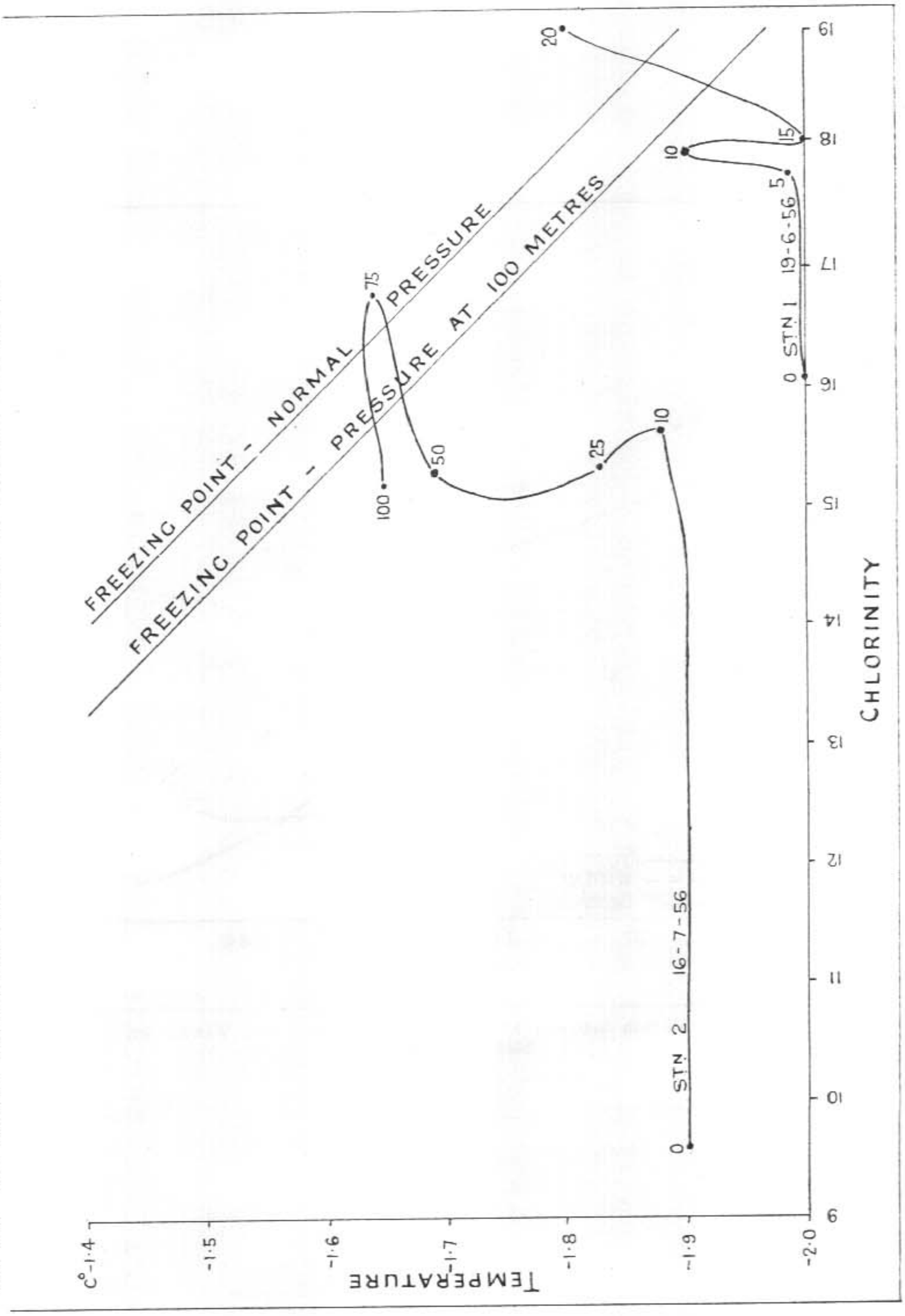


FIG. 41A—The relation between temperature, chlorinity and freezing point at Station 1 on 19.6.56, and Station 2 on 16.7.56.

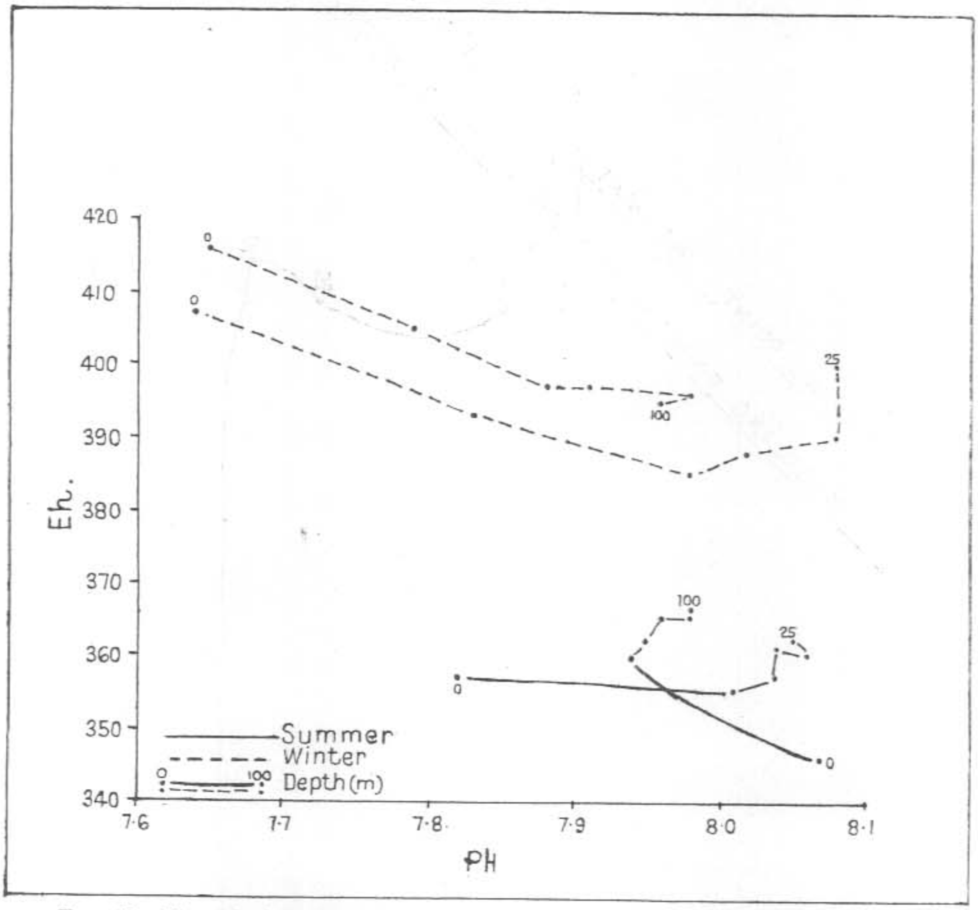


FIG. 42—The relation between Eh and pH in Summer and Winter waters at Stations 1 and 2.

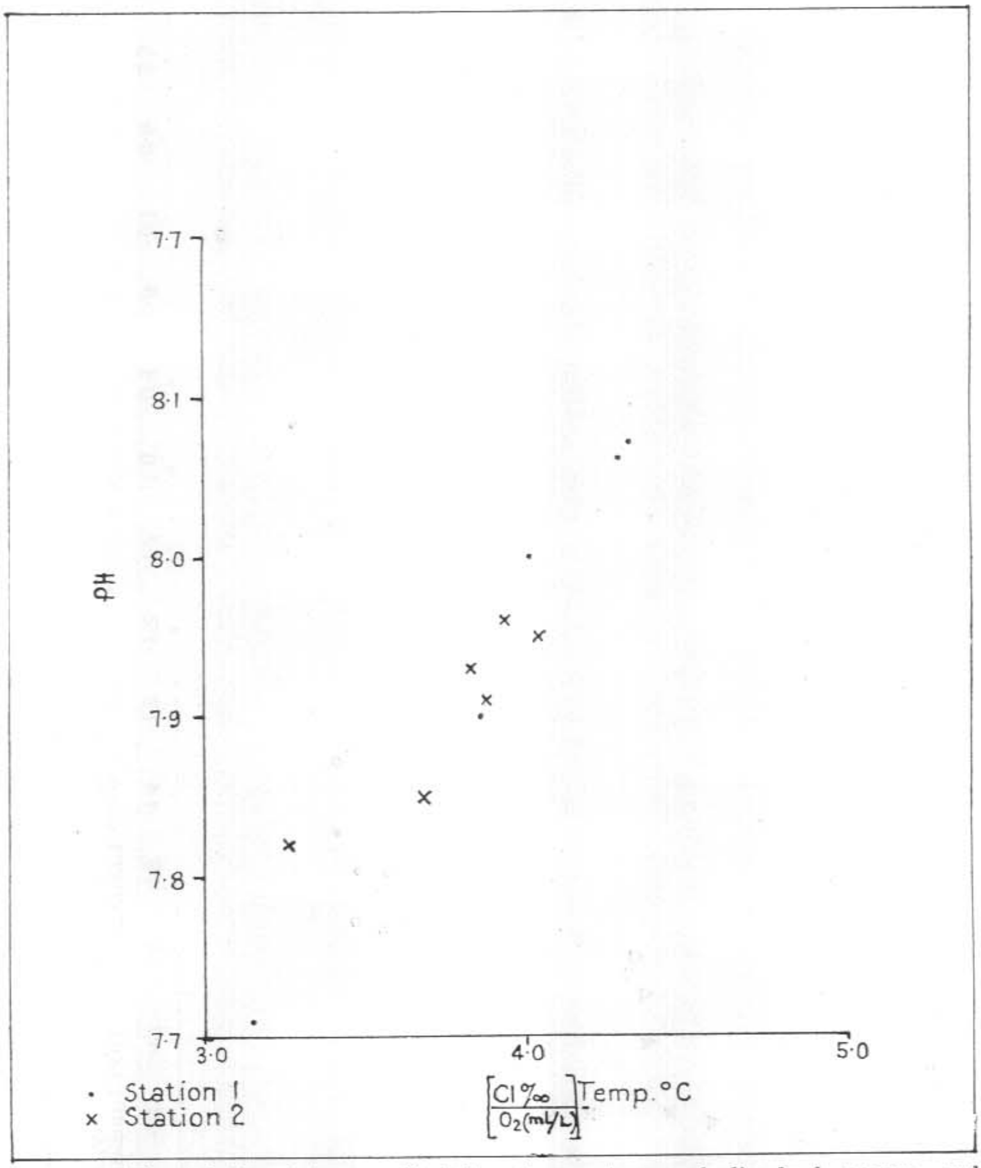


FIG. 43—The relation between chlorinity, temperature and dissolved oxygen, and pH at Stations 1 and 2.

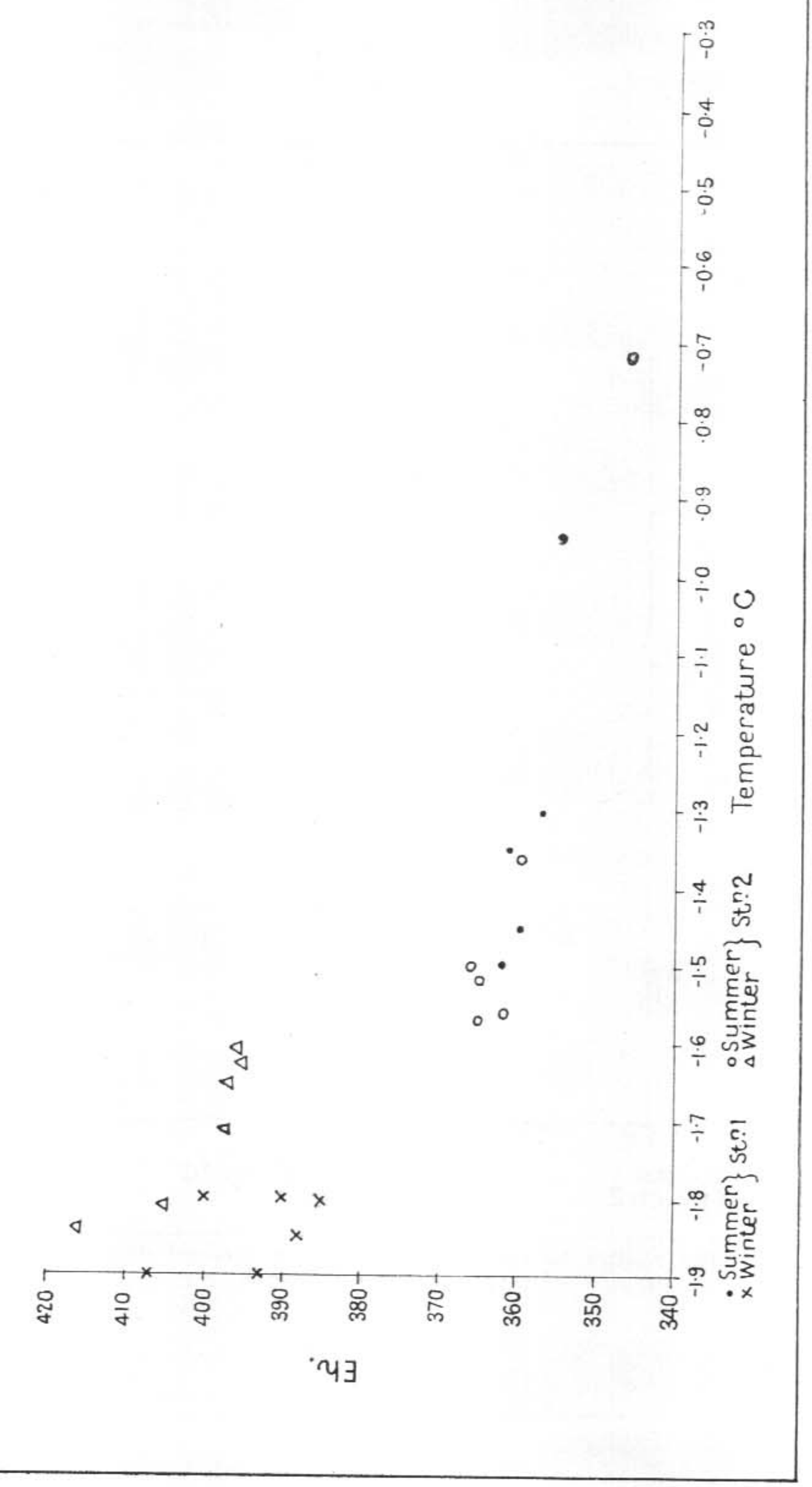


FIG. 44—The relation between Eh and temperature in the waters at Station 1 and 2.

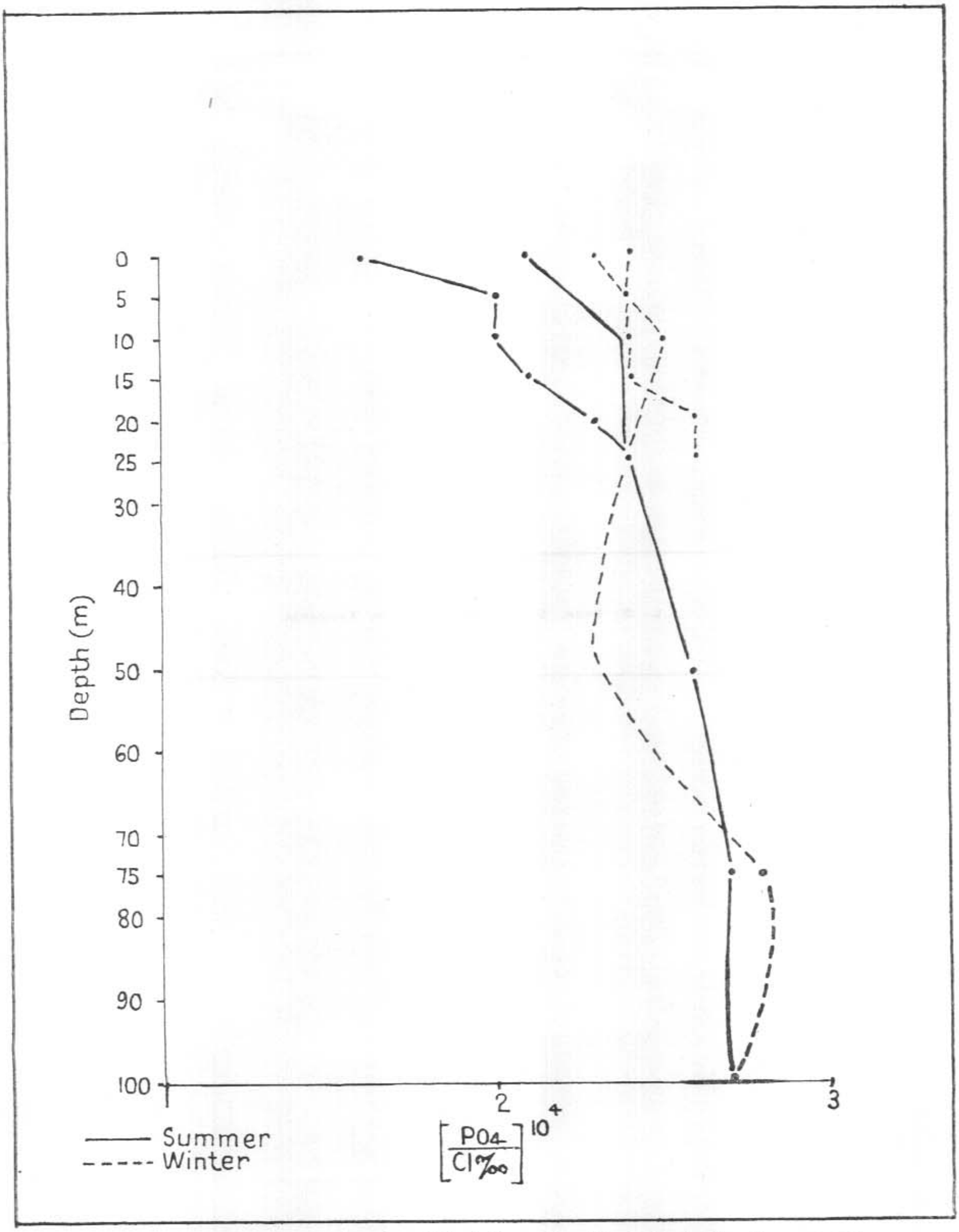


FIG. 45—Changes in the phosphate/chlorinity ratio with depth in the Summer and Winter waters at Stations 1 and 2.

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