AN ANNUAL CYCLE OF PHYTOPLANKTON, WITH SPECIAL REFERENCE TO THE DIATOMS AND ARMORED DINOFLAGELLATES, AT LOGY AND ROBIN HOOD BAYS, AVALON PENINSULA, NEWFOUNDLAND, FEBRUARY, 1970 - JANUARY, 1971

YI-HUNG LIN

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by

© Yi-Hung Lin, B. Sc.

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ABSTRACT

During the period of February 1970 to January 1971, a qualitative and quantitative investigation of the phytoplankton population, with particular reference to the diatoms and armored dinoflagellates, was carried out at Logy and Robin Hood Bays on the east coast of the Avalon Peninsula of Newfoundland.

Samples were collected at three depths in the bays and from the pumphouse of the Marine Sciences Research Laboratory. Related physical factors: water temperatures, Secchi disc readings, weather conditions, sea states and monthly total hours of bright sunshine, were simultaneously determined.

Water samples preserved in Lugol's solution were examined by the sedimentation method using an inverted microscope. Net samples were examined for forms which might be missing from the water samples.

The annual cycle of phytoplankton pattern found was as follows: a very low winter population of diatoms, dinoflagellates, and other flagellates was replaced by a large population of diatoms (mainly species of Chaetoceros and Thalassiosira) during the spring bloom. With a reduction in numbers and species of diatoms in the late spring, the phytoplankton population became low and irregular during the summer and autumn and consisted mainly of naked dinoflagellates and Cryptomonas sp.

Generally speaking, the vertical distribution of diatoms was variable at the three depths sampled, while largest numbers of dinoflagellates and other flagellates were found mainly in the upper water layers.

The seasonal and vertical distribution of phytoplankton abundance was related to such physical factors as water temperature, solar radiation and stability of the water column.

During the warm season the alternate increase and decrease of the phytoplankton population appeared to be due to the material examined, the methods employed and such local factors as water movements and run-off which might bring about varying growth conditions of these organisms. The phytoplankton was found to differ in numbers and species between bay and pumphouse waters because these sampling locations represented different ecological conditions of water movements and algal flora.

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The sampling program required the assistance of the Marine Sciences Research Laboratory in providing boats and personnel; the skillful technical field assistance of Mr. M. Hickey and Mr. R. Scaplen, is gratefully acknowledged.

Special thanks are due to Dr. A. Bursa, specialist in phytoplankton, for the identification of some difficult specimens, particularly Actiniscus pentasterias Ehrenberg v. arcticus Bursa and Cryptomonas sp.

INTRODUCTION

"The facilities of the Marine Sciences Research Laboratory at Logy Bay clearly make exhaustive investigations directed towards not only a better understanding of the marine biota of the colder waters of the northwest Atlantic, but also a very detailed knowledge of the productivity and other aspects of the ecology of selected study areas. Large areas of Newfoundland's coastal waters have not yet been subjected to significant pollution through human agency. Selective research of this sort will, therefore, not only yield basic information at the specific and community levels but can provide much-needed baseline information against which future pollution can be monitored."

----------MSRL Tech. Rep. No. 1, 1969

Since the end of the 19th century, there have been a number of investigations dealing with the distribution of phytoplankton in the coastal waters of eastern Canada. These studies have been carried out in the region from Ellesmere (including Smith Sound) to Hudson Strait (Cleve, 1873, 1896; Davidson, 1931; Polunin, 1934; Seidenfaden, 1947; Bursa, 1961a, 1961b, 1969), Labrador Sea (Iselin, 193[illegible]. Holmes, 1956), Gulf of St. Lawrence (Bailey, 1913a, 1913b; Gran, 1919; Bailey and Mackey, 1921; Brunel, 1962), east coast of Nova Scotia (Bailey and Mackey, 1921), Bay of Fundy and Gulf of Maine (Bailey, 1910, 1912, 1915, 1917; McMurrich, 1917; Fritz, 1921; Davidson, 1934; Gran and Braarud, 1935), Grand Banks (Movchan, 1967, 1970a, 1970b). Very few phytoplankton studies have been carried out on the Atlantic coast of of Newfoundland (Frost, 1938; Lackey and Lackey, 1970).

Of the studies mentioned, two have been carried out on a year-round basis in waters which influence oceanographic conditions along the Atlantic coast of Newfoundland. Bursa (1961b) carried out investigations at Igloolik on the Foxe Basin whose waters mix with those of Hudson Bay to flow out of Davis Strait, joining the Labrador Current. Holmes (1956) collected samples from an open sea area (Station B: 56°30' N; 50°00' W) where the Labrador and West Greenland Currents meet. Because the inshore portion of the Labrador Current flows south along the east coast of Newfoundland, the data of these workers has contributed much useful information for the study of the annual cycle of phytoplankton in the area investigated in the present study.

The more recent work of Movchan (1967, 1970a, 1970b) has presented data for the seasonal variation of phytoplankton off the south-east coast of Newfoundland. However, this worker collected his samples mainly on the Grand Banks in April and November, 1958, March, 1960 and September, 1961. Frost (1938) investigated fluctuations in the species of dinoflagellates of the genus Ceratium from the Labrador coast to the Grand Banks, including the circum-coastal waters of Newfoundland. Her samples were collected only in the June-July and August-September periods of the years 1931 to 1935. Lackey and Lackey (1970) prepared a checklist of microorganisms, including phytoplankton, collected in the Logy Bay area (Avalon Peninsula, Newfoundland) during late July and early August, 1969.

The purpose of the present research has been to examine, both qualitatively and quantitatively, the temporal and spatial distribution of phytoplankton, with particular reference to the diatoms and the armored dinoflagellates, of Logy and Robin Hood Bays, Avalon Peninsula, Newfoundland.

HYDROGRAPHY

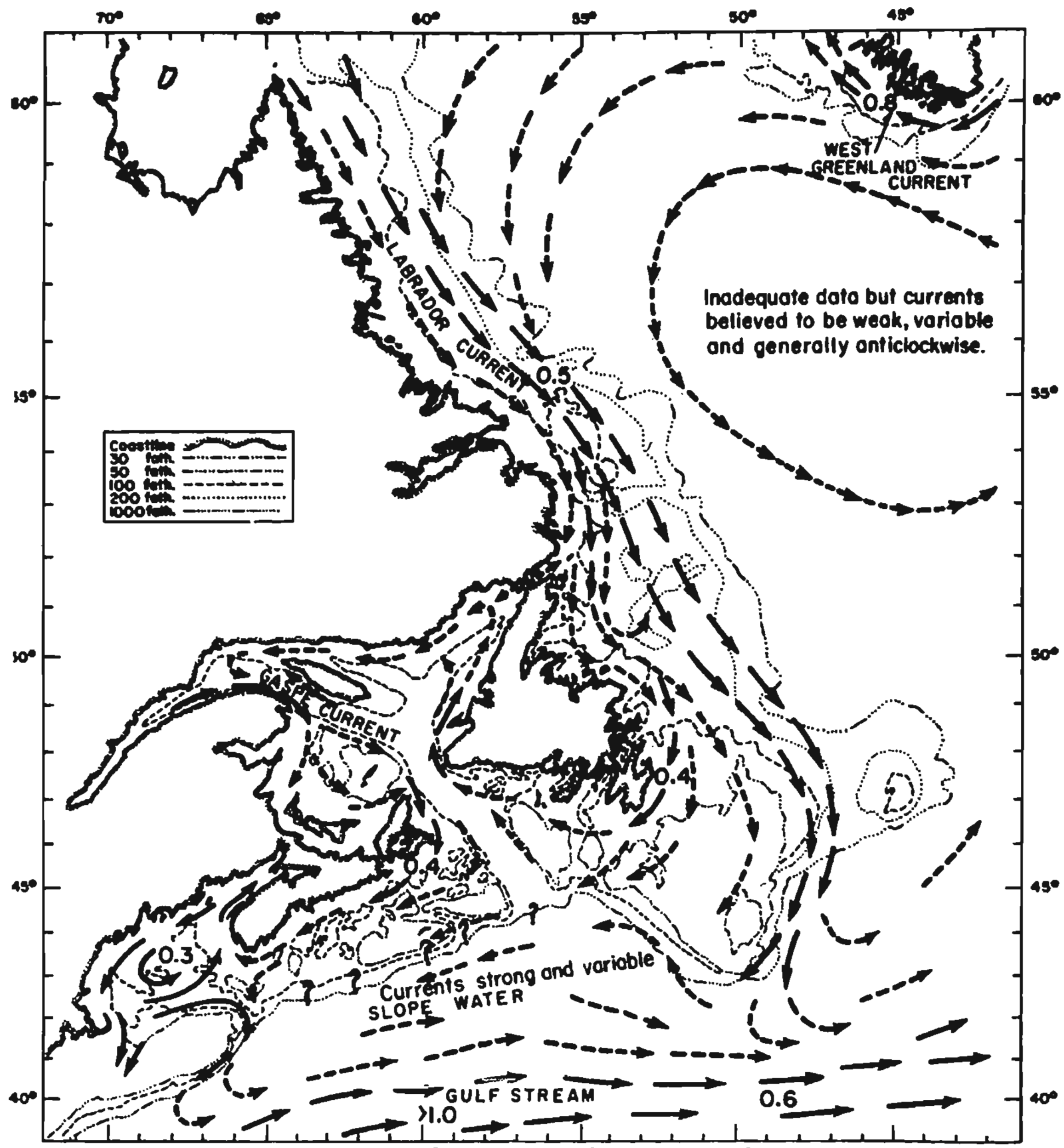
A current of very cold water flows southward from the north into Baffin Bay along the east coast of Baffin Island, thence into Davis Strait and along the Labrador coast into the Labrador Sea. In the Labrador Sea region it is joined by another cold current emerging from Hudson Bay through Hudson Strait to form the inshore, cold portion of the Labrador Current. Part of the slightly warmer West Greenland Current, which flows north along the west coast of Greenland, turns westward when approaching Davis Strait and also joins to form the offshore portion of the Labrador Current.

The inshore stream of the Labrador Current, which contains the cold polar water, is a low temperature and low salinity water compared to the offshore warmer and more saline water which flows deep along the outer slopes of the continental shelf and the Grand Banks.

The Labrador Current flows south along the eastern coast of Newfoundland and spreads far and wide over the Grand Banks where it meets the northward incursion of the warm and relatively high salinity waters of the Gulf Stream (Fig. 1). Thus, the inshore portion of the Labrador Current, which is confined to the continental shelf, dominates the region of Logy and Robin Hood Bays on the Avalon Peninsula.

The waters of the Labrador Current flowing along the east coast of Newfoundland show winter temperatures of -1 C to -1.5 C, and occasionally

Figure 1. Current systems around Newfoundland (after Templeman, 1966).



Typical circulation of surface waters in the southern part of the ICNAF area during spring and summer. *Solid arrows:* current direction relatively persistent; *broken arrows:* current direction less persistent. *Numbers*: approximate speed of current in knots.

lower, from the surface to 183 m (100 fathoms) or deeper. At depths of 219 - 274 m (120 - 150 fathoms) or deeper in the same inshore areas, the temperature reaches 0 C.

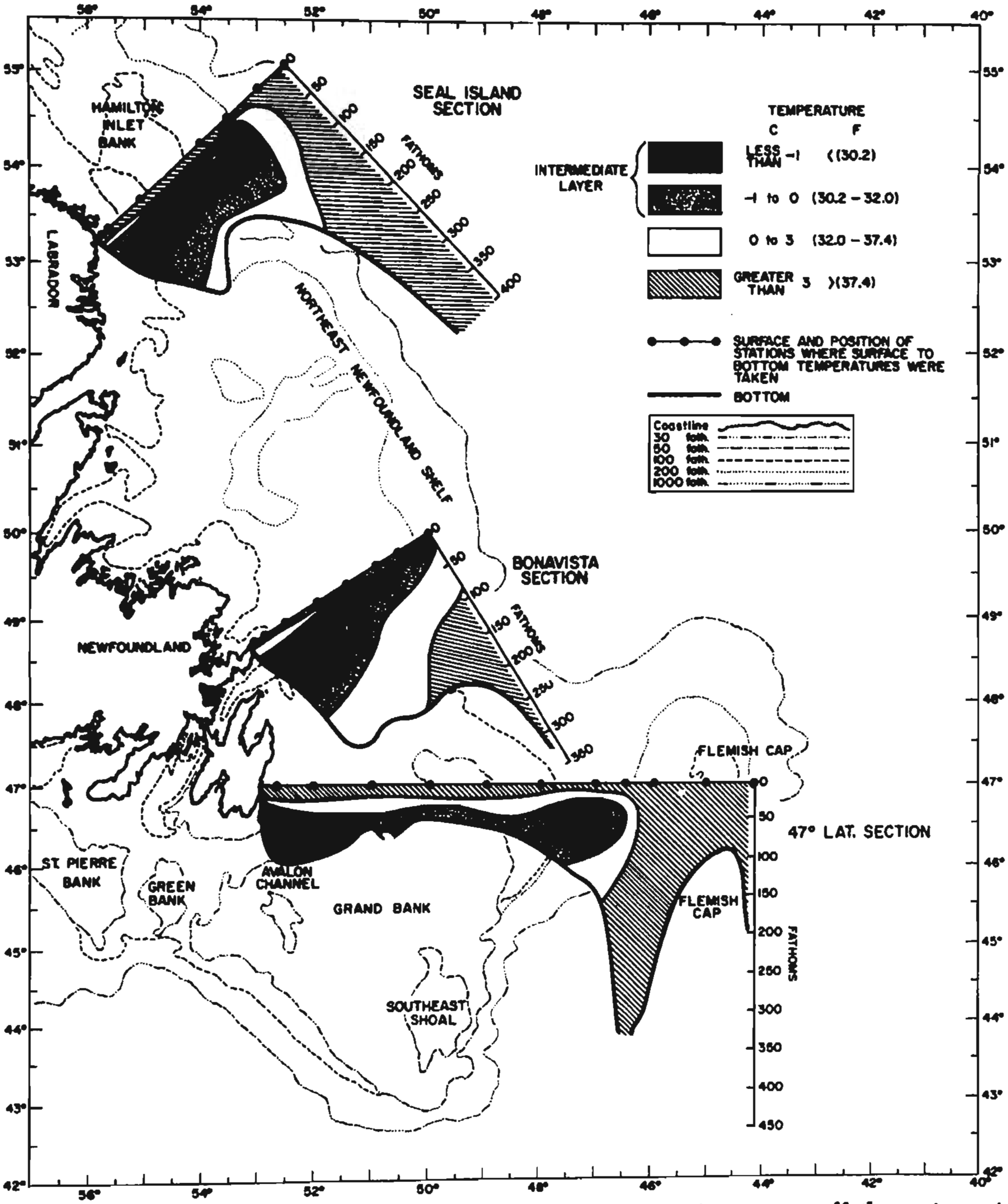
Following the warming of the water in the spring, three thermal layers of water appear along the Newfoundland coast: an upper warm, an intermediate cold and a deep warm layer (Fig. 2). The upper two layers are from the colder, westward part of the Labrador Current; the deeper, warmer layer lies off shore and is derived from the West Greenland Current but it is found only where the water is deeper then 183 - 219 m (100 - 120 fathoms).

Fig. 3 shows the average monthly sea temperature regime for the Cape Spear area just south of Logy and Robin Hood Bays. These temperatures are highest between June and November and lowest during the winter. The depth is not great enough for the presence of the warmer oceanic water.

Salinity conditions, from 20 m to the surface, along the east coast Newfoundland are irregular. These variations are brought about by tidal currents, precipitation and run-off. Generally, the salinity is about 32 ‰ in the upper layer of inshore water in comparison with higher values ranging from 33 ‰ to 34 ‰ of the deeper waters at 183 - 274 m (100 - 150 fathoms) in same area.

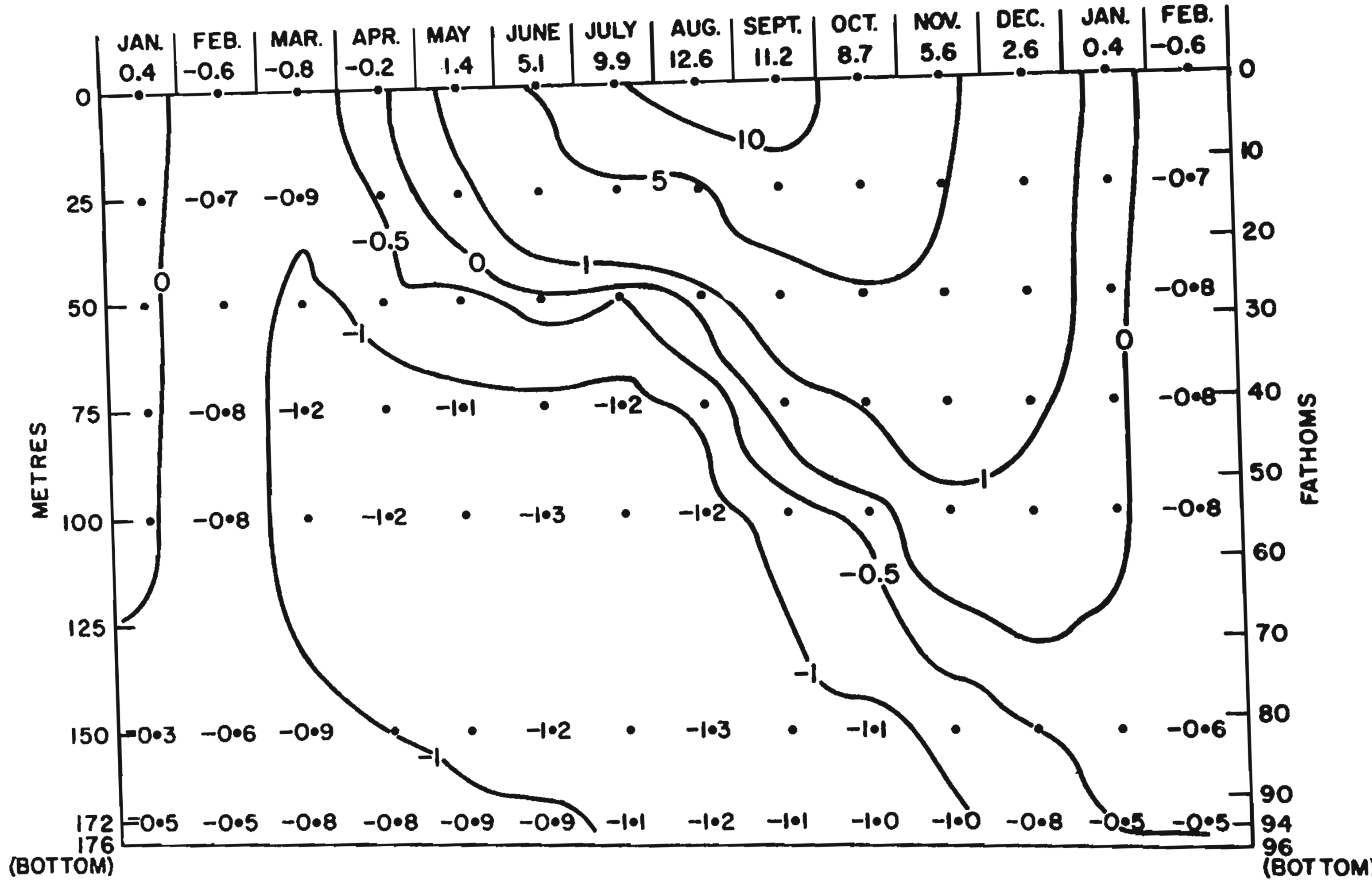
The above discussion is based on the data of Iselin (1930), Hachey (1961), Templeman and Fleming (1963), Ramster (1964), Templeman (1965, 1966, 1970).

Figure 2. Generalized temperature sections, surface to bottom, in summer off the east coast of Newfoundland and southern Labrador (after Templeman, 1966; Templeman and Fleming, 1963).



Generalized temperature sections, surface to bottom, in summer off the east coast of Newfoundland and southern Labrador (from Templeman and Fleming, 1963b).

Figure 3. Average monthly sea temperature regime for the Cape Spear, 1950-1962 (after Templeman, 1965, 1966).



Average monthly sea temperatures (degrees C) at various depths for 1950—62 at Hydrographic Station 27, two nautical miles off Cape Spear, near St. John's (From Templeman, 1965d, Fig. 1).

MATERIALS AND METHODS

A. Bay sampling

1. Stations

Phytoplankton sampling was carried out at two locations on the east coast of the Avalon Peninsula, Newfoundland (Fig. 4). One of these was Logy Bay (47° 36' N; 52° 40' W), situated about 0.8 km northeast of the Marine Sciences Research Laboratory (MSRL) of the Memorial University of Newfoundland. The other station was Robin Hood Bay (47° 38' N; 52° 39' W) located about 1.6 km southeast of the MSRL. Sampling was carried out at Logy Bay in approximately 40 meters of water and at Robin Hood Bay in approximately 60 meters of water. Some freshwater run-off enters the Logy Bay area; none enters the Robin Hood Bay area.

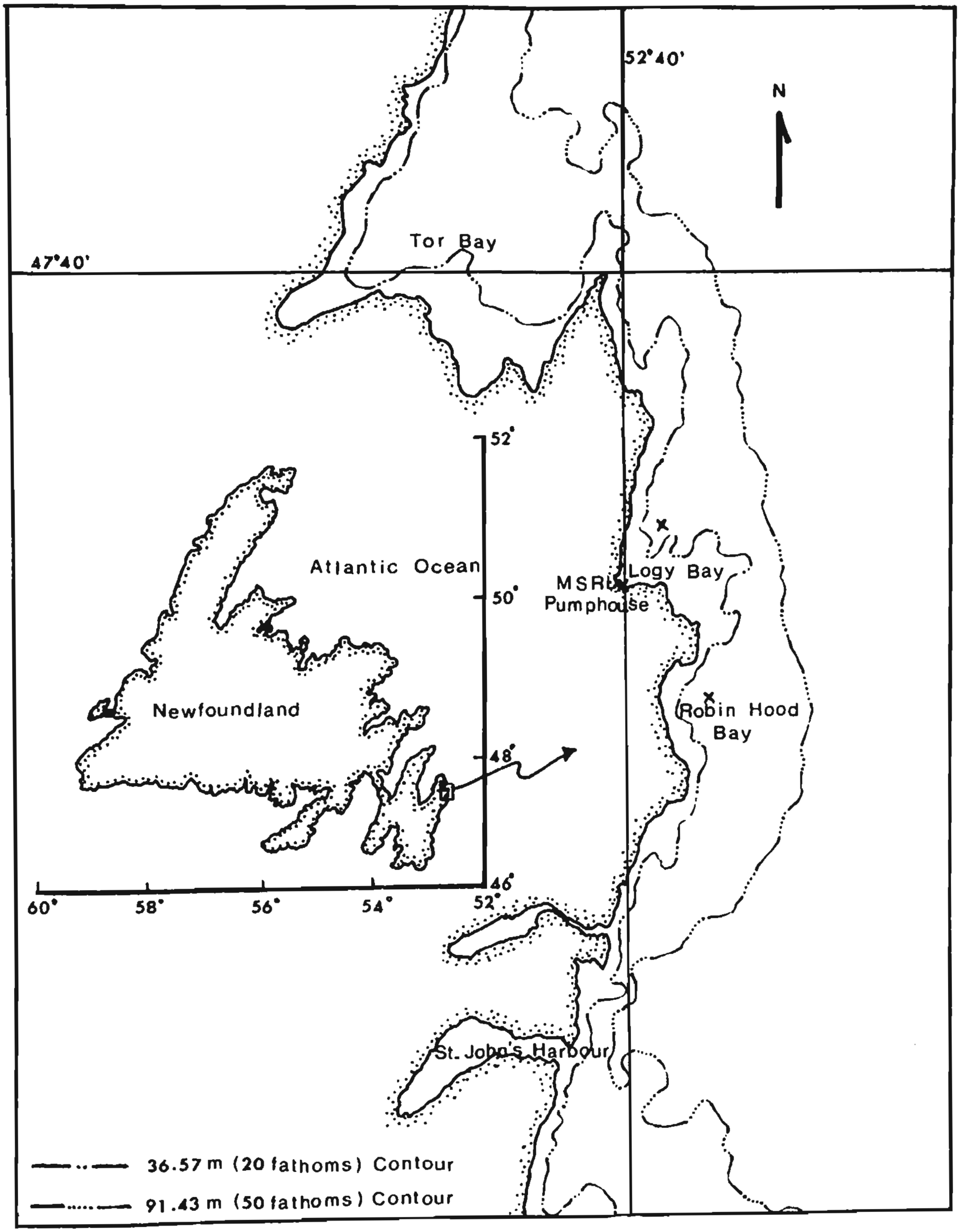
2. Sampling period

Twenty-two sampling trips were carried out from February, 1970 to January, 1971. Of these the first 19 were carried out at Logy Bay at one to three week intervals. Of the last three samplings at Robin Hood Bay, one involved a five week interval.

3. Sampling procedures

Plankton samples were collected from either the MSRL's launch, "Teal" or from rented vessels. Two methods were used:

Figure 4. Northeast coast of the Avalon Peninsula, Newfoundland, showing plankton sampling locations (x).


52°40'
N
Tor Bay
47°40'
52°
Atlantic Ocean
50°
Newfoundland
48°
46°
60°
58°
56°
54°
52°
MSRL
Pumphouse
Logy Bay
Robin Hood
Bay
St. John's Harbour
36.57 m (20 fathoms) Contour
91.43 m (50 fathoms) Contour

a) Nansen bottle samples

These samples were collected from the surface, 15 m and 30 m. Each sample was drawn off to fill a glass jar holding about 800 ml. These samples were used for both the qualitative and quantitative determination of phytoplankton populations.

b) Net samples

A Clarke-Bumpus sampler of 13 cm aperture, fitted with a No. 20 nylon net (0.076 mm hominal mesh aperture) was used. Oblique nauls were made from 30 m to 15 m to the surface. The towing time at each depth was five minutes. Occasionally, the tows were begun at 45 m and continued to the usual levels. Each sample, together with net washings, was stored in a glass jar. The net samples were used primarily for the qualitative determination of phytoplankton, and particularly as a check on population composition as determined from the water samples.

4. Measurements

a) Bathythermograph determinations

Temperatures from surface to bottom were measured by means of a bathythermograph (BT) on most of sampling trips. A surface "bucket" temperature determination was made at the same time and used to correct the BT trace.

b) Secchi disc readings

A rough estimate of the depth of light penetration into the water was made on each sampling trip by means of a white Secchi disc, 30.5 cm diameter. The disc was lowered into the water until it was just lost from view and the length of attached cable read from the meter wheel.

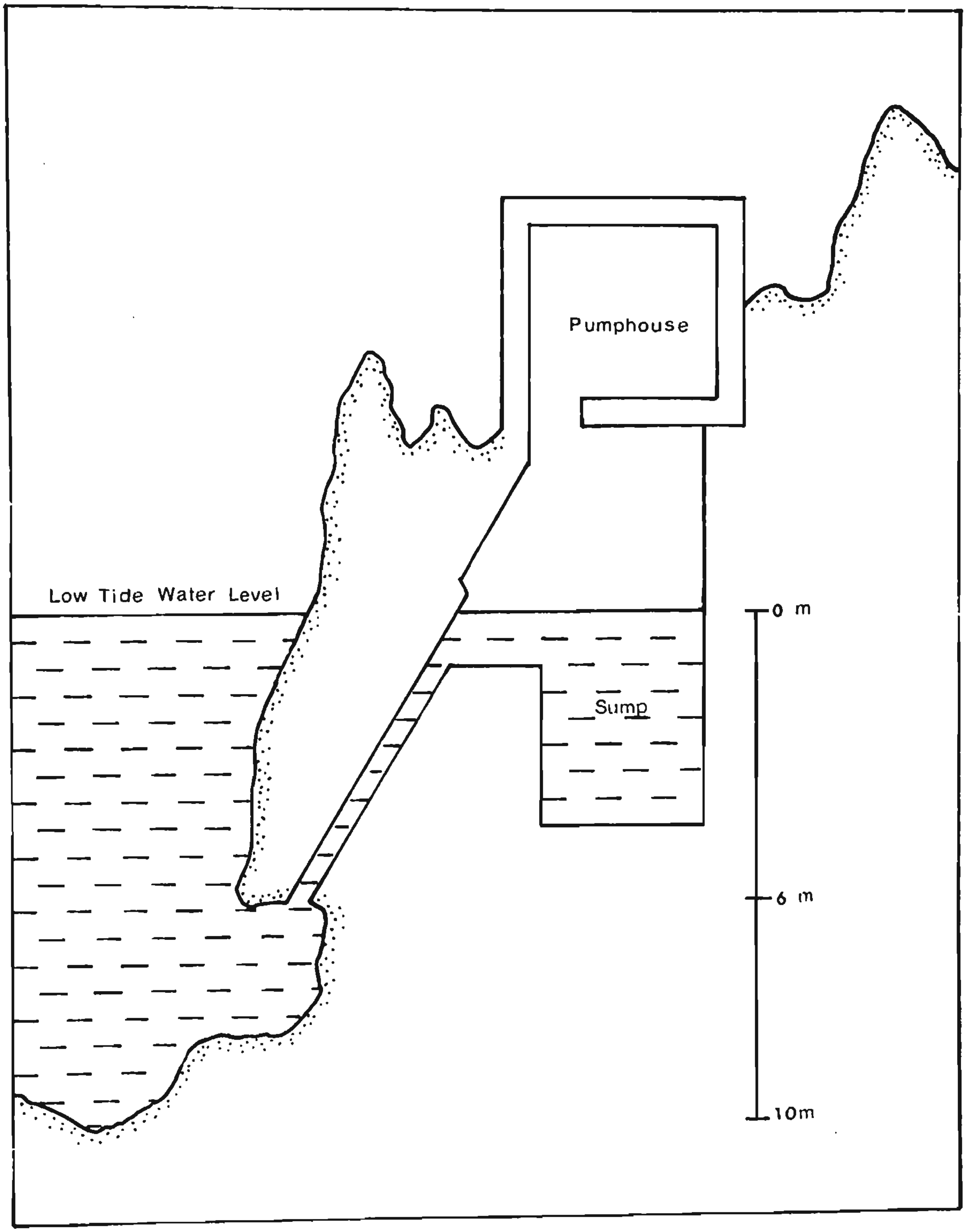
c) Other data

1) Observations on weather, wind force and direction, sea state, and swell were made on each sampling trip.
2) Mean air temperature, total hours of bright sunshine, average monthly wind speed, and prevailing wind direction for the sampling period were obtained from the meteorological station at St. John's (Torbay) Airport, Newfoundland.

B. Pumphouse sampling

Water samples for phytoplankton determination were also taken from the surface water of the MSRL's pumphouse sump (Fig. 5). Sea water enters the sump from an intake located approximately six m below the sea surface at low tide level. It is then pumped to a reservoir from which the sea water is fed into the laboratory. Pumphouse sampling was carried out on the same day as each sampling trip, and, in addition, on those days when the weather was unsuitable for boat work, or when the vessel was out of commission due to engine breakdown. The surface water temperature was also determined at each sampling.

Figure 5. Cross-section of the MSRL pumphouse showing sump and its communication with the sea.


Pumphouse
Low Tide Water Level
Sump
0 m
6 m
10m

C. Processing of samples

1. Preservation of samples

a) Water samples

On return to the laboratory, each water sample was treated with Lugol's solution (1 : 100) to kill and preserve the plankton. Lugol's solution was the preservative of choice, in preference to formalin, because it permitted more efficient settling of the organisms by weighting them (Lund, Kipling, and LeCren, 1958) and because it permitted better observation of the internal structures of both diatoms and dinoflagellates. For the naked flagellates (except Coccolithophores), in addition, little alteration in cell morphology was observed.

b) Net plankton samples

Net plankton samples were preserved by the addition of sodium borate-neutralized 40 % formalin to give a final concentration of 5 % in each sample.

2. Settling of water samples

Following the addition of Lugol's solution to a water sample and thorough stirring to suspend the plankton organisms, an aliquot was poured into a cylindrical chamber supported on a plate chamber (Carl Zeiss No. 478619) and the plankton allowed to settle into the latter for not less then 24 hours. For most of the samples, a 100 ml cylindrical chamber (Carl Zeiss No. 478614) was used. For the one spring bloom sample (May 11) examined, a 50 ml cylindrical chamber (Carl Zeiss No. 478613) was used.

At the end of the settling period, the cylindrical chamber was replaced by a cover plate and the settled organisms were examined with a Carl Zeiss UPL inverted microscope. For improved resolution, a condenser was always employed.

3. Counting and identification

Counting was carried out (magnification of 390x) by tracing a path back and forth over one-half the area (265.5 mm^2) of the plate chamber using a mechanical stage. This enabled examination of the equivalent of 1,159.4 fields at the magnification used. A higher magnification (625x) was used where necessary as an aid in identification.

The following kinds of organisms were counted: diatoms, armored dinoflagellates, naked dinoflagellates, coccolithophores, silicoflagellates, and other flagellates. For species of diatoms occurring in chains, the total numbers of cells in each chain, rather than the number of chains alone, were counted. Identification to species, wherever possible, was carried out.

4. Examination of net samples

Well-stirred aliquots of net plankton samples were examined using plate chambers as examination containers. This procedure was carried out to find those organisms retained in the No. 20 net and which, due to scarcity in the plankton, might have been absent from the corresponding settling samples.

D. Literature sources used for identification of organisms

Many literature sources were referred to for identification. The following were used to the greatest extent: Brunel (1962), Cupp (1943), Hendey (1964), and Lebour (1925, 1930). Sources used to a lesser extent included: Bursa (1969), Gaarder (1954), Gran (1908), Lemmermann (1908), and Paulsen (1908).

RESULTS

A. Temperature

The data for water temperatures taken during the sampling period (Fig. 7; Table 1, Appendices) show that the water column was homogenous for the samplings of January and February (top to bottom temperature differences did not exceed 0.1 C) and nearly homogenous for the samplings of December, March, and April (top to bottom temperature differences ranged from 0.7 to 1.7 C).

Figure 7 also shows that from May to September the vertical temperature distribution was such as to bring about thermal stratification. Table 2 (Appendices) presents data on the extent of stratification. This began at depths below the surface ranging from 10 to 40 m and showed thicknesses of 5 to 12 m. Stratification was most pronounced on July 27, August 10, August 25, and September 14. For the first and third dates, two thermoclines were observed on each date; the lower one in each case being most pronounced in terms of temperature change per meter of depth. The second and fourth dates each showed a single thermocline, showing temperature changes of 0.8 C and 0.9 C, respectively, per meter of depth.

Figure 6 and Table 1 (Appendices) show the temperature changes which occurred during the sampling period at each of the depths sampled and in the pumphouse.

Surface water temperatures decreased from 0.8 C (February 10)

Figure 6. Annual total phytoplankton, Secchi disc readings, and water temperatures during the sampling period.
(Upper figure: Total phytoplankton and Secchi disc readings.
Lower figure: Water temperatures.)

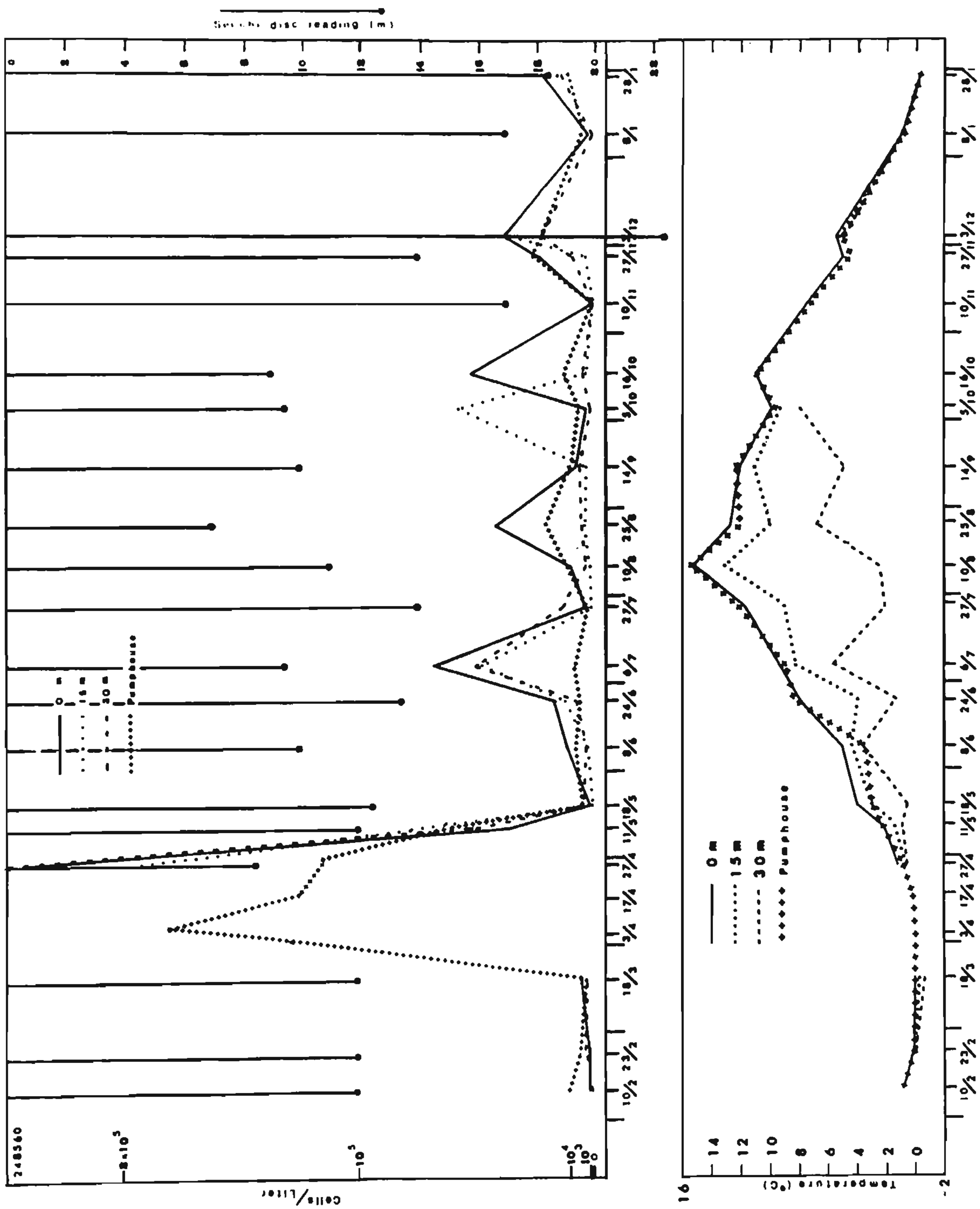

Secchi disc reading (m)
Cells/Liter
Temperature (°C)
0 m
15 m
30 m
Pumphouse

Figure 7. Vertical distribution of temperatures in sampling areas as determined by bathythermograph.

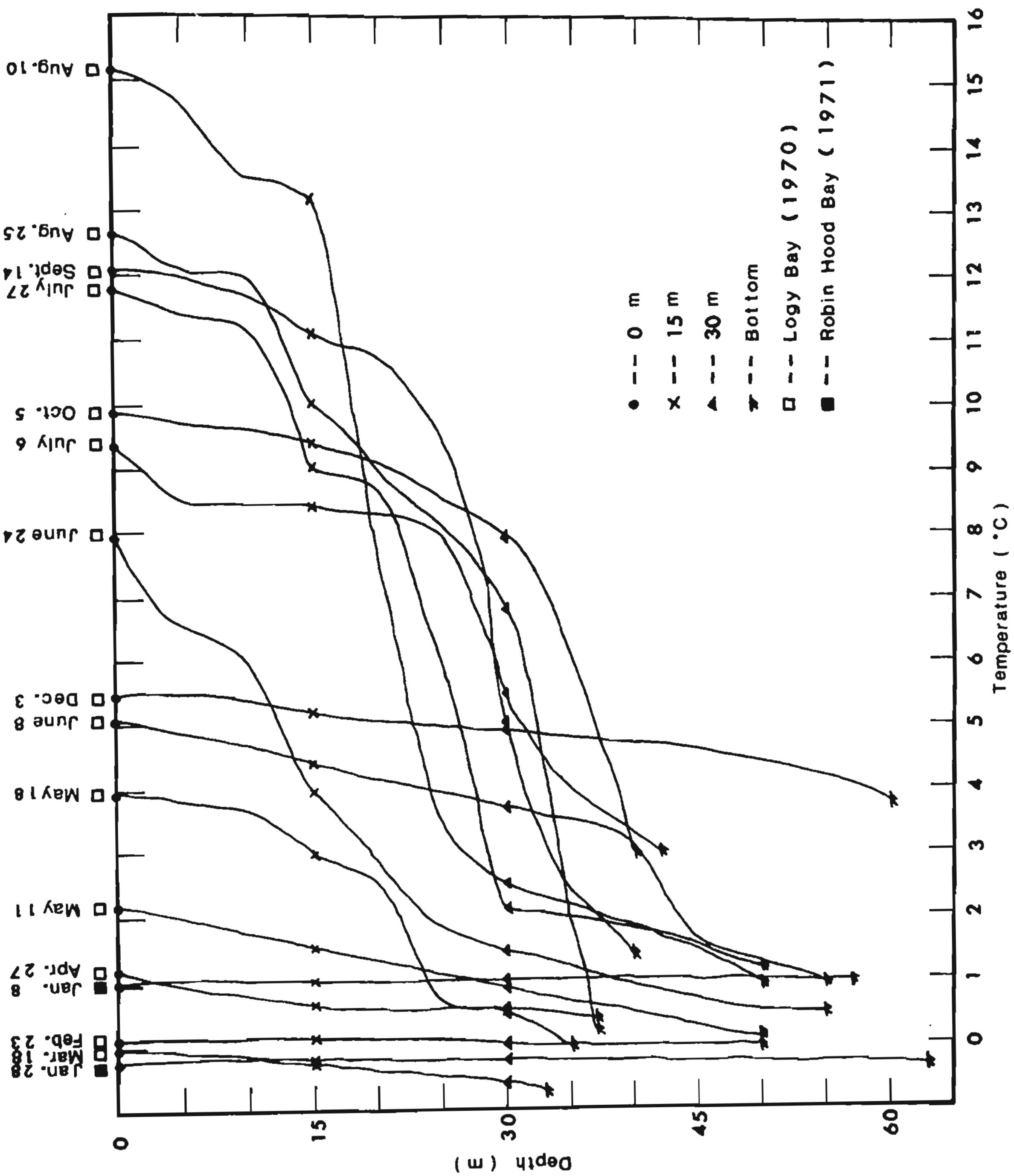

Aug. 10
Aug. 25
Sept. 14
July 27
Oct. 5
July 6
June 24
Dec. 3
June 8
May 18
May 11
Apr. 27
Jan. 8
Feb. 23
Mar. 18
Jan. 28
0 m
15 m
30 m
Bottom
Logy Bay (1970)
Robin Hood Bay (1971)
Temperature (°C)
Depth (m)
0
15
30
45
60
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Figure 8: Annual total phytoplankton abundance during the sampling period.

(see page 52)

to 0 C (March 18). Begining with the observation of April 27, surface temperatures increased rapidly, reaching a maximum of 15.2 C (August 10). Following this date, surface temperatures decreased, but more slowly than the previous rate of increase. Further, the decrease was not continual, being interrupted by increases of 1.1 C on October 16 and 0.5 C on December 3. On January 28, the lowest temperature of the sampling period, -0.2 C, was reached.

At the 15 m depth, the lowest temperature of the sampling period, -0.3 C, was reached on March 18. Commencing in April, temperatures increased continuously except for a drop of 0.4 C between June 8 and June 24. The maximum temperature reached was 13.2 C on August 10. During this period, although the general trend approximated that for the surface temperatures, 15 m temperatures lagged behind surface temperatures by differences of 0.6 C to 4.0 C, the latter occurring during the June temperature drop. Following the maximum temperature reached, temperatures decreased, being interrupted, however, by a increase of 1.1 C on September 14. Subsequently, temperatures fell continuously, approximating the surface temperatures very closely.

Temperature changes at 30 m followed a pattern quite different from that observed for the upper layers. Beginning in April, a series of temperature increases and decreases was observed. Each of the temperature increases was greater then the previous one, giving the following sequence: 0.9 C (May 11), 3.7 C (June 8), 5.5 C (July 6), 6.8 C (August 25) and 8.0 C (October 5). The last one was the maximal 30 m temperature reached for the sampling period and occurred nearly two months after surface and 15 m maxima had occurred. Subsequent temperatures showed a decrease approximating surface and 15 m temperatures quite closely. The lowest temperature observed at 30 m was -0.6 C on March 18.

Pumphouse temperatures, with some minor deviations, showed very close agreement with surface temperatures.

B. Meteorological data and sea state data

Meteorological data (weather, wind force and direction) and state of sea and swell during the sampling period are presented in Table 3 (Appendices).

C. Mean monthly meteorological observations

These data which include mean monthly air temperatures, total hours of bright sunshine, and average monthly speed and prevailing direction of wind are given in Table 4 (Appendices).

D. Secchi disc readings

Light transmission values, using the Secchi disc, for the period of the investigation, are shown in Fig. 6 and in Table 5 (Appendices). These values ranged from a minimum of 7 m (August 25) to a maximum of 22.5 m (December 3). In general, it was difficult to show correlations between these values and the phytoplankton populations; neither the lowest nor the highest Secchi disc readings reflected the highest and lowest concentrations, respectively, of phytoplankton.

E. General seasonal distribution and species succession (all three depths)

The species found in this study were divided into the following groups: diatoms (centric and pennate forms), dinoflagellates (armored and naked forms) and other flagellates. Species which were found only in the net samples were given in the species lists for each sampling date(Tables 6 to 27, Appendices).

The seasonal distribution of species is shown in Tables 1, 2, 3, and 4 for spring, summer, autumn and winter, respectively. Figures 9 to 18 also show the seasonal distribution for a number of selected species of diatoms and armored dinoflagellates.

The spring (March 18 - May 11) flora was characterized by the presence of large numbers (1000 or more cells/l) of species of *Chaetoceros* and *Thalassiosira*. Other species also present in large numbers (1000 cells/l or more) were *Bacteriosira fragilis*, *Detonula confervacea*, *Eucampia zodiacus*, *Achnanthes taeniata*, *Fragilaria oceanica*, and *Navicula vanhoffenii*. The armored dinoflagellate species were present in very low numbers.

Figure 9. Annual cycle of Bacteriosira fragilis and Eucampia zodiacus.

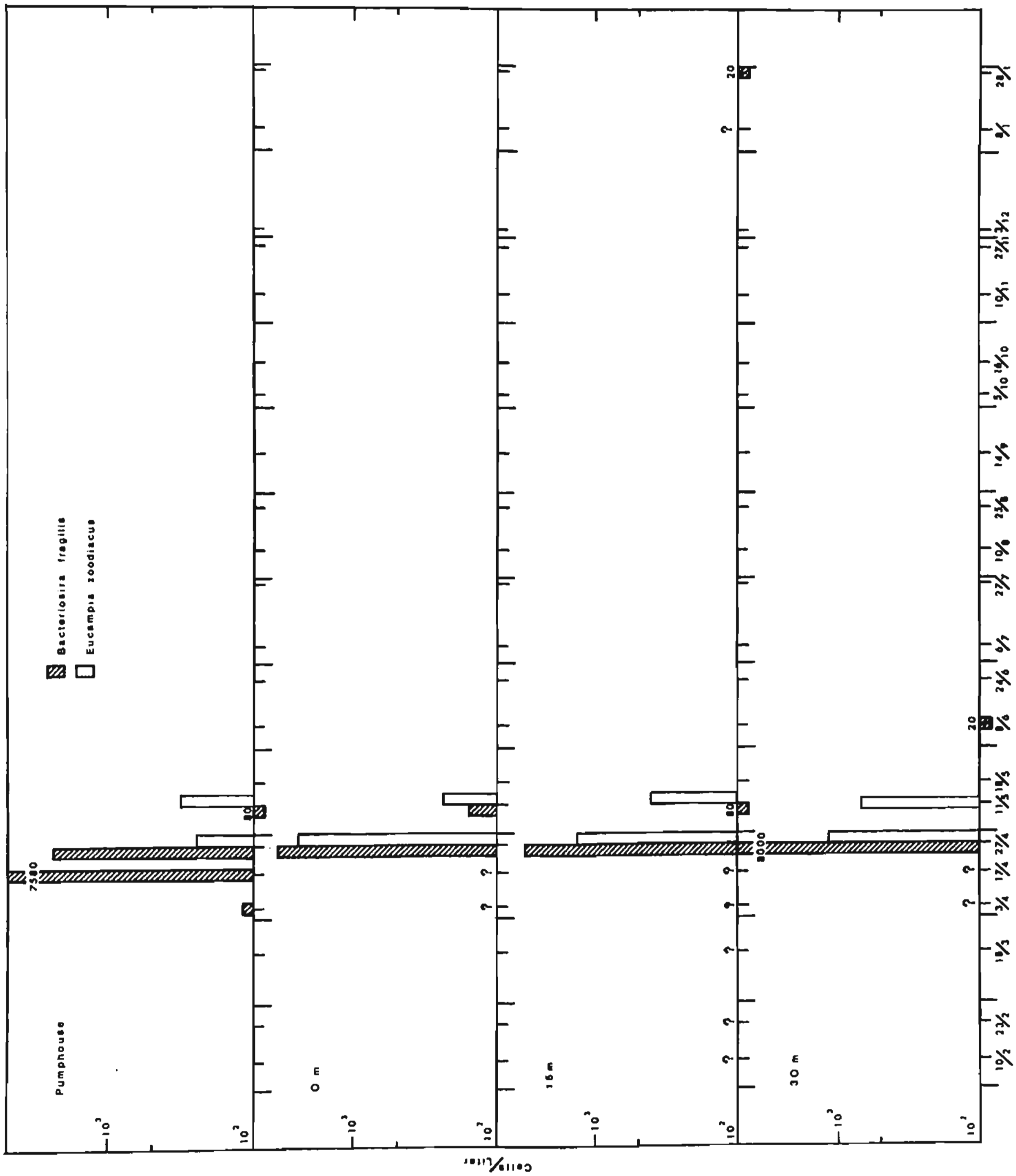

Bacteriosira fragilis
Eucampia zoodiacus
Pumphouse
0 m
15 m
30 m
Cells/Liter
7380
8000
80
20

Figure 10. Annual cycle of Chaetoceros affine, Chaetoceros constritum, and Chaetoceros debile.

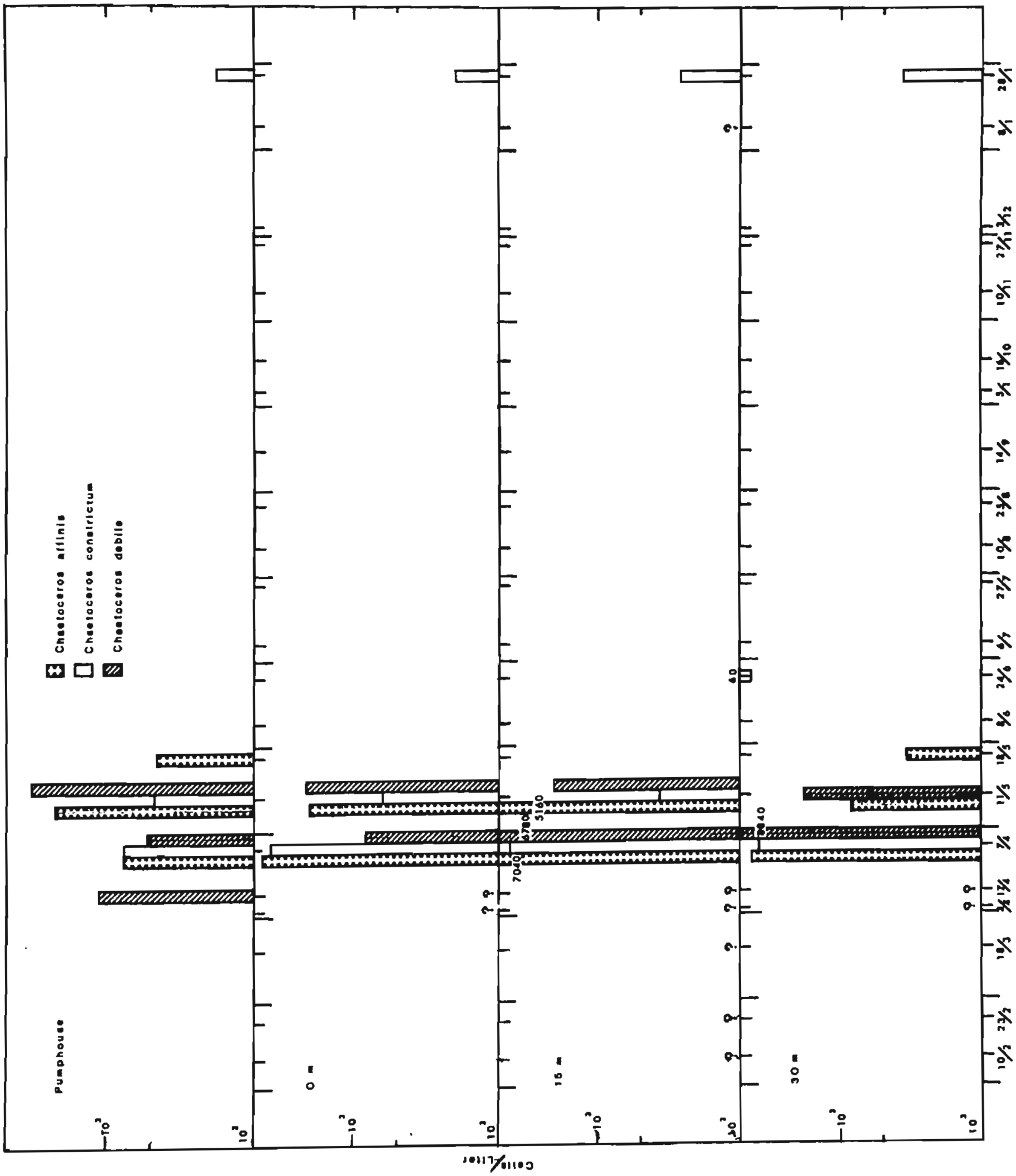

Chaetoceros affinis
Chaetoceros constrictum
Chaetoceros debile
Pumphouse
0 m
15 m
30 m
Cells/Liter
7040
6780
5160
840
40

Figure 11. Annual cycle of *Chaetoceros convolutum*, *Chaetoceros convolutum* f. *trisetosa*, and *Chaetoceros decipiens*.

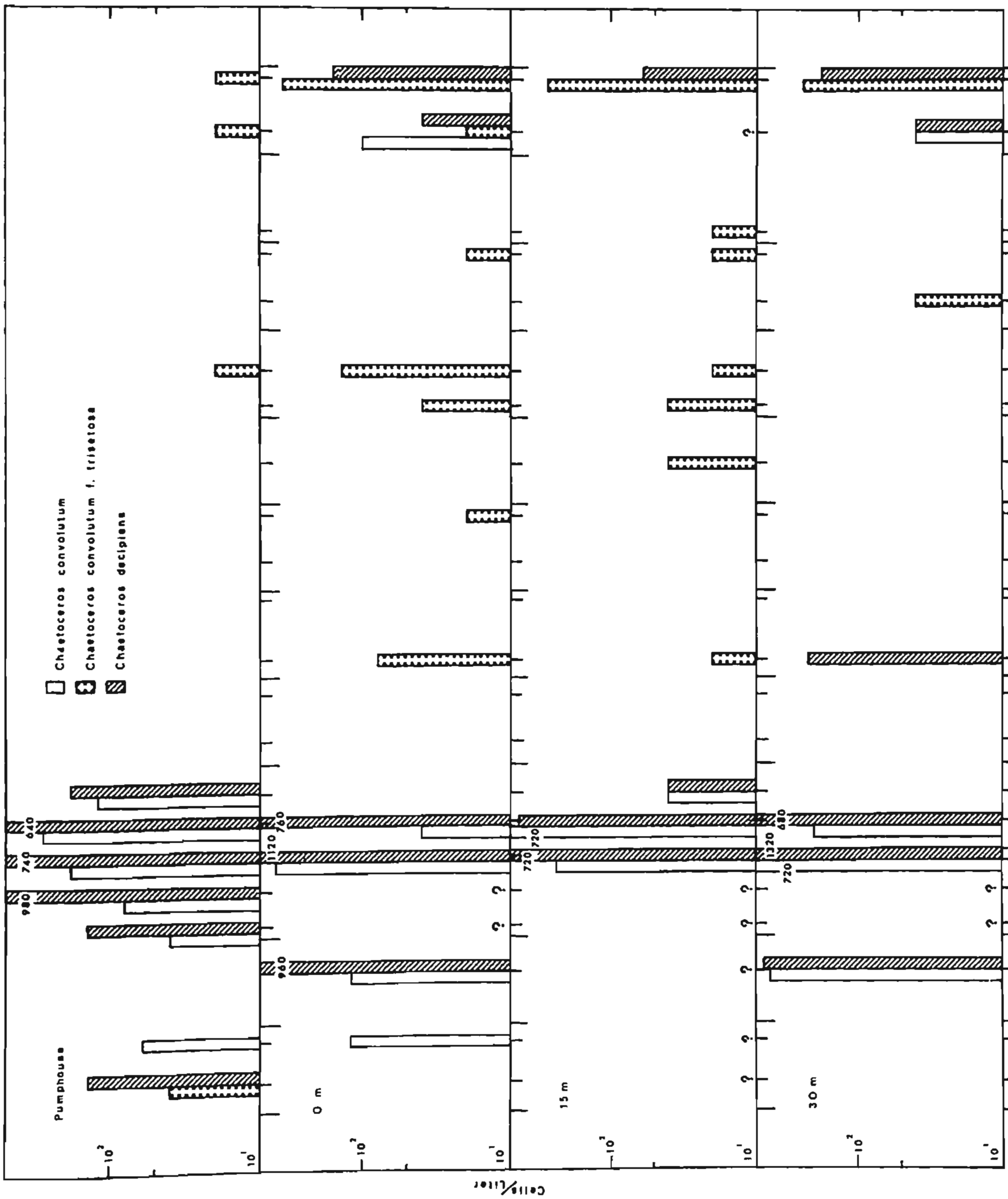

Pumphouse
0 m
15 m
30 m
Chaetoceros convolutum
Chaetoceros convolutum f. trisetosa
Chaetoceros decipiens
Cells/Liter
10²
10¹
980
740
640
1120
760
960
720
1320
680
?
19/2
23/2
18/3
3/4
17/4
27/4
11/5
18/5
8/6
24/6
6/7
27/7
19/8
25/8
14/9
3/10
16/10
19/11
27/11
3/12
8/1
28/1

Figure 12. Annual cycle of *Chaetoceros sociale* and *Thalassiosira nordenskioldii*.

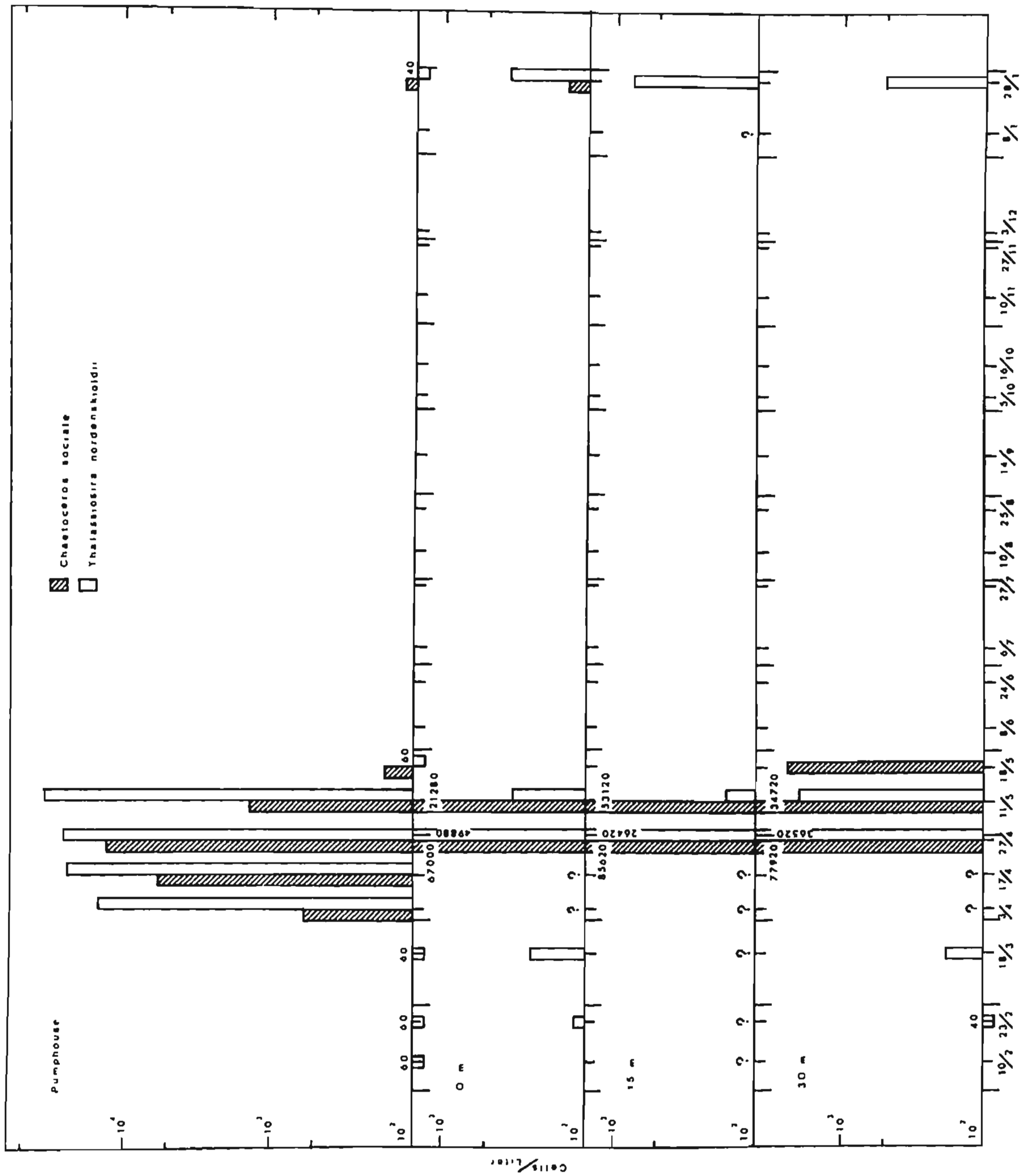

Chaetoceros sociale
Thalassiosira nordenskioldii
Pumphouse
0 m
15 m
30 m
Cells/Liter
67000
49880
21280
85620
26420
33120
77920
36520
34720

Figure 13. Annual cycle of Fragilaria oceanica and Nitzschia closterium.

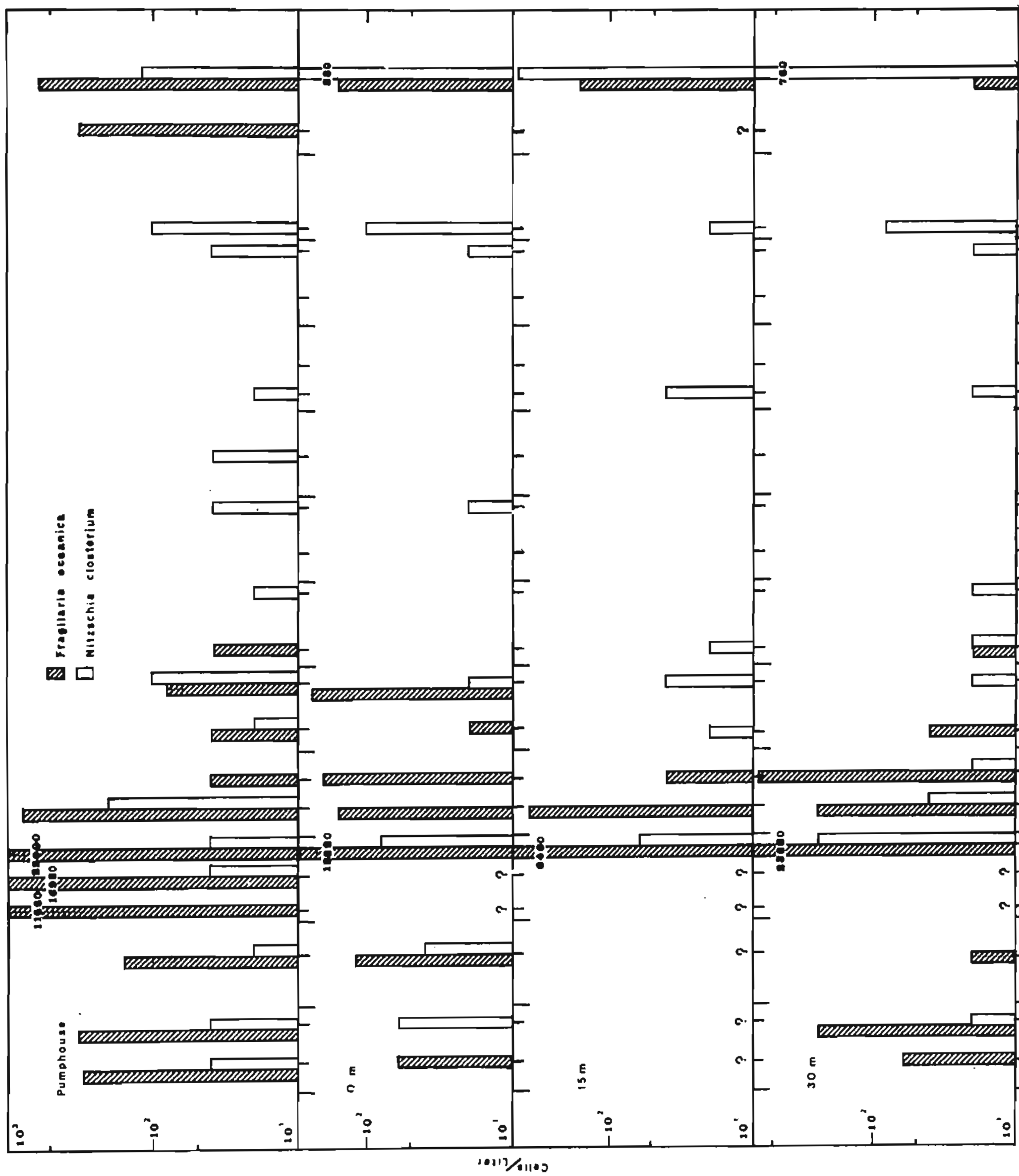

Fragilaria oceanica
Nitzschia closterium
Pumphouse
0 m
15 m
30 m
Cells/Liter

Figure 14. Annual cycle of Leptocylindrus danicus and Skeletonema costatum.

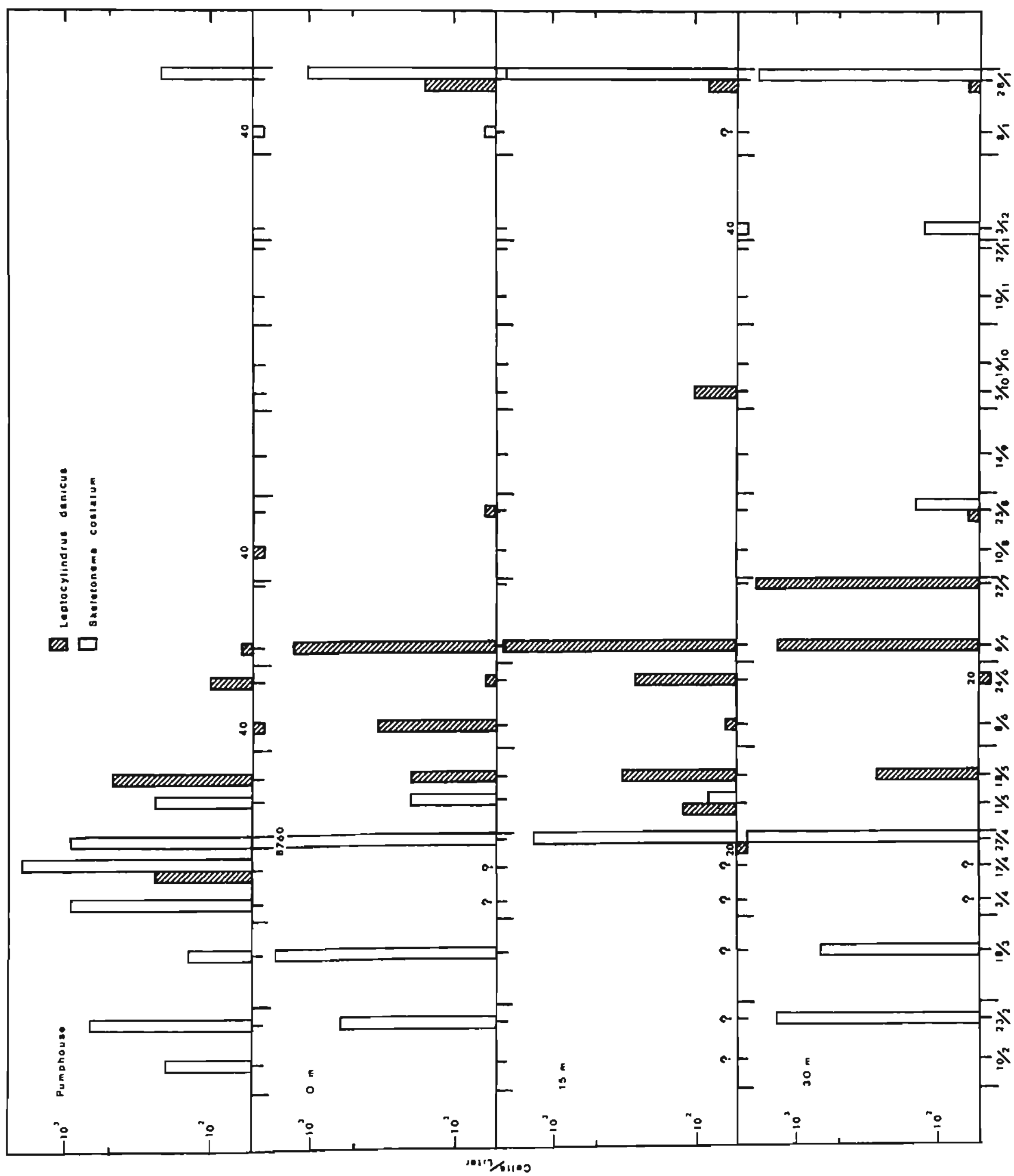

Leptocylindrus danicus
Skeletonema costatum
Pumphouse
0 m
15 m
30 m
Cells/Liter

Figure 15. Annual cycle of *Licmophora* sp.

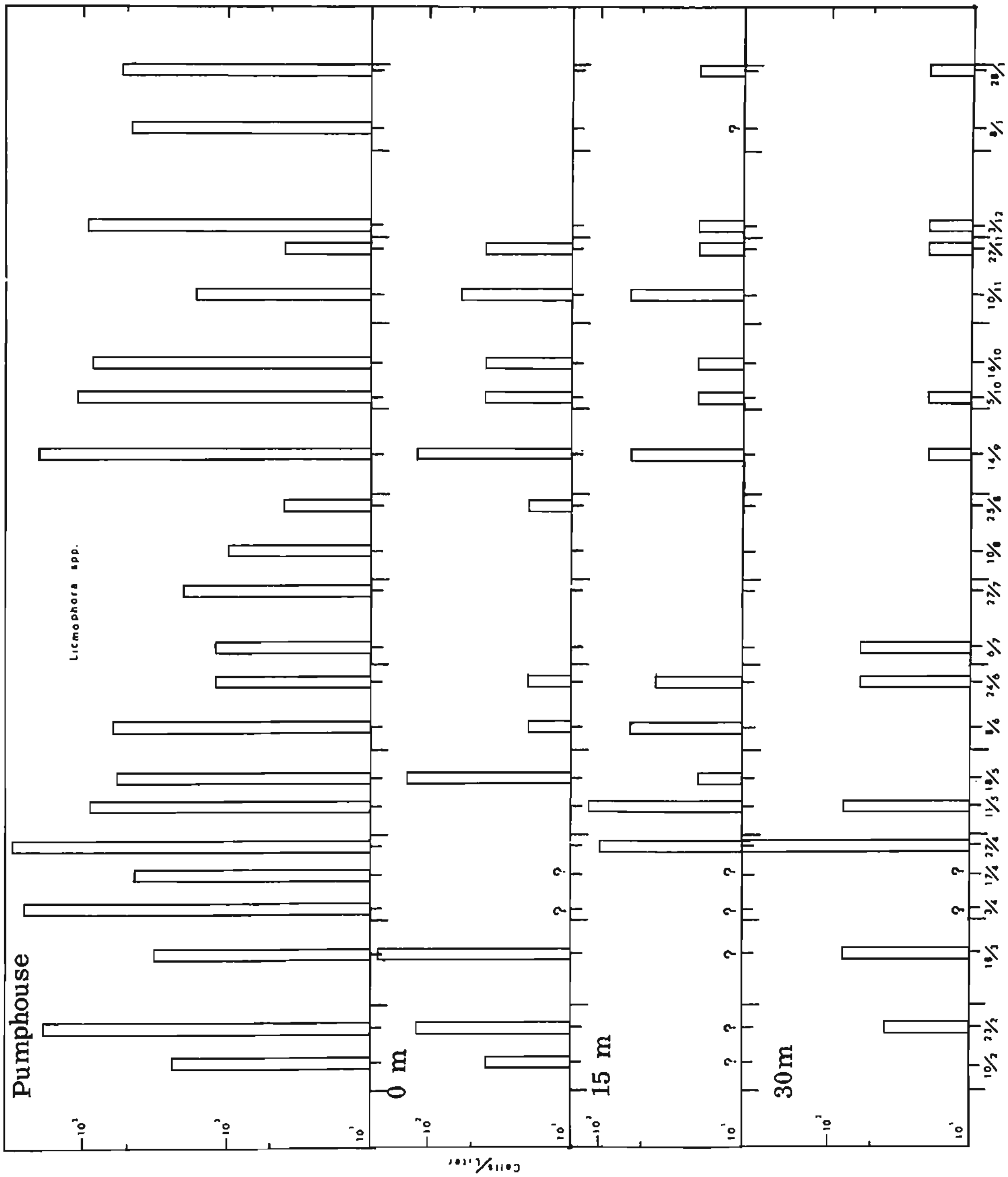

Pumphouse
0 m
15 m
30m
Licmophora spp.
Cells/Liter

Figure 16. Annual cycle of Actiniscus pentasteria v. arcticus and Minuscula bipes.

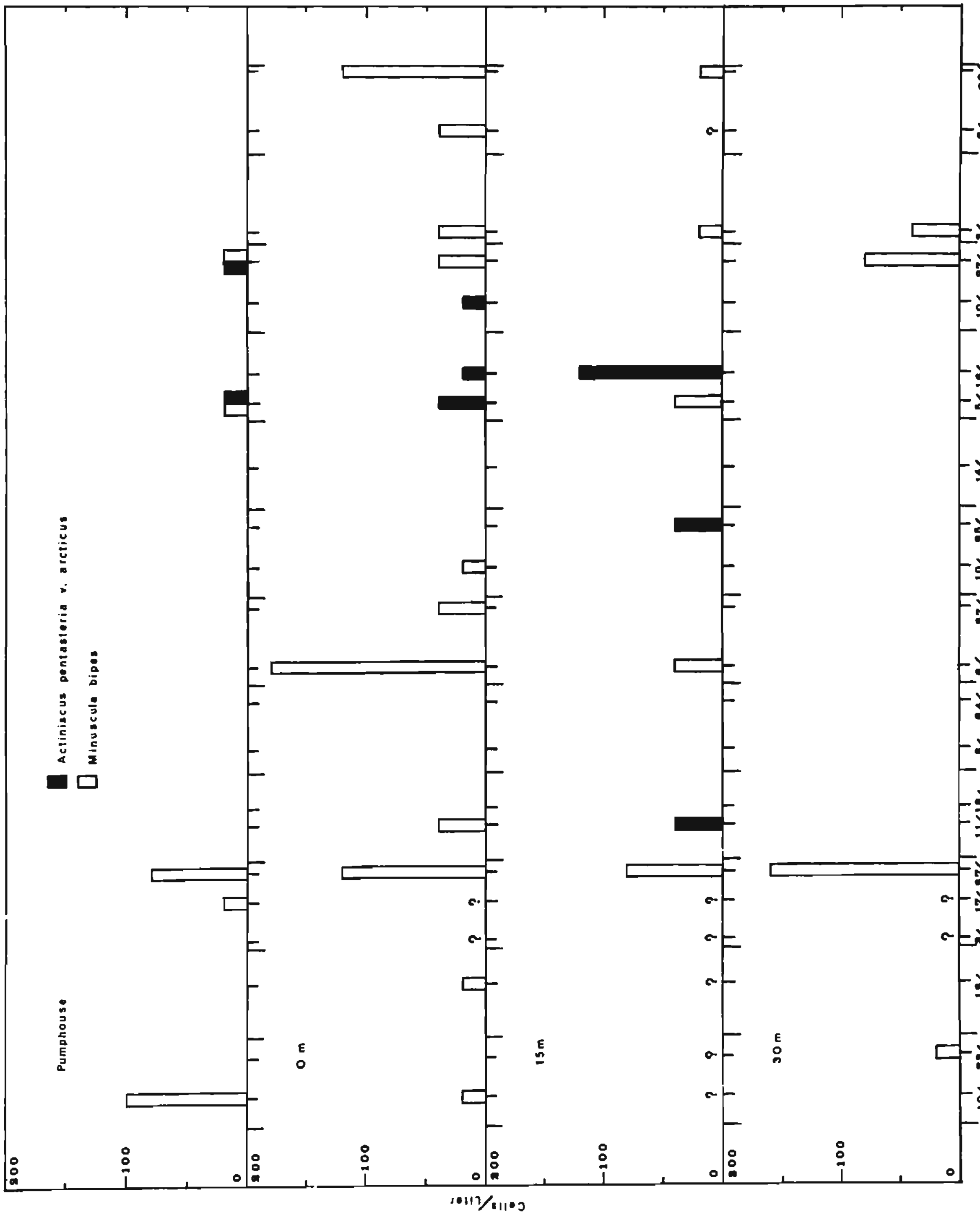

Actiniscus pentasteria v. arcticus
Minuscula bipes
Pumphouse
0 m
15 m
30 m
200
100
0
Cells/Liter

Figure 17. Annual cycle of Ceratium arcticum, Ceratium fusus, Ceratium longipes, and Ceratium tripos.

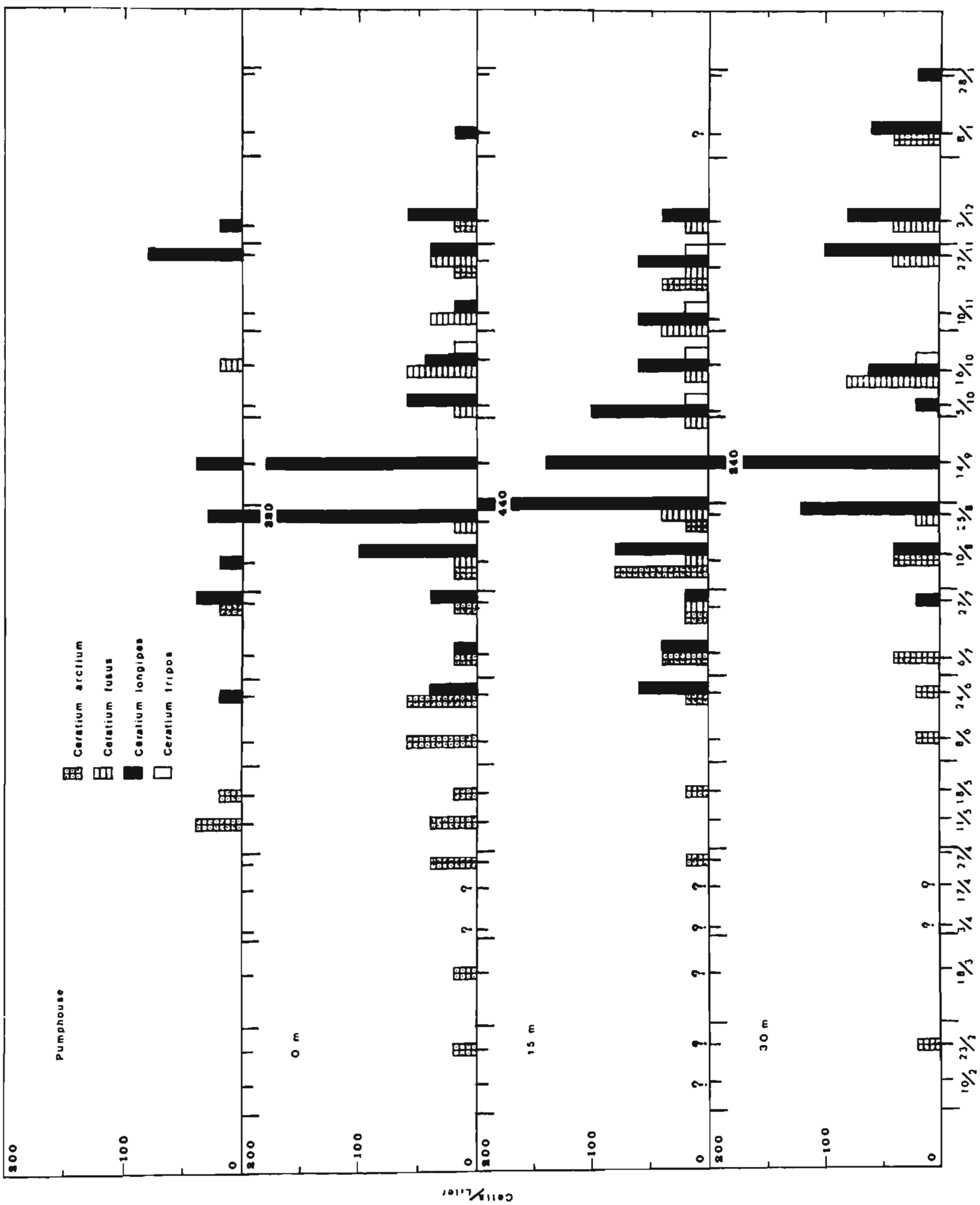
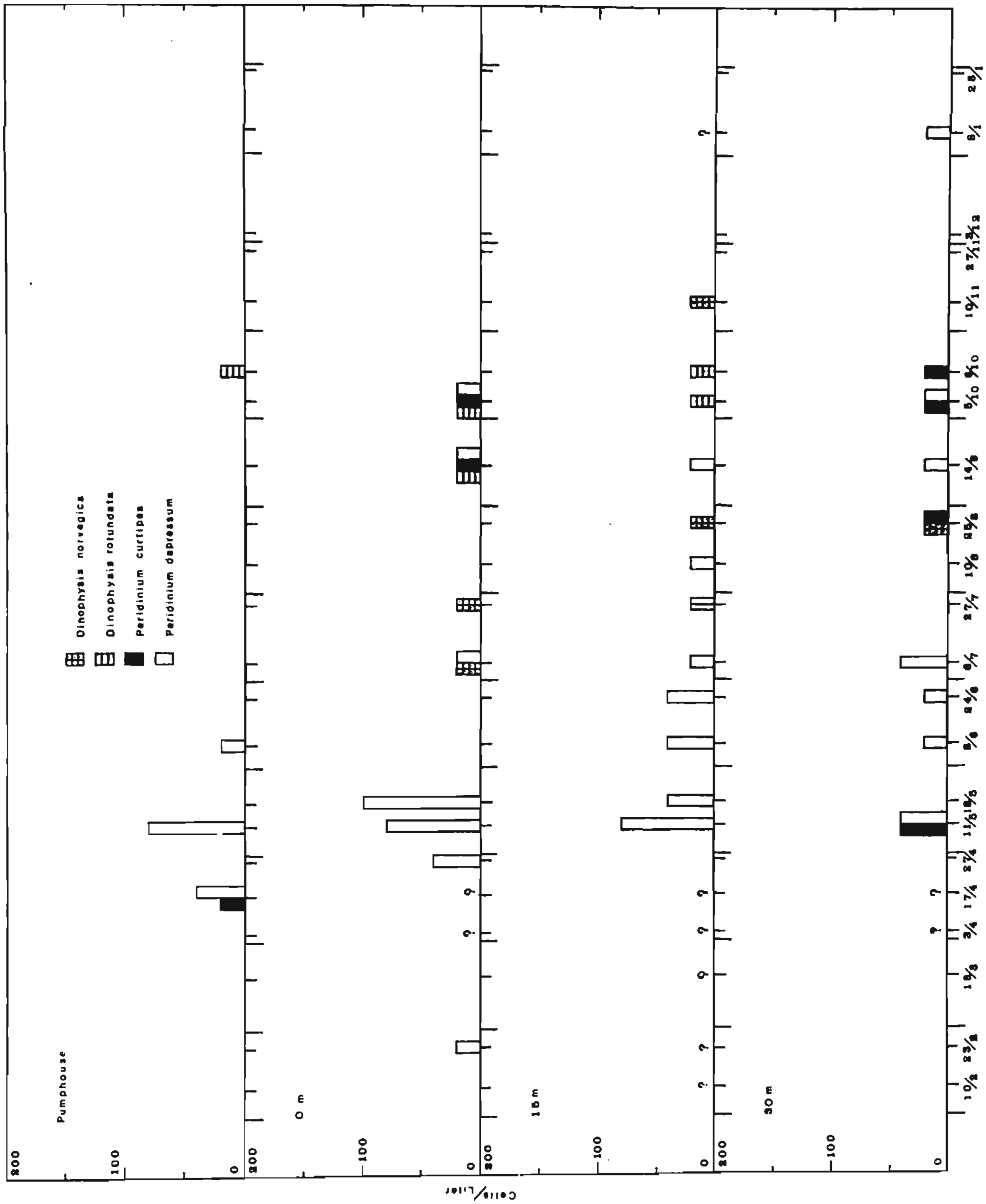

Ceratium arcticum
Ceratium fusus
Ceratium longipes
Ceratium tripos
Pumphouse
0 m
15 m
30 m
Cells/Liter
200
100
0
280
440
240

Figure 18. Annual cycle of Dinophysis norvegica, Dinophysis rotundata, Peridinium curtipes, and Peridinium depressum.


Pumphouse
0 m
15 m
30 m
Dinophysis norvegica
Dinophysis rotundata
Peridinium curtipes
Peridinium depressum
Cells/Liter
200
100
0

The naked dinoflagellates, however, were present in large numbers (1000 or more cells/l). A few species of flagellates, Minuscula bipes, Cryptomonas sp. and Eutreptia sp. occurred in numbers between 100 and 1000 cells/l.

The summer (May 18 - August 25) flora was characterized by comparatively small and variable numbers of cells for most of the period. Small numbers of diatoms (particularly several species of Chaetoceros, Leptocylindrus danicus, Fragilaria oceanica and Navicula vanhoffenii) were present at the May 18 sampling. Thereafter the diatom population was reduced to very low levels although Leptocylindrus danicus persisted for much of the remainder of the summer in numbers of 100 to 1633 cells/l. The armored dinoflagellates also were present in very low numbers. The dominant forms throughout the summer were the naked dinoflagellates (160 to 22220 cells/l) and Cryptomonas sp. (120 to 31280 cells/l).

The autumn (September 14 - November 10) flora showed the fewest numbers of all species for the entire sampling period. Both diatoms and armored dinoflagellates were present in low numbers. The naked dinoflagellates, however, occurred in very large numbers (3520 - 15560 cells/l) except on the last sampling date of the period. Similarly, Cryptomonas sp. occurred in moderate to large numbers (1530 - 12700 cells/l) except on the last sampling date of the period.

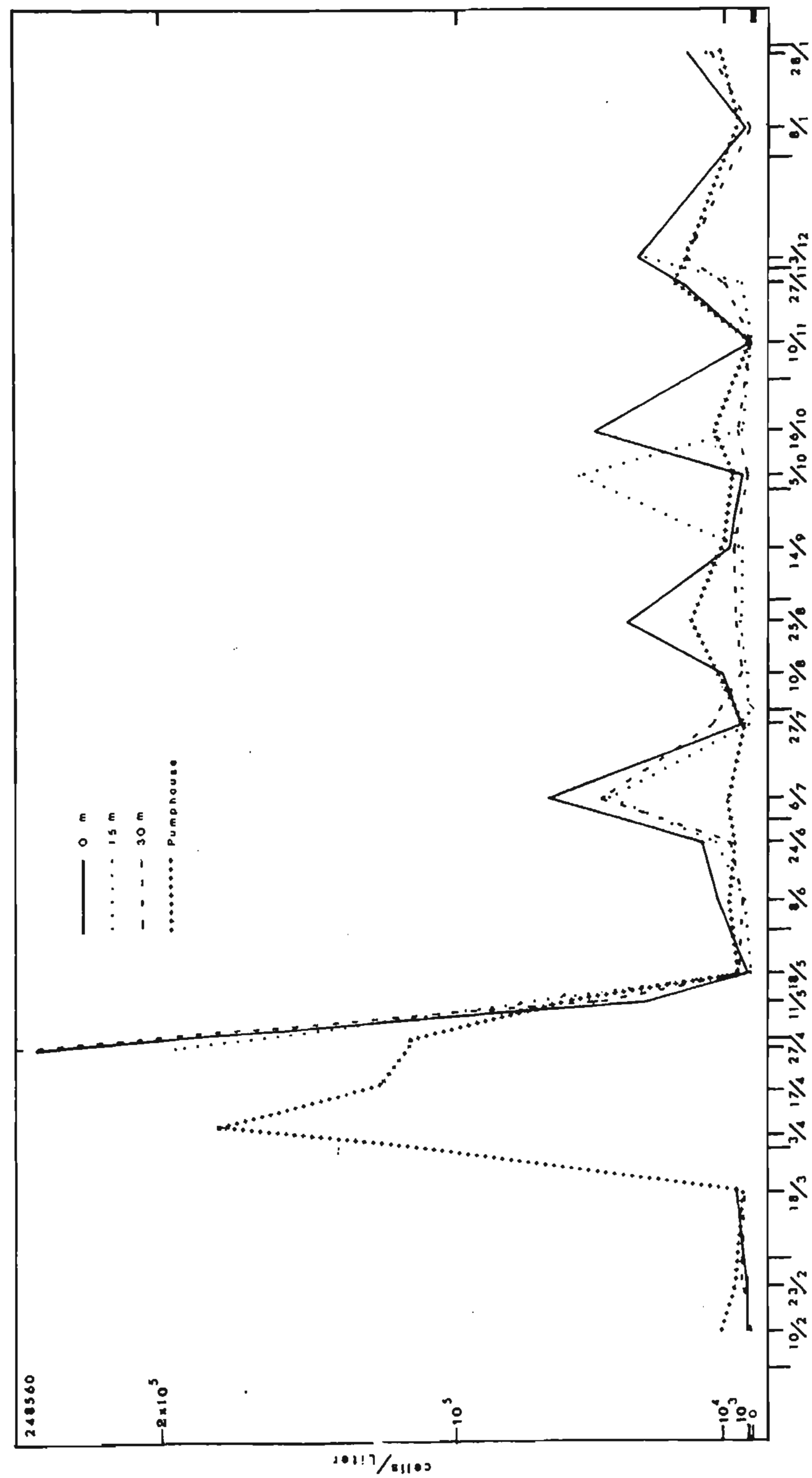
During the winter period of February 10 - February 23, 1970 and November 27, 1970 - January 28, 1971, the numbers of diatom species, particularly those of centric diatoms, showed an increase over those observed in the autumn. Numbers of cells per liter of most of the species, however, were low until January 28. Exceptions were Skeletonema costatum, Navicula sp. and Nitzschia delicatissima, which were present in numbers of 1000 or more cells/l. Dinoflagellates and other flagellates showed nearly the same numbers of species as in the autumn. Naked dinoflagellates and Cryptomonas sp. were dominant at this time. On January 28, there was a sharp increase in the numbers of most species of diatoms, but not of the dinoflagellates or other flagellates.

F. Seasonal and vertical changes in phytoplankton abundance

Changes in phytoplankton abundance in the Logy Bay and Robin Hood Bay areas in 1970 - 1971, for each of the depths sampled and the pumphouse, are shown in Figures 6 and 8 (Fig. 8 see page 52).

Population densities at all depths were lowest during February and the first half of March 1970, and during January 1971. Following this, a very rapid increase in numbers occurred. This was demonstrated from the pumphouse samples, in the absence of data from the bay localities, in March and early April. The maximum populations for all depths were observed at the end of April. This constituted the spring bloom in which diatoms predominated. By this time, however, the pumphouse populations were

Figure 8. Annual total phytoplankton abundance during the sampling period.


0 m
15 m
30 m
Pumphouse
cells/Liter
248560
2x10^5
10^5
10^4
10^3
0
10/2
23/2
18/3
3/4
17/4
27/4
11/5
18/5
8/6
24/6
6/7
27/7
10/8
25/8
14/9
5/10
19/10
10/11
27/11
13/12
8/1
28/1

already showing a decline in numbers. By the middle of May populations at all levels and in the population had declined to the winter levels already mentioned.

For the remainder of the year, phytoplankton abundance was quite variable. During the period of July to December, four distinct maxima (first week in July, last week in August, middle of October and first week in December) were observed at the surface. These varied in magnitude but all were considerably smaller than the spring maximum.

At 15 m depth, three maxima were observed (first week in July, first week in October and first week in December). The first maximum was somewhat less than that observed at the surface. The second 15 m maximum was slightly higher than the third surface maximum, while the third 15 m maximum was of approximately the same magnitude as that of the fourth surface maximum. The second 15 m maximum preceded the third surface maximum by eleven days.

At 30 m depth, two peaks were observed (first week in July, first week in December). The first 30 m peak was approximately the same in magnitude as the first 15 m peak. The second 30 m peak was lower than the third 15 m peak.

The pumphouse samples showed three maxima (first week in August, middle of October, last week in November). The third peak was somewhat greater in magnitude than the first. The second peak was lower than the first and third.

The percentage composition of the phytoplankton during the sampling period, for diatoms, dinoflagellates and other flagellates at each depth, and from the pumphouse, is shown in Table 5.

Diatoms dominated the Logy Bay and Robin Hood Bay phytoplankton in the winter and spring (February 10, February 23, March 18, probably also on April 3 and April 17, April 27, May 11 and May 18 in 1970 and January 8 and January 28 in 1971). The greatest percentages of these for all three depths were reached on April 27 and May 11. By May 18, a decline was noticeable, while by June 8, the diatom population constituted only a small percentage of the total phytoplankton. Diatom dominance was also reflected in the pumphouse samples. On November 10, the diatoms were again dominant at all three levels and the pumphouse, but fell sharply thereafter, increasing again on January 8 and finally becoming dominant again on January 28. Pumphouse samples again reflected diatom dominance.

Following the decline of the diatom populations in the spring, the dinoflagellates attained dominance, but only for brief periods as compared with the more extended dominance shown by the diatoms. Thus, dinoflagellate dominance, at all levels, was observed on June 8, June 24, September 14 and November 27. For the pumphouse samples, however, the dinoflagellates were dominant only on June 8. On September 14, they were nearly equal to the percentage of other flagellates, while on June 24 and November 27 they were outnumbered by the diatoms and other flagellates, respectively.

The other flagellates began to show dominance on July 6 and persisted in this on July 27 and August 10. The October 5 and December 3 samples also showed this dominance. However, this dominance was rather brief.

The pumphouse samples of July 6, August 10, October 5 and December 3 reflected the dominance of the other flagellates in the bay waters on these dates. However, these forms also dominated in the pumphouse samples on October 16 and November 27, although this was not reflected in the bay water samples.

DISCUSSION

General distribution

The results of this year-round study at Logy and Robin Hood Bays show that the composition of the phytoplankton is comparable to the findings of Cleve (1873, 1896); Iselin (1930); Davidson (1931); Seidenfaden (1947); Holmes (1956); and Bursa (1961a, 1961b) in the arctic and subarctic waters of eastern Canada. A mixture of species, characteristic of arctic and temperate, as well as oceanic and neritic waters, and originating from various water masses, is strongly influenced by the southward flow of the Labrador Current through the study region. The major phytoplankton components, however, are neritic, temperate species. However, Asteromphalus hookeri, Chaetoceros atlanticum, Ch. boreale, Ch. convolutum, Rhizosolenia alata, Rh. hebetata, and Rh. styliformis are considered as oceanic temperate species, characteristic of the West Greenland Current or outer portion of the Labrador Current. Similarly, Bacteriosira fragilis, Chaetoceros concavicorne, Ch. decipiens, Thalassiosira nordenskioldii, Achnanthes taeniata, Amphiprora hyperborea, Navicula vanhoffenii, Nitzschia closterium, Stauroneis quadripedis, Arctiniscus pentasteria v. arcticus, Ceratium arcticum, and Peridinium curtipes are arctic species, carried southward into the study area by the inner portion of the Labrador Current.

A mixture of arctic and temperate phytoplankton as describe here, was also reported by Movchan (1967, 1970a, 1970b) in the Grand Banks area during the spring and autumn. Undoubtedly, arctic species are carried southward to Logy Bay, Robin Hood Bay and the Grand Banks by the Labrador Current. However, a small number of tropical species was represented in the Grand Banks. It seems that the southern portion of Movchan's study region is mainly influenced by the Gulf Stream (Movchan, 1970a), but the species of the tropical flora, in the absence of Gulf Stream influence, do not reach the southeast coast of Newfoundland. The report of Lackey & Lackey (1970) confirms the absence of Gulf Stream species from Logy Bay, with the exceptions of *Ceratium tripos* and *C. massiliense* (= *C. longipes* ?). Frost (1938) gave a report on the genus *Ceratium* as an indicator of hydrographic conditions in Newfoundland waters and found that those species (*Ceratium fusus*, *C. lineatum*, *C. macroceros* and *C. tripos*) which show a strong Gulf Stream preference were mainly in the most southerly waters of Newfoundland, and that arctic, cold water species (*Ceratium arcticus* and *C. longipes*) were mostly represented on the northern coast of Newfoundland.

In the present study, the data also show that more cold water species of *Ceratium* were found than those of warmer water. This again indicates that Gulf Stream influence was not strong enough at Logy Bay and Robin Hood Bay during the study period to transport significant numbers of warm water species into the area. The composition of the phytoplankton at Logy Bay and Robin Hood Bay is comparable with that of the region from the Gulf of

St. Lawrence to the Bay of Fundy (Davidson, 1934; Gran and Braarud, 1935 and Brunel, 1962). After comparing species from many sources, Iselin (1930) was able to describe "the fact that so many species common off Labrador are also common in the Gulf of Maine, and in the Norwegian fjords, is evidence that temperature and salinity are of minor importance in the distribution of phytoplankton". Iselin's remarks appear to be borne out by the results of this investigation. The origins and movements of the principal water masses control the distribution of phytoplankton species (Ross, 1954).

Vertical distribution

Vertical distribution patterns of dinoflagellates, other flagellates and diatoms showed marked seasonal variations during the present study. Populations of the first two groups occurred predominantly in the upper rather than in the lower water layers. This observation follows Bursa's (1961b), quantitative studies on the vertical distribution of these organisms. Similar observations have been reported for dinoflagellates in the Labrador Sea (Holmes, 1956), and Gran (1912) reported that Ceratium species decrease in abundance with increase in depth. Higher temperatures and light intensities in the surface layers would seem probable reasons for the distributions indicated, especially when actively motile species are involved. Gran (1912) reasoned that the vertical distribution of the genus Ceratium is a reflection of the ability of these organisms to change position actively according to the intensity of the light and higher temperature at the surface. The phenomenon of vertical distribution shown by dinoflagellates and other flagellates is also supported experimentally by Hasle (1950) and Jitts _et al._(1964).

Vertical distribution of diatoms in the area of Logy Bay and Robin Hood Bay is difficult to relate to temperature and solar radiation, because the maxima and minima occurred irregularly with depth in the year-round study.

Steele and Yentsch (1960), using an experiment with _Skeletonema costatum_, explained seasonal variations in the vertical distribution of chlorophyll. Their description is that "during early spring when nutrients are sufficient, phytoplankton cells would tend to have a low sinking rate, and populations undergoing rapid growth would tend to accumulate near the surface. In late summer when nutrients are depleted in the surface water phytoplankton would sink and accumulate in the nutrient rich water at the base of the euphotic zone."

Gran (1932) mentioned that after a period of growth the plankton may sink and accumulation may occur at a certain depth below the surface. The sinking rate of several marine diatoms is influenced by cell age, size and shape, and mode of colony formation (Smayda and Boleyn, 1965, 1966a, 1966b). Bursa (1960b), contributed that the factor of sinking is reflected in the vertical distribution of phytoplankton.

In the present study, insufficient data were obtained during the spring bloom. Diatom populations did not concentrate in lower layers after maximal growth. Also, no nutrient data were collected in this study. It is difficult, therefore, to explain the vertical distribution of diatoms as a function of sinking. Since the samples were obtained in shallow coastal waters, however, the results may not be comparable with those obtained from oceanic conditions. The greater hydrographic and biological variability of coastal as compared with oceanic waters is well known (Gran, 1932). Water movements have, presumably, more influence on vertical distribution of non-motile diatoms than on motile dinoflagellates or other flagellates.

During the cold seasons of the year, rough seas brought about a complete mixing of the water column, as shown by the bathythermographic traces. The turbulence would seem to carry the diatoms from upper to lower depths and vice versa. On the other hand, though the water column became more stable and was distinctly stratified in the summer and autumn, the variable position of thermocline from time to time indicated that the water column was still more or less unstable.

There is also the possibility that in this inshore water area pennate diatoms such as Licmophora sp. and other forms which are usually epiphytic or epilithic, may appear to become planktonic at any time, due to tidal and wave action on the rocky shores and seaweeds.

Seasonal phenomena

Winter:

Many authors have considered that the low winter populations of phytoplankton can be explained by the low light and water temperatures, and the instability of water conditions (Gran, 1932; Gran and Braarud, 1935; Holmes, 1956; Ryther and Hulburt, 1960). Based on the winter physical data at Logy Bay and Robin Hood Bay, an homogenous water column, accompanied by low water temperatures, rough seas and low bright sunshine hours, may account for the low phytoplankton population.

Spring:

After the mixing of the water column in the previous season nutrients were probably rich in the spring. Water temperatures were gradually increasing especially at the surface, and some stratification was occurring. Increased day length and increasing monthly bright sunshine hours were also observed.

The remarkable spring diatom development may thus be partly assumed due to high nutrient levels, increasing light intensity and duration and increasing surface water temperatures which resulted in partial stability of the water column.

Similar reasons have also been proposed by Davidson (1934), Gran and Braarud (1935), Riley (1947), Patrick (1948), Holmes (1956), Bursa (1960b) and Movchan (1967, 1970b). Observations at Igloolik indicated that a rise of temperature and light after the winter, the stability of the water column and high values of inorganic phosphate would seem to be necessary for the phytoplankton maximum (Bursa, 1960b).

Holmes (1956) suggested that the increase in phytoplankton populations in the Labrador Sea undoubtedly reflected improved light conditions, ample nutrient supplies and a stabilization of the water column. On the Grand Banks, Movchan (1967, 1970b) concluded that the factor of high vertical stability in the upper 100 m water controlled the intensive phytoplankton population when phosphate and nitrate had already been supplied in this water layer. Gran and Braarud (1935) found that in the Bay of Fundy, the largest population of phytoplankton was related to a moderately stable water column accompanied by sufficient phosphate and nitrate. According to Davidson (1934), marked reduction in surface salinity from river discharge with consequent stability of the water preceded the spring maximum of phytoplankton in the Passamaquoddy region. However, low salinities during the ice melting period were related to poor phytoplankton populations in Hudson Bay and northern Foxe Basin, and lowered salinity preceding the gradual increase of the surface spring diatom population was observed at Igloolik (Bursa, 1960b).

Summer & autumn:

Generally speaking the summer and autumn phytoplankton populations were changeable and were not very rich compared with the previous season. They were mainly composed of dinoflagellates and other flagellates. Higher water temperatures and solar radiation were observed during these seasons. Marked thermoclines occurred from May 18 to September 14.

The decrease of species and number of diatoms observed following the spring bloom may be in part due to the increase in illumination, to the point where the intensity, particularly at the sea surface, may become great enough to inhibit the growth of most diatoms in the summer and autumn. The high light intensity in the warm seasons, however, did not appear to be detrimental for the growth of dinoflagellates and other flagellates. The relatively high temperature in the summer and autumn was probably also of equal importance with light in affecting the seasonal distribution of different organisms.

Experimentally, Braarud (1961) and Jitts _et al._ (1964) have reported on the different light and temperature requirements for growth in diatoms, dinoflagellates and other flagellates. In eastern Canada it has similarly been observed that abundant growth of diatoms occurs in low light and temperature conditions, but dinoflagellates and other flagellates in high light and temperature conditions (Davidson, 1934; Gran and Braarud, 1935; Holmes, 1956 and Bursa, 1961b). Seasonal succession in diatoms between diatoms in spring and dinoflagellates in summer, was noticeable at Igloolik (Bursa, 1961b).

Holmes' data (1956) showed, in general, that following the maximal autotrophic phytoplankton in the spring, the high heterotrophic phytoplankton abundance took place in the summer in the Labrador Sea. In the Bay of Fundy, where the diatoms were succeeded by dinoflagellates, populations were very poor in the summer months of June and August (Gran and Braarud, 1935). Based on surface and vertical haul observations in the Passamaquoddy region, Davidson (1934) was able to demonstrate that after the largest diatom maximum a slight diatom decrease was common through June to July, and the autumn diatom maxima were comparatively small. Nutrient depletion was also partly the result of decreasing diatom abundance in this area in the warm season after spring bloom nutrients had already been exhausted. Furthermore, mixing of further nutrients from the bottom layers was impossible owing to the marked stratification of the water column. Hence, in the upper waters, nutrients reached their annual lowest value, which was insufficient to support diatom growth.

There are many further factors (grazing, salinity, nutrients, sinking, etc.) which affect the distribution of phytoplankton populations (Gran and Braarud, 1935; Steemann Nielsen, 1935; Riley, 1947a, 1947b; Munk and Riley, 1952; Steele and Yentsch, 1960 and Bursa, 1960b). For the complete understanding of phytoplankton distribution in Logy Bay and Robin Hood Bay, all of these factors, as well as intensive studies of light, water temperature and water conditions would be necessary and were beyond the scope of the present investigation.

The general seasonal pattern of phytoplankton abundance at Logy Bay and Robin Hood Bay is that phytoplankton population densities were low in the winter, and that following the spring diatom bloom low densities of phytoplankton, mainly dinoflagellates and other flagellates, alternated with several small pulses in the summer and autumn. These seasonal fluctuations are not in accord with the classical bimodal cycle known for temperate waters, where low summer phytoplankton density is, in general, followed by a small peak in the autumn, this small peak mainly consisting of diatoms. In this study, diatoms did predominate in the samples of November 10 but the peak was very small when compared with the autumn maximum in the classical bimodal cycle.

Differences in sampling techniques used here and by other workers, could in part account for differing results (e.g. sample collection by water or net; preservation in Lugol's solution or formalin solution, and analytical methods, such as ^{14}C technique or centrifuge method or sedimentation; volumes of samples examined).

In summer the rapid increases or decreases of dinoflagellates and other flagellates in this shallow inshore water may also be partly due to local responses as described in the section on vertical distribution. It is well known that blooms of dinoflagellates and other flagellates are related to circumstances such as warm weather, suitable wind, low salinity, high nutrients, the presence of biological controls, trace metals, stimulators and inhibitors (Gran, 1932; Ryther, 1954; Collier, 1958; Holmes, Williams and Eppley, 1967 and Braarud and Heimdal, 1970). In addition to upwellings, run-off plays an important role in affecting these biological and chemical factors. In the inner Oslofjord, Hasle and Smayda (1960) stated that the mass occurrences of dinoflagellates are the result of biological pollution by sewage.

There are small streams which bring freshwater down into Logy Bay water (Lackey and Lackey, 1970), and fluctuations in phytoplankton populations may also in part be the result of varying amounts of nutrients present in run-off from time to time. Alternate increases and decreases of dinoflagellates and other flagellates, it could be argued, indicate that Logy Bay and Robin Hood Bay are periodically polluted by sewage or biological and chemical agents from the land. The problem will be unresolved until more intensive investigations, especially of nutrients, are carried out.

Pumphouse samples:

In contrast to centric diatoms, dinoflagellates and other flagellates, the pennate diatoms were more abundant in the pumphouse samples, both qualitatively and quantitatively.

The pumphouse is situated on a rocky shore, far from the offshore water. It is also quite near the sandy bottom of Logy Bay and is adjacent to an abundance of benthic algae on the nearby rocky shore.

According to the data, pennate diatoms from pumphouse samples consisted mainly of epiphytic and/or benthic species of Cocconeis, Fragilaria, Licmophora, Navicula, Nitzschia, Rhabdonema, Rhoicosphenia, Striatella in larger numbers than from the bay water. On the other hand, at least three oceanic centric species (Chaetoceros atlanticum, Rhizosolenia alata and Rh. styliformis) were only found in the bay water.

It is wellunderstood that diatoms attach to seaweeds, sand grains and inter-tidal substrata (Castenholz, 1963; Takano, 1964) and benthic ones are deposited at the bottom (Smyth, 1955; Takano, 1964). Since the pumphouse is fully exposed to the movements of waves and tides, the presence of more epiphytic and benthic pennates in pumphouse samples than elsewhere is readily explained.

The evidence that more pennate diatoms as well as neritic forms were observed in the pumphouse may be also partly due to the fact that some facultative epiphytes may become planktonic (Hopkins, 1964).

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TABLES(TEXT)

NOTE: In the following tables, scientific names were not underlined for reasons of legibility.

Table 1. Species distribution of phytoplankton in the spring (March 18-May 11)*

	18/3	3/4**	17/4**	27/4	11/5
Diatoms:					
Centric					
Asteromphalus hookeri	20	p	p	27	0
Bacteriosira fragilis	0	p	p	4833p	80p
Biddulphia aurita	0			0p	0
Chaetoceros affine	0			5200p	2693p
Ch. atlanticum	0			40	40
Ch. boreale	0		p	347	187
Ch. ceratosporum	0		p	60	280p
Ch. concavicorne	0			40p	107p
Ch. constrictum	0			3860 p	333p
Ch. convolutum	260	p	p	453p	320p
Ch. curvisetum	0			2580p	120p
Ch. debile	0		p	5487p	2013p
Ch. decipiens	700	p	p	1053p	627p
Ch. sociale	0	p	p	76847p	36373p
Ch. teres	0			1867p	3307p
Ch. sp.	0		p	2700p	1667p
Coscinodiscus centralis	30	p		20p	0
C. sp.	20			0	13
Coscinosira polychorda	0	p	p	467	0
Detonula confervacea	0		p	2247p	53p
Eucampia zodiacus	0			1653p	4 40p
Lauderia borealis	0		p	233p	93p
Leptocylindrus danicus	0		p	7	40
Porosira glacilis	0	p	p	987p	67p
Rhizosolenia fragilissima	0			40	13
Rh. hebetata	0		p	7p	53p
Skeletonema costatum	1190p	p	p	4107p	93p
Thalassiosira decipiens	50p	p	p	1740p	0
Th. gravida	40p	p	p	8340p	93p
Th. nordenskioldii	210p			37607p	800p
Th. sp.	0			0p	0
Unidentified forms	60p	p		0	0
Pennate					
Achnanthes taeniata	0		p	6393p	200p
Amphiprora hyperborea	0			460p	27
Amphora sp.	0		p	0	0
Cocconeis sp.	30p	p	p	0 p	0
Fragilaria oceanica	70p	p	p	16340p	253 p
Licmophora sp.	150p	p	p	167p	67p

(continued)

Table 1. (continued).

	18/3	3/4**	17/4**	27/4	11/5
Navicula vanhoffenii	0	p	p	22253p	0
N. sp.	270p	p	p	513p	160p
Nitzschia closterium	20p		p	127p	13p
N. delicatissima	0			147p	0
N. longissima	0			33	27
N. seriata	0			60	120
Rhabdonema minutum	0			0	0p
Rhoicosphenia curvata	10p	p	p	0	27p
Stauroneis quadripedis	0			673p	0
Striatella delicatula	10p	p	p	40p	27p
Thalassionema nitzschioides	460p		p	13	173
Thalassiothrix longissima	0			493p	0
Unidentified forms	390p	p	p	5107p	1760p
Dinoflagellates:					
Armored					
Arctiniscus pentasteria v. arcticus	0			0	13
Ceratium arcticum	10			20	13p
Exuviella baltica	0			0	0p
Minuscula bipes	10		p	120p	13
Oxytoxum sp.	0			33	27
Peridium breve	0		p	60p	0
P. curtipes	0		p	0	13
P. depressum	0		p	13	67
P. pellucidum	0	p		53p	0
P. punctulatum	20		p	73p	40p
P. saltans	0			0	13
Unidentified forms	0			100p	53p
Naked	200p	p	p	9473p	2320p
Other flagellates:					
Coccolithus pelagicus	40	p	p	87p	0p
Cryptomonas sp.	60p	p	p	933p	187p
Distephanus speculum	10	p	p	13p	0
Ebria tripartita	20			0	0
Eutreptia sp.	20p	p	p	160p	0
Unidentified forms	0		p	33	13

(continued)

Table 1. (continued)

* For each date:

1. Values given are in cells/l for species from bay samples and represent the average of counts from the depths sampled.
2. p = species found in pumphouse samples for a given date.
3. Data for bay and pumphouse samples given in Tables (Appendices)

** = No bay sampling carried out.

Table 2. Species distribution of phytoplankton in the summer (May 18-August 25).

	18/5	8/6	24/6	6/7	27/7	10/8	25/8
Diatoms:							
Centric							
Bacteriosira fragilis	0	7	0	0	0	0	0
Chaetoceros affine	113p	0	0	0	0	0	0
Ch. atlanticum	86	13	0	0	0	0	0
Ch. ceratosporum	0	0	60	13	7	0	0
Ch. constrictum	0	0	20	0	0	0	0
Ch. convolutum	13p	0	0	0	0	0	0
Ch. convolutum f. trisetosa	0	0	0	33	0	0	7
Ch. curvisetum	0	0	0	33	0	0	0
Ch. decipiens	13 p	0	0	73	0	0	0
Ch. simplex	0	0	0	7	0	0	0
Ch. sociale	8 0p	0	0	0	0	0	0
Ch. sp.	393p	0	0	0	0	0	0
Coscinodiscus centralis	7	0	0	0	0	0	0
C. sp.	0	7	0	0	0	0	0
Leptocylindrus danicus	260p	10 0	113p	1633p	600	0p	4 0
Melosira moniliformis	13	107	0	0	0	0	0
M. nummuloides	93	0	0	0	0	0	0
Rhizosolenia alata	13	0	0	0	0	0	0
Rh. fragilissima	7	0	0	0	0	13	0
Rh. hebetata	0	0	27	0	7	0p	0
Rh. styliformis	0	0	0	0	7	0	0
Skeletonema costatum	0	0	0	0	0	0	47
Thalassiosira gravida	0p	0	0	0	0	0	0
Th. nordenskioldii	0p	0	0	0	0	0	0
Th. sp.	35p	0	0	0	0	0	0
Pennate							
Achnanthes taeniata	47	0p	0	0	7	0	0
Amphiprora hyperborea	7	7	0	0	0	0	0
Cocconeis sp.	0p	7p	7p	0	0	0	0
Fragilaria oceanica	260p	20p	80p	7p	0	0	0
Gyrosigma sp.	0	7	0	0	0	0	0
Licmophora sp.	53p	27p	40p	20p	0p	0p	7p
Navicula vanhoffenii	333p	0	0	0	0	0	0
N. sp.	100p	7	0p	0	0	0p	13
Nitzschia closterium	7	7p	27p	13	7p	0	7p
N. delicatissima	0	0	20	47	0	40p	220p
N. longissima	0	7	0	0	0	0	0
N. seriata	0	0	0	0	0	0p	0

(continued)

Table 2. (continued)

	18/5	8/6	24/6	6/7	27/7	10/8	25/8
Rhabdonema minutum	0p	7	0p	0	13	0	0
Rhoicosphenia curvata	0 p	13	0p	0	0 p	0	0
Striatella delicatula	0p	0	13	0	0	0 p	0
Thalassiothrix longissima	7	0	0	0	0	0	0
Unidentified forms	647 p	87p	47p	20p	80	40p	113p
Dinoflagellates:							
Armored							
Arctiniscus pentasteria v. arcticus	0	0	0	0	0	0	13
Ceratium arcticum	13p	27	33	33	13p	47	7
C. fusus	0	0	0	0	7	13	27
C. longipes	0	0	33p	20	27p	73p	293p
Dinophysis lenticula	0	0	7	0	0	0	0
D. norvegica	0	0	0	7	13	0	13
D. punctata	0	0	13	7	20	0	7
Exuviella baltica	0	20 0	40	47p	7p	7	60
Glenodinium sp.	0	33p	0	0	0	0	0
Minuscula bipes	0	0	0	73	13	7	0
Oxytoxum sp.	0	0	0p	0	0	0	0
Peridinium breve	7	0	0p	0	0	0	7
P. cerasus	0	0	0	0	0	0	7
P. curtipes	0	0	0	0	0	0	7
P. depressum	47	20p	20	27	0	7	0
P. pellucidum	0	0	20	0	0	0	0
P. sp.	0	0	20	0	0	0	0
Unidentified forms	0	13	0	20	0	7	7
Naked	167p	4507p	8613p	22220p	1873p	1607p	6853p
Other flagellates:							
Coccolithus pelagicus	0p	0	0	0	0	0	0
Cryptomonas sp.	120p	680 p	3067 p	31280p	3073p	3133p	9533p
Diaphanoeca sp.	0	0	0	0	40p	0	0
Distephanus speculum	0	0	0	0	0	7	0
Ebria tripartita	0	0	0	0	0	0	13
Eutreptia sp.	0	0	27	27	7	0	7
Unidentified forms	0	0	0	7	580p	520p	187p

Table 3. Species distribution of phytoplankton in the autumn (September 14–November 10)

	14/9	5/10	16/10	10/11
Diatoms:				
Centric				
Biddulphia aurita	0	0p	0	0
Chaetoceros convolutum f. trisetosa	13	27	53p	13
Leptocylindrus danicus	0	33	0	0
Melosira moniliformis	0	0p	0p	0
Rhizosolenia hebetata	0	0	0	7
Unidentified forms	0	0	0	47
Pennate				
Asterionella sp.	0	87	0	0
Cocconeis sp.	0	0p	7	0
Grammatophora marina	0	13p	20	0
Licmophora sp.	67p	27p	20p	40p
Navicula sp.	0	7	0	20
Nitzschia closterium	0p	20p	0	0
N. delicatissima	120p	40	33	20
N. longissima	0	0	0	7
N. seriata	0	0	67	0
Rhoicosphenia curvata	0	0	0p	0p
Striatella delicatula	0	0	13p	13
Unidentified forms	53p	500p	353p	567p
Dinoflagellates:				
Armored				
Arctiniscus pentasteria v. arcticus	0	13p	47	7
Ceratium fusus	0	13	53p	27
C. longipes	187p	60	53	27
C. tripos	0	7	20	7
Dinophysis acuminata	7	0	0	0
D. norvegica	0	0	0	7
Exuviella baltica	7	33p	0	0
Minuscula bipes	0	13p	0	0
Peridinium breve	7	7	0	0
P. cerasus	7	7	0	0
P. curtipes	7	13	7p	0
P. depressum	20	13	0	0
P. sp.	0	0	0	13
Phalacroma rotundatum	7	13	7p	0

(continued)

Table 3. (continued)

	14/9	5/10	16/10	10/11
Naked	3520p	7586p	15566p	33p
Other flagellates:				
Cryptomonas sp.	1533p	12673p	3713p	0
Diaphanoeca sp.	0p	0	0p	0
Distephanus speculum	13	40	107p	40
Ebria tripartita	113	7p	67p	0
Eutreptia sp.	0	53	67	0
Unidentified forms	326p	340 p	493p	160p

Table 4. Species distribution of phytoplankton in the winter (February 10-February 23 and November 27-January 28).

	10/2	23/2	27/11	3/12	8/1	28/1
Diatoms:						
Centric						
Asteromphalus hookeri	0	20	0	0	0	0
Bacteriosira fragilis	0	0	0	0	0	7
Chaetoceros atlanticum	0	0	13	0	0	0
Ch. boreale	0	0	0	0	0	7
Ch. ceratosporum	0	0	0	0	0	687p
Ch. concavicorne	0	0	0	0	0	27p
Ch. constrictum	0	0	0	0	0	273p
Ch. convolutum	0	60p	0	0	70	0
Ch. convolutum f. trisetosa	0p	0	13	7	10p	293p
Ch. decipiens	0p	133	0	0	0	0
Ch. sociale	0	0	0	0	0	47p
Ch. teres	0	0	0	0	0	247p
Coscinodiscus centralis	30	70p	0	0	0	0
C. sp.	0	20	0	0	0	0
Coscinosira polychorda	0	10	0	0	0	0
Leptocylindrus danicus	0	0	0	0	0	100
Melosira nummuloides	0	0p	0	0	0p	0
M. sp.	0	0	0	0	0	13
Pleurosigma sp.	0	0	0	0	0	7
Rhizosolenia alata	0	0	0	0	0	13
Skeletonema costatum	0p	1000p	0	53	30p	1706p
Thalassiosira decipiens	0	40	0	0	0	13
Th. gravida	0	60p	0	0	0	0
Th. nordenskioldii	0p	80p	0	0	0	540p
Unidentified forms	0	0	7p	7	0p	0
Pennate						
Asterionella sp.	0	0	0	0	50	0
Cocconeis sp.	10p	50p	0	13	10p	7p
Fragilaria oceanica	60p	120p	0	0	0p	113
Grammatophora marina	0	0	0	0	0	7
Licmophora sp.	20p	80p	33p	13p	0p	13p
Navicula sp.	2230p	70	7	0	0	7
Nitzschia closterium	0p	40	13p	67p	0	693p
N. delicatissima	190p	0p	40	73p	150	6920p
N. longissima	20p	0	7	20	0	100p
N. seriata	0	60p	40p	47	0	27

(continued)

Table 4. (continued)

	10/2	23/2	27/11	3/12	8/1	28/1
Rhoicosphenia curvata	0	10p	0	7p	0	47p
Striatella delicatula	0p	20p	0	20p	0p	0p
Thalassionema nitzschioides	140p	320p	0	33	0	453p
Thalassiothrix longissima	0	0	0	0	160p	7
Unidentified forms	60 p	560p	480p	280p	80p	820p
Dinoflagellates:						
Armored						
Arctiniscus pentasteria v. arcticus	0p	0	0	0	0	0
Ceratium arcticum	0	20	20	7	20	0
C. fusus	0	0	33	20	0	0
C. longipes	0	0	67p	60p	40	7
C. tripos	0	0	7	0	0	0
Dinophysis acuminata	0	0	0	0	0	7
D. punctata	0p	0	0	0	0	0
Exuviella baltica	250p	130	0	0	0	0
Minuscula bipes	10p	10	40p	33p	20	47
Peridinium breve	0	0	13p	13p	0	27
P. depressum	0	10	0	0	10	0
Unidentified forms	0	10p	40p	34	20	60p
Naked	0	0	8313p	11893p	230p	0
Other flagellates:						
Coccolithus pelagicus	20	20p	0	0	0	0
Cryptomonas sp.	320p	30p	322p	18407p	210p	1140p
Distephanus sp.	30	50p	27p	47p	0	13
Eutreptia sp.	0p	20	173p	200p	930p	413p
Unidentified forms	0	0	67p	1220p	250p	13p

Table 5. Percentages of phytoplankton at depths sampled and in pumphouse

		0 m	15 m	30 m	Pumphouse
Feb. 10	Diatoms	45.2		46.8	35.2
	Dinoflagellates	28.8	ns	37.1	43.2
	Other flagellates	26.0		16.1	21.5
23	Diatoms	79.0		86.6	98.1
	Dinoflagellates	13.4	ns	11.9	0.3
	Other flagellates	7.6		1.5	1.6
Mar. 18	Diatoms	88.8		94.7	93.1
	Dinoflagellates	7.4	ns	2.3	0
	Other flagellates	3.8		3.0	6.9
Apr. 3	Diatoms				99.7
	Dinoflagellates	ns	ns	ns	0.1
	Other flagellates				0.2
17	Diatoms				97.2
	Dinoflagellates	ns	ns	ns	2.2
	Other flagellates				0.6
27	Diatoms	94.0	95.4	95.9	95.9
	Dinoflagellates	5.3	4.1	3.6	3.6
	Other flagellates	0.7	0.5	0.5	0.5
May 11	Diatoms	83.9	97.2	99.6	86.5
	Dinoflagellates	14.9	2.6	0.4	13.5
	Other flagellates	1.2	0.2	0	1.0
18	Diatoms	67.5	87.2	96.4	85.0
	Dinoflagellates	22.8	12.8	1.1	12.1
	Other flagellates	9.7	0	2.5	2.9
June 8	Diatoms	4.2	10.9	14.0	17.0
	Dinoflagellates	82.0	80.3	79.7	71.3
	Other flagellates	13.8	8.8	6.3	11.7
24	Diatoms	3.1	5.3	2.4	38.1
	Dinoflagellates	69.1	75.0	70.3	43.3
	Other flagellates	27.8	19.7	27.3	18.6
July 6	Diatoms	2.0	5.0	3.8	5.0
	Dinoflagellates	44.2	38.0	37.5	32.1
	Other flagellates	53.8	57.0	58.7	62.9

(continued)

Table 5. (continued)

July 27	Diatoms	0	1.1	15.7	25.0
	Dinoflagellates	16.4	23.3	35.7	47.3
	Other flagellates	83.6	75.6	48.6	27.7
Aug. 10	Diatoms	1.2	1.7	3.0	4.1
	Dinoflagellates	29.9	36.2	35.0	46.8
	Other flagellates	68.9	62.1	62.0	49.1
25	Diatoms	1.4	4.6	10.0	1.7
	Dinoflagellates	43.5	52.7	18.1	50.0
	Other flagellates	55.1	42.7	71.9	48.3
Sept. 14	Diatoms	2.5	6.8	4.9	24.1
	Dinoflagellates	65.9	67.4	55.6	38.0
	Other flagellates	31.6	25.8	39.5	37.9
Oct. 5	Diatoms	21.0	1.5	22.7	27.3
	Dinoflagellates	34.7	36.4	27.7	31.3
	Other flagellates	44.3	62.1	49.6	41.4
16	Diatoms	1.4	11.5	9.3	19.9
	Dinoflagellates	81.8	43.8	39.9	25.0
	Other flagellates	16.8	44.7	50.8	55.1
Nov. 10	Diatoms	69.0	62.3	76.3	86.3
	Dinoflagellates	11.9	19.3	3.4	1.9
	Other flagellates	19.1	17.5	20.3	11.8
27	Diatoms	3.1	14.0	6.0	5.1
	Dinoflagellates	69.1	59.0	67.1	33.3
	Other flagellates	27.8	27.0	26.9	61.6
Dec. 3	Diatoms	1.3	1.6	3.8	13.8
	Dinoflagellates	40.6	43.5	20.8	29.0
	Other flagellates	58.1	54.9	62.4	57.2
Jan. 8	Diatoms	11.8		51.2	90.2
	Dinoflagellates	22.4	ns	13.3	5.3
	Other flagellates	65.8		35.5	4.5
28	Diatoms	60.9	92.7	88.4	61.0
	Dinoflagellates	23.5	3.0	5.0	18.2
	Other flagellates	15.6	4.3	6.6	20.8

ns: not sampled.

TABLES (APPENDICES)

Table 1. Sea and pumphouse temperatures during the sampling period.

	Temperature (C)				
	0 m	15 m	30 m	Bottom (Depth m)	Pumphouse
February 10	0.8	*	*	*	0.8
23	0.1	0.1	0.0	0.0 (50)	0.0
March 18	0.0	-0.3	-0.6	-0.7 (33)	0.0
April 3	*	*	*	*	0.0
17	*	*	*	*	0.2
27	1.2	0.6	0.5	0.4 (37)	0.9
May 11	2.2	1.5	0.9	0.1 (50)	2.2
18	4.0	3.0	0.5	0.0 (35)	3.0
June 8	5.1	4.4	3.7	1.0 (55)	4.0
24	8.0	4.0	1.3	0.5 (55)	8.4
July 6	9.4	8.4	5.5	3.0 (42)	9.0
27	11.8	9.0	2.1	0.9 (55)	12.2
August 10	15.2	13.2	2.5	1.2 (50)	15.4
25	12.7	10.0	6.8	0.2 (37)	12.0
September 14	12.1	11.1	5.0	1.4 (40)	12.3
October 5	9.9	9.4	8.0	3.0 (40)	9.7
16	11.0	*	*	*	11.0
November 10	7.5	*	*	*	7.2
27	5.0	*	*	*	4.5

(continued)

Table 1. (continued)

	Temperature (C) 0 m	15 m	30 m	Bottom (Depth m)	Pumphouse
December 3	5.5	5.2	4.9	3.8 (60)	5.0
January 8	1.0	1.0	1.0	1.0 (57)	0.8
28	-0.2	-0.2	-0.2	-0.3 (63)	-0.2

* not determined

Table 2. Thermal stratification of water masses sampled

	Depth of thermocline (m)		Temperature range (C)		Temperature change
	From	To	From	To	(C/m)
May 18	20	26	2.5	0.6	0.3
June 8	40	45	3.3	1.5	0.4
24	10	15	6.0	4.0	0.4
July 6	26	38	8.0	3.6	0.4
27	9	15	11.3	9.0	0.4
	20	30	8.7	2.2	0.7
August 10	15	27	13.2	3.1	0.8
25	10	15	12.0	10.0	0.4
	31	37	6.5	0.2	1.1
September 14	26	34	9.5	2.7	0.9

Table 3. Weather and sea state observation*.

		Weather	Wind		Sea state	Swell
			Force	Direction		
Feb.	10	Mainly cloudy	Light air	NE	Slight	Moderate
	23	Broken clouds	Moderate breeze	SW	Rough	Heavy
Mar	18	Broken clouds	Moderate gale	SW	Very rough	Heavy
Apr.	3	Fair	Fresh breeze	SE	Rough	Moderate
	17	Sunny	Light air	SE	Rough	None
	27	Broken clouds	Gentle breeze	W	Rough	Moderate
May	11	Overcast sky	Moderate breeze	SW	Moderate	Moderate
	18	Blue sky	Strong breeze	SW	Moderate	None
June	8	Overcast sky	Strong breeze	SW	Rough	Moderate
	24	Broken clouds	Strong breeze	SW	Rough	Moderate
July	6	Broken clouds	Moderate breeze	NE	Slight	Moderate
	27	Blue sky	Light air	SW	Calm	None
Aug.	10	Mainly cloudy	Light air	SW	Calm	None
	25	Broken clouds	Strong breeze	SW	Rough	Moderate
Sept.	14	Broken clouds	Gentle breeze	SW	Calm	None
Oct.	5	Gloomy	Fresh breeze	SE	Rough	Moderate
	16	Fair	Light air	SW	Calm	None
Nov.	10	Blue sky	Calm	NE	Calm	None
	27	Fair	Light breeze	S	Smooth	None
Dec.	3	Overcast sky	Fresh breeze	SW	Slight	None
Jan.	8	Overcast sky	Strong breeze	NW	Rough	Heavy
	28	Overcast sky	Fresh breeze	W	Very rough	Heavy

* Footnotes for Table 3.

1. Descriptions based on U. S. Hydrographic Office, Special Publication: Manual for Coding and Punching Oceanographic Data on Cards. Washington, D. C., 1960.
2. Weather
   Blue sky: clear or hazy atmosphere
   Fair: few clouds; scattered sky
   Mainly cloudy: 1/2 sky covered
   Broken clouds: 3/4 sky covered
   Overcast sky: whole sky covered
3. Wind force: m/sec. (knots)
   Calm: 0.515 (1)
   Light air: 0.515-1.545 (1-3)
   Light breeze: 2.060-3.090 (4-6)
   Gentle breeze: 3.605-5.150 (7-10)
   Moderate breeze: 5.665-8.240 (11-16)
   Fresh breeze: 8.755-10.815 (17-21)
   Strong breeze: 11.330-13.905 (22-27)
   Moderate gale: 14.420-16.995 (28-33)
4. Sea state: height in m (feet)
   Calm-glassy: 0 (0)
   Calm-rippled: 0-0.1 (0-1/3)
   Smooth-wavelet: 0.1-0.5 (1/3-1 2/3)
   Slight: 0.5-1.2 (1 2/3-4)
   Moderate: 1.2-2.4 (4-8)
   Rough: 2.4-4.0 (8-13)
   Very rough: 4.0-6.1 (13-20)

Table 4. Mean monthly meteorological observations, Torbay Airport, St. John's, Newfoundland.

	Mean monthly air temperature (C)	Total hours of bright sunshine	Wind	
			Average monthly speed (M. P. H.)	Prevailing direction
1970				
February	- 1.2	74.5	15.3	S
March	0.5	75.9	13.3	WSW
April	0.7	95.0	14.2	N
May	6.8	192.2	14.6	WSW
June	11.7	185.7	14.4	WSW
July	15.5	258.0	13.6	WSW
August	17.5	155.1	13.9	WSW
September	10.6	124.6	12.7	W
October	7.0	108.1	14.2	W
November	4.9	74.7	13.1	S
December	- 2.8	56.7	17.4	WNW
1971				
January	- 5.1	54.9	18.7	W

Table 5. Secchi disc readings during the sampling period.

		Secchi disc reading (m)
Feb.	10	12.0
	23	12.0
Mar.	18	12.0
Apr.	3	*
	17	*
	27	8.5
May	11	12.0
	18	12.5
June	8	10.0
	24	13.5
July	6	9.5
	27	14.0
Aug.	10	11.0
	25	7.0
Sept.	14	10.0
Oct.	5	9.5
	16	9.0
Nov.	10	17.0
	27	14.0
Dec.	3	22.5
Jan.	8	17.0
	28	18.5

* not determined.

Table 6. Phytoplankton data (February 10, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	30 m	Pumphouse
Diatoms:			
Centric			
Chaetoceros convolutum f. trisetosa	0	0	20
Ch. decipiens	0	0	140
Coscinodiscus centralis	60	20	0
Skeletonema costatum	0	0	200
Thalassiosira nordenskioldii	0	0	40
TOTAL	60	20	400
Pennate			
Cocconeis sp.	20	0	40
Fragilaria oceanica	60	60	300
Licmophora sp.	40	0	240
Navicula sp.	100	360	180
Nitzschia closterium	0	0	40
N. delicatissima	320	40	1500
N. longissima	40	0	180
Striatella delicatula	0	0	20
Thalassionema nitzschioides	220	60	580
Unidentified forms	80	40	60
TOTAL	880	560	3140
Dinoflagellates:			
Armored			
Dinophysis punctata	0	0	20
Exuviella baltica	260	240	180
Minuscula bipes	20	0	100
TOTAL	280	240	300
Naked			
TOTAL	320	220	4060
Other flagellates:			
Coccolithus pelagicus	40	0	0

(continued)

Table 6. (continued)

	0 m	30 m	Pumphouse
Cryptomonas sp.	460	180	1340
Distephanus speculum	40	20	0
Eutreptia sp.	0	0	820
TOTAL	540	200	2160
TOTAL NUMBERS:	2080	1240	10060

Recorded from net sample only: Chaetoceros atlanticum, Ch. concavicorne, Coscinodiscus sp., Rhizosolenia styliformis, Ceratium arcticum, C. fusus, C. longipes, Peridinium depressum, P. pellucidum.

Table 7. Phytoplankton data (February 23, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	30 m	Pumphouse
Diatoms:			
Centric			
Asteromphalus hookeri	20	20	0
Chaetoceros convolutum	120	0	60
Coscinodiscus centralis	60	80	20
C. sp.	20	20	0
Coscinosira polychorda	0	20	0
Melosira nummuloides	0	0	40
Skeletonema costatum	600	1400	680
Thalassiosira decipiens	20	60	0
Th. gravida	40	80	40
Th. nordenskioldii	120	40	60
TOTAL	1000	1720	900
Pennate			
Cocconeis sp.	20	80	220
Fragilaria oceanica	0	240	320
Licmophora sp.	120	40	1900
Navicula sp.	100	40	0
Nitzschia closterium	60	20	40
N. seriata	0	120	20
Rhoicosphenia curvata	20	0	100
Striatella delicatula	0	40	220
Thalassionema nitzschioides	180	460	920
Unidentified forms	380	740	1580
TOTAL	880	1780	5340
Dinoflagellates:			
Armored			
Ceratium arcticum	20	20	0
Exuviella baltica	120	140	0
Minuscula bipes	0	20	0
Peridinium depressum	20	0	0
Unidentified forms	20	0	20
TOTAL	180	180	20

(continued)

Table 7. (continued)

	0 m	30 m	Pumphouse
Naked			
TOTAL	140	300	0
Other flagellates:			
Coccolithus pelagicus	20	20	20
Cryptomonas sp.	60	0	60
Distephanus speculum	60	40	20
Eutreptia sp.	40	0	0
TOTAL	180	60	100
TOTAL NUMBERS:	2380	4040	6360

Recorded from net sample only: Chaetoceros decipiens, Ceratium longipes.

Table 8. Phytoplankton data (March 18, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	30 m	Pumphouse
Diatoms:			
Centric			
Asteromphalus hookeri	20	20	0
Chaetoceros convolutum	120	400	0
Ch. decipiens	960	440	0
Coscinodiscus centralis	20	40	0
C. sp.	20	20	0
Skeletonema costatum	1720	660	140
Thalassiosira decipiens	20	80	20
Th. gravida	40	40	20
Th. nordenskioldii	240	180	60
Unidentified forms	80	40	40
TOTAL	3240	1920	280
Pennate			
Cocconeis sp.	20	40	220
Fragilaria oceanica	120	20	160
Licmophora sp.	220	80	320
Navicula sp.	100	440	120
Nitzschia closterium	40	0	20
Rhoicosphenia curvata	20	0	100
Striatella delicatula	20	0	60
Thalassionema nitzschioides	760	160	260
Unidentified forms	200	580	80
TOTAL	1500	1320	1340
Dinoflagellates:			
Armored			
Ceratium arcticum	20	0	0
Minuscula bipes	20	0	0
Peridinium punctulatum	0	40	0
TOTAL	40	40	0
Naked			
TOTAL	360	40	0

(continued)

Table 8. (continued)

	0 m	30 m	Pumphouse
Other flagellates:			
Coccolithus pelagicus	40	40	40
Cryptomonas sp.	80	40	60
Distephanus speculum	20	0	0
Ebria tripartita	20	20	0
Eutreptia sp.	40	0	20
TOTAL	200	100	120
TOTAL NUMBERS:	5340	3420	1740

Recorded from net sample only: Rhizosolenia styliformis, Thalassiothrix longissima, Ceratium fusus, C. longipes, Peridium depressum, P. pallidum, P. pellucidum.

Table 9. Phytoplankton data (April 3, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	Pumphouse
Diatoms:	
Centric	
Asteromphalus hookeri	20
Bacteriosira fragilis	120
Chaetoceros convolutum	40
Ch. decipiens	140
Ch. sociale	580
Coscinodiscus centralis	20
Coscinosira polychorda	320
Porosira glacialis	3040
Skeletonema costatum	920
Thalassiosira decipiens	1080
Th. gravida	3580
Th. nordenskioldii	15060
Unidentified forms	20
TOTAL	24940
Pennate	
Cocconeis sp.	100
Fragilaria oceanica	11560
Licmophora sp.	2560
Navicula vanhoffenii	400
N. sp.	60
Rhoicosphenia curvata	220
Striatella delicatula	240
Unidentified forms	140340
TOTAL	155480
Dinoflagellates:	
Armored	
Peridinium pellucidum	20
TOTAL	20
Naked	
TOTAL	100

(continued)

Table 9. (continued)

	Pumphouse
Other flagellates:	
Coccolithus pelagicus	80
Cryptomonas sp.	180
Distephanus speculum	20
Eutreptia sp.	60
TOTAL	340
TOTAL NUMBERS:	180880

Table 10. Phytoplankton data (April 17, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	Pumphouse
Diatoms:	
Centric	
Bacteriosira fragilis	7580
Chaetoceros boreale	280
Ch. ceratosporum	140
Ch. convolutum	80
Ch. debile	1180
Ch. decipiens	980
Ch. sociale	5920
Ch. sp.	380
Coscinosira polychorda	40
Detonula confervacea	1480
Lauderia borealis	120
Leptocylindrus danicus	240
Porosira glacialis	6040
Rhizosolenia hebetata	20
Skeletonema costatum	2080
Thalassiosira decipiens	2000
Th. gravida	13 180
Th. nordenskioldii	25160
TOTAL	66900
Pennate	
Achnanthes taeniata	1360
Amphora sp.	760
Cocconeis sp.	140
Fragilaria oceanica	16980
Licmophora sp.	440
Navicula vanhoffenii	520
N. sp.	260
Nitzschia closterium	40
Rhoicosphenia curvata	140
Striatella delicatula	380
Thalassionema nitzschioides	1120
Unidentified forms	33080
TOTAL	55220

(continued)

Table 10. (continued)

	Pumphouse
Dinoflagellates:	
Armored	
Minuscula bipes	20
Peridinium breve	20
P. curtipes	20
P. depressum	40
P. punctulatum	40
TOTAL	140
Naked	
TOTAL	2560
Other flagellates:	
Coccolithus pelagicus	140
Cryptomonas sp.	440
Distephanus speculum	100
Eutreptia sp.	60
Unidentified forms	60
TOTAL	800
TOTAL NUMBERS:	125620

Table 11. Phytoplankton data (April 27, 1970).

Location: Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Asteromphalus hookeri	0	40	40	0
Bacteriosira fragilis	3480	3120	8000	2380
Biddulphia aurita	0	0	0	60
Chaetoceros affine	4360	7040	4200	780
Ch. atlanticum	120	0	0	0
Ch. boreale	760	80	200	0
Ch. ceratosporum	160	20	0	0
Ch. concavicorne	120	0	0	100
Ch. constrictum	3800	4020	3760	780
Ch. convolutum	400	240	720	180
Ch. curvisetum	3600	2380	1760	480
Ch. debile	840	6780	8840	540
Ch. decipiens	1120	720	1320	740
Ch. sociale	67000	85620	77920	13320
Ch. teres	3480	1160	960	820
Ch. sp.	1360	4580	5660	2060
Coscinodiscus centralis	40	20	0	20
Coscinosira polychorda	720	560	120	0
Detonula confervacea	840	1700	4200	880
Eucampia zodiacus	2480	1320	1160	240
Lauderia borealis	240	100	360	100
Leptocylindrus danicus	0	20	0	0
Porosira glacialis	2280	420	260	1420
Rhizosolenia fragilissima	40	0	80	0
Rh. hebetata	0	20	0	20
Skeletonema costatum	8760	1360	2200	920
Thalassiosira decipiens	3520	620	1080	940
Th. gravida	6800	7740	10480	4200
Th. nordenskioldii	49880	26420	36520	26700
Th. sp.	0	0	0	120
TOTAL	166200	156100	169840	57800
Pennate				
Achnanthes taeniata	4400	7140	7640	9660

(continued)

Table 11. (continued)

	0 m	15 m	30 m	Pumphouse
Amphiprora hyperborea	240	300	840	40
Cocconeis sp.	0	0	0	280
Fragilaria oceanica	18880	6460	23680	22600
Licmophora sp.	0	100	400	3120
Navicula vanhoffenii	32840	10 200	23 720	9980
N. sp.	240	220	1080	40
Nitzschia closterium	80	60	240	40
N. delicatissima	40	120	280	20
N. longissima	0	20	80	0
N. seriata	0	60	120	0
Stauroneis quadripedis	200	66 0	1160	320
Striatella delicatula	0	80	40	540
Thalassionema nitzschioides	40	0	0	0
Thalassiothrix longissima	148 0	0	0	80
Unidentified forms	2600	3520	9200	6700
TOTAL	61040	28 940	68480	53420
Dinoflagellates:				
Armored				
Ceratium arcticum	40	20	0	0
Minuscula bipes	120	80	160	80
Oxytoxum sp.	60	40	0	0
Peridinium breve	120	20	40	20
P. depressum	40	0	0	0
P. pellucidum	80	40	40	20
P. punctulatum	80	20	120	80
Unidentified forms	80	60	160	40
TOTAL	620	280	520	240
Naked				
TOTAL	12100	7760	8560	3980
Other flagellates:				
Coccolithus pelagicus	80	60	120	60
Distephanus speculum	40	0	0	40
Cryptomonas sp.	128 0	680	840	420
Eutreptia sp.	160	160	160	60
Unidentified forms	40	20	40	0
TOTAL	1600	920	1160	580

(continued)

Table 11. (continued)

	0 m	15 m	30 m	Pumphouse
TOTAL NUMBERS:	241560	194000	248560	116020

Recorded from net sample only: Coscinodiscus oculus-iridis, Fragilaria islandica, Pleurosigma sp., Thalassiothrix longissima, Ceratium fusus, C. longipes, Peridinium pallidum.

Table 12. Phytoplankton data (May 11, 1970).

Location : Logy Bay
Volume examined/sample : 25 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Bacteriosira fragilis	160	80	0	80
Chaetoceros affine	2080	5160	840	2320
Ch. atlanticum	120	0	0	0
Ch. boreale	0	240	320	0
Ch. ceratosporum	120	440	280	760
Ch. concavicorne	40	40	240	440
Ch. constrictum	640	360	0	480
Ch. convolutum	40	720	200	280
Ch. curvisetum	0	0	360	160
Ch. debile	2160	2080	1800	3440
Ch. decipiens	760	440	680	640
Ch. sociale	21280	53120	34720	36880
Ch. teres	1160	5720	3040	160
Ch. sp.	400	2680	1920	1920
Coscinodiscus sp.	0	40	0	0
Detonula confervacea	80	80	0	120
Eucampia zodiacus	240	400	680	320
Lauderia borealis	80	0	200	80
Leptocylindrus danicus	0	120	0	0
Porosira glacialis	40	120	40	40
Rhizosolenia fragilissima	40	0	0	0
Rh. hebetata	0	120	40	40
Skeletonema costatum	200	80	0	240
Thalassiosira gravida	0	120	160	520
Th. nordenskioldii	320	160	1920	1400
TOTAL	29960	72320	47440	50320
Pennate				
Achnanthes taeniata	120	40	440	160
Amphiprora hyperhorea	0	0	80	0
Fragilaria oceanica	160	360	240	760
Licmophora sp.	0	120	80	880
Navicula sp.	40	280	160	120
Nitzschia closterium	0	0	40	200
N. longissima	40	0	40	0
N. seriata	80	0	280	0

(continued)

Table 12. (continued)

	0 m	15 m	30 m	Pumphouse
Rhabdonema minutum	0	0	0	40
Rhoicosphenia curvata	0	0	80	40
Striatella delicatula	0	0	80	40
Thalassionema nitzschioides	80	400	40	0
Unidentified forms	480	320	4480	680
TOTAL	1000	1520	6040	2920
Dinoflagellates:				
Armored				
Actiniscus pentasteria v. arcticus	0	40	0	0
Ceratium arcticum	40	0	0	40
Exuviella baltica	0	0	0	160
Minuscula bipes	40	0	0	0
Oxytoxum sp.	40	40	0	0
Peridinium curtipes	0	0	40	0
P. depressum	80	80	40	80
P. punctulatum	80	0	40	40
P. saltans	40	0	0	0
Unidentified forms	40	40	80	40
TOTAL	360	200	200	360
Naked				
TOTAL	5120	1800	40	8040
Other flagellates:				
Coccolithus pelagicus	0	0	0	120
Cryptomonas sp.	400	160	0	480
Unidentified forms	40	0	0	0
TOTAL	440	160	0	600
TOTAL NUMBERS:	36880	76000	53720	62240

Recorded from net sample only: Coscinodiscus centralis, C. curvatulus, C. oculus-iridis, Fragilaria islandica, Rhizosolenia shrubsolei, Rh. styliformis, Thalassiothrix longissima, Ceratium longipes, Dinophysis norvegica, Peridinium conicoides, P. ovatum, P. pallidum, P. pellucidum, Halosphaera viridis.

Table 13. Phytoplankton data (May 18, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros affine	0	0	340	460
Ch. atlanticum	80	40	140	0
Ch. convolutum	0	40	0	120
Ch. decipiens	0	40	0	180
Ch. sociale	0	0	240	160
Ch. sp.	820	40	320	1560
Coscinodiscus centralis	20	0	0	0
Leptocylindrus danicus	200	320	260	480
Melosira moniliformis	0	40	0	0
M. nummuloides	0	80	200	0
Rhizosolenia alata	0	0	40	0
Rh. fragilissima	0	20	0	0
Thalassiosira gravida	0	0	0	40
Th. nordenskioldii	0	0	0	60
Th. sp.	0	0	100	40
TOTAL	1120	620	1640	3100
Pennate				
Achnanthes taeniata	0	0	140	0
Amphiprora hyperhorea	0	0	20	0
Cocconeis sp.	0	0	0	20
Fragilaria oceanica	120	40	620	40
Licmophora sp.	140	20	0	580
Navicula vanhoffeni	0	0	1000	240
N. sp.	60	60	180	280
Nitzschia closterium	0	0	20	0
Rhabdonema minutum	0	0	0	40
Rhoicosphenia curvata	0	0	0	40
Striatella delicatula	0	0	0	40
Thalassiothrix longissima	0	0	20	0
Unidentified forms	100	80	1760	820
TOTAL	420	200	3760	2120

(continued)

Table 13. (continued)

	0 m	15 m	30 m	Pumphouse
Dinoflagellates:				
Armored				
Ceratium arcticum	20	20	0	20
Peridinium breve	0	20	0	0
P. depressum	100	40	0	0
TOTAL	120	80	0	20
Naked				
TOTAL	400	40	60	720
Other flagellates:				
Coccolithus pelagicus	0	0	0	20
Cryptomonas sp.	220	0	140	160
TOTAL	220	0	140	180
TOTAL NUMBERS:	2280	940	5600	6140

Recorded from net sample only: Bacteriosira fragilis, Chaetoceros breve, Ch. boreale, Nitzschia seriata, Ceratium fusus, C. longipes, C. sp., Dinophysis norvegica, Peridinium curtipes, P. pallidum, P. pellucidum, P. saltans, Halosphaera viridis.

Table 14. Phytoplankton data (June 8, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Bacteriosira fragilis	0	0	20	0
Chaetoceros atlanticum	0	40	0	0
Coscinodiscus sp.	0	0	20	0
Leptocylindrus danicus	240	60	0	40
Melosira moniliformis	0	0	320	0
TOTAL	240	100	360	40
Pennate				
Achnanthes taeniata	0	0	0	100
Amphiprora hyperborea	0	0	20	0
Cocconeis sp.	0	20	0	20
Fragilaria oceanica	20	0	40	40
Gyrosigma sp.	0	0	20	0
Licmophora sp.	20	60	0	620
Navicula sp.	0	0	20	0
Nitzschia closterium	0	20	0	20
N. longissima	20	0	0	0
Rhabdonema minutum	0	20	0	0
Rhoicosphenia curvata	0	40	0	120
Unidentified forms	180	60	20	620
TOTAL	240	220	120	1540
Dinoflagellates:				
Armored				
Ceratium arcticum	60	0	20	0
Exuviella baltica	260	200	140	0
Glenodinium sp.	20	20	60	120
Peridinium depressum	0	40	20	20
P. sp.	20	20	0	0
TOTAL	360	280	240	140
Naked				
TOTAL	8940	2080	2500	6480

(continued)

Table 14. (continued)

	0 m	15 m	30 m	Pumphouse
Other flagellates:				
Cryptomonas sp.	1560	260	220	1080
TOTAL	1560	260	220	1080
TOTAL NUMBERS	11340	2940	3440	9280

Recorded from net sample only: Chaetoceros convolutum, Ch. decipiens, Fragilaria islandica, Ceratium fusus, C. longipes, Dinophysis norvegica, Peridinium curtipes, P. pallidum, P. pellucidum, Halosphaera viridis.

Table 15. Phytoplankton data (June 24, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros ceratosporum	0	180	0	0
Ch. constrictum	0	60	0	0
Leptocylindrus danicus	60	260	20	100
Rhizosolenia hebetata	0	40	40	0
TOTAL	60	540	60	100
Pennate				
Cocconeis sp.	0	20	0	40
Fragilaria oceanica	240	0	0	80
Licmophora sp.	20	40	60	120
Navicula sp.	0	0	0	20
Nitzschia closterium	20	40	20	100
N. delicatissima	60	0	0	0
Rhabdonema minutum	0	0	0	40
Rhoicosphenia curvata	0	0	0	180
Striatella delicatula	40	0	0	0
Unidentified forms	100	0	40	1940
TOTAL	480	100	120	2520
Dinoflagellates:				
Armored				
Ceratium arcticum	60	20	20	0
C. longipes	40	60	0	20
Dinophysis lenticula	20	0	0	0
D. punctata	40	0	0	0
Exuviella baltica	20	100	0	0
Oxytoxum sp.	0	0	0	20
Peridinium depressum	0	40	20	0
P. pellucidum	20	20	20	0
P. sp.	20	20	20	0
TOTAL	220	260	80	40
Naked				
TOTAL	11760	8860	5220	2940

(continued)

Table 15. (continued)

	0 m	15 m	30 m	Pumphouse
Other flagellates:				
Cryptomonas sp.	4780	2380	2040	1280
Eutreptia sp.	40	20	20	0
TOTAL	4820	2400	2060	1280
TOTAL NUMBERS:	17340	12160	7540	6880

Recorded from net sample only: Nitzschia seriata, Rhizosolenia styliformis, Ceratium fusus, Dinophysis norvegica, Peridinium curtipes, P. pallidum, P. sp., Halosphaera viridis.

Table 16. Phytoplankton data (July 6, 1970)

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros ceratosporum	0	0	40	0
Ch. convolutum f. trisetosa	80	20	0	0
Ch. curvisetum	0	0	100	0
Ch. decipiens	0	0	220	0
Ch. simplex	0	0	20	0
Leptocylindrus danicus	1280	2260	1360	60
TOTAL	1360	2280	1740	60
Pennate				
Fragilaria oceanica	0	0	20	40
Licmophora sp.	0	0	60	120
Nitzschia closterium	0	20	20	0
N. delicatissima	20	80	40	0
Unidentified forms	0	0	60	180
TOTAL	20	100	200	340
Dinoflagellates:				
Armored				
Ceratium arcticum	20	40	40	0
C. longipes	20	40	0	0
Dinophysis norvegica	20	0	0	0
D. punctata	20	0	0	0
Exuviella baltica	40	60	40	60
Minuscula bipes	180	40	0	0
Peridinium depressum	20	20	40	0
Unidentified forms	0	20	40	0
TOTAL	320	220	160	60
Naked				
TOTAL	29880	17860	18920	2520

(continued)

Table 16. (continued)

	0 m	15 m	30 m	Pumphouse
Other flagellates:				
Cryptomonas sp.	36800	27140	29900	5060
Eutreptia sp.	20	20	40	0
Unidentified forms	20	0	0	0
TOTAL	36840	27160	29940	5060
TOTAL NUMBERS:	68420	47620	50960	8040

Recorded from net sample only: Chaetoceros atlanticum, Ch. convolutum, Coscinodiscus centralis, C. oculis-iridis, Flagilaria cylindrus, Nitzschia seriata, Rhizosolenia hebetata, Rh. shrubsolei, Thalassiosira nordenskioldii, Th. sp., Thalassiothrix longissima
Ceratium fusus, C. sp., Dinophysis lenticula, Peridinium breve, P. conicoides, P. curtipes, P. pallidum, P. pellucidum, P. sp., Halosphaera viridis.

Table 17. Phytoplankton data (July 27, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros ceratosporum	0	0	20	0
Leptocylindrus danicus	0	0	1800	0
Rhizosolenia hebetata	0	0	20	0
Rh. styliformis	0	0	20	0
TOTAL	0	0	1860	0
Pennate				
Achnanthes taeniata	0	0	20	0
Licmophora sp.	0	0	0	200
Nitzschia closterium	0	0	20	20
Rhabdonema minutum	0	20	20	0
Rhoicosphenia curvata	0	0	0	40
Unidentified forms	0	0	240	480
TOTAL	0	20	300	740
Dinoflagellates:				
Armored				
Ceratium arctium	20	20	0	20
C. fusus	0	20	0	0
C. longipes	40	20	20	40
Dinophysis norvegica	20	20	0	0
D. punctata	0	40	20	0
Exuviella baltica	20	0	0	20
Minuscula bipes	40	0	0	0
TOTAL	140	120	40	80
Naked				
TOTAL	460	300	4860	1320

(continued)

Table 17. (continued)

	0 m	15 m	30 m	Pumphouse
Other flagellates:				
Cryptomonas sp.	2140	760	6320	600
Diaphanoeca sp.	0	0	120	80
Eutreptia sp.	0	0	20	0
Unidentified forms	920	600	220	140
TOTAL	3060	1360	6680	820

TOTAL NUMBERS:

Recorded from net sample only: Chaetoceros atlanticum, Fragilaria cylindrus, Rhizosolenia shrubsolei, Thalassiothrix longissima, Peridinium depressum, P. sp., Phalacroma rotundatum, Halosphaera viridis.

Table 18. Phytoplankton data (August 10, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Leptocylindrus danicus	0	0	0	40
Rhizosolenia fragilissima	0	0	40	0
Rh. hebetata	0	0	0	20
TOTAL	0	0	40	60
Pennate				
Licmophora sp.	0	0	0	100
Navicula sp.	0	0	0	40
Nitzschia delicatissima	80	20	20	20
N. seriata	0	0	0	120
Striatella delicatula	0	0	0	20
Unidentified forms	40	20	60	100
TOTAL	120	40	80	400
Dinoflagellates:				
Armored				
Ceratium arcticum	20	80	40	0
C. fusus	20	20	0	0
C. longipes	100	80	40	20
Exuviella baltica	0	20	0	0
Minuscula bipes	20	0	0	0
Peridinium depressum	0	20	0	0
P. sp.	20	0	0	0
TOTAL	180	220	80	20
Naked				
TOTAL	2880	620	1320	5180
Other flagellates:				
Cryptomonas sp.	6520	740	2140	5020
Distephanus speculum	0	0	20	0
Unidentified forms	520	700	340	440
TOTAL	7040	1440	2480	5460

(continued)

Table 18. (continued)

	0 m	15 m	30 m	Pumphouse
TOTAL NUMBERS:	10220	2320	4000	11120

Recorded from net sample only: Fragilaria sp. , Dinophysis norvegica, Peridinium pellucidum, Halosphaera viridis.

Table 19. Phytoplankton data (August 25, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

Diatoms:				
Centric				
Chaetoceros convolutum f. trisetosa	20	0	0	0
Leptocylindrus danicus	60	0	60	0
Skeletonema costatum	0	0	140	0
TOTAL	80	0	200	0
Pennate				
Licmophora sp.	20	0	0	40
Navicula sp.	0	20	20	0
Nitzschia closterium	20	0	0	40
N. delicatissima	360	140	160	80
Unidentified forms	120	60	160	180
TOTAL	520	220	340	340
Dinoflagellates:				
Armored				
Actiniscus pentasterias v. arcticus	0	40	0	0
Ceratium arcticum	0	20	0	0
C. fusus	20	40	20	0
C. longipes	320	440	120	60
Dinophysis norvegica	20	20	0	0
D. punctata	20	0	0	0
Exuviella baltica	20	100	60	0
Peridinium breve	0	20	0	0
P. cerasus	20	0	0	0
P. curtipes	0	20	0	0
Unidentified forms	20	0	0	0
TOTAL	440	700	200	60
Naked				
TOTAL	17940	1840	780	10180

(continued)

Table 19. (continued)

	0 m	15 m	30 m	Pumphouse
Other flagellates:				
Cryptomonas sp.	22960	1820	3820	9840
Ebria tripartita	0	40	0	0
Eutreptia sp.	0	20	0	0
Unidentified forms	320	180	60	40
TOTAL	23280	2060	3880	9880
TOTAL NUMBERS:	42260	4820	5400	20460

Recorded from net sample only: Peridinium depressum, P. ovatum, P. pallidum, P. pellucidum, P. pyriforme, Phalacroma rotundatum.

Table 20. Phytoplankton data (September 14, 1970)

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros convolutum f. trisetosa	0	40	0	0
TOTAL	0	40	0	0
Pennate				
Licmophora sp.	120	60	20	2080
Nitzschia closterium	0	0	0	40
N. delicatissima	80	80	200	40
Unidentified forms	0	80	80	340
TOTAL	200	220	300	2500
Dinoflagellates:				
Armored				
Ceratium longipes	180	140	240	40
Dinophysis acuminata	20	0	0	0
Exuviella baltica	20	0	0	0
Peridinium breve	0	20	0	0
P. cerasus	20	0	0	0
P. curtipes	20	0	0	0
P. depressum	20	20	20	0
Phalacroma rotundatum	20	0	0	0
TOTAL				
Naked				
TOTAL	5040	2380	3140	3900
Other flagellates:				
Cryptomonas sp.	2240	440	1920	3780
Diaphanoeca sp.	0	0	0	20
Distephanus speculum	0	20	20	0
Ebria tripartita	40	80	220	0
Unidentified forms	280	440	260	120
TOTAL	2560	980	2420	3920
TOTAL NUMBERS:	8100	3800	6120	10360

(continued)

Table 20. (continued)

Recorded from net sample only: Navicula sp., Ceratium fusus, C. tripos, Dinophysis norvegica, Peridinium pallidum.

Table 21. Phytoplankton data (October 5, 1970).

Location : Logy Bay
Volume examined/sample 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Biddulphia aurita	0	0	0	20
Chaetoceros convolutum f. trisetosa	40	40	0	0
Leptocylindrus danicus	0	100	0	0
Melosira moniliformis	0	0	0	40
TOTAL	40	140	0	60
Pennate				
Asterionella sp.	40	140	80	0
Cocconeis sp.	0	0	0	20
Grammatophora marina	20	20	0	60
Licmophora sp.	40	20	20	1100
Navicula sp.	0	20	0	0
Nitzschia closterium	0	40	20	20
N. delicatissima	0	100	20	0
Unidentified forms	680	400	400	640
TOTAL	780	740	540	1840
Dinoflagellates:				
Armored				
Actiniscus pentasteria v. arcticus	40	0	0	20
Ceratium fusus	20	20	0	0
C. longipes	60	100	20	0
C. tripos	0	20	0	0
Exuviella baltica	100	0	0	60
Minuscula bipes	0	40	0	20
Peridinium breve	0	0	20	0
P. cerasus	20	0	0	0
P. curtipes	20	0	20	0
P. depressum	20	0	20	0
Phalacroma rotundatum	20	20	0	0
TOTAL	300	200	80	100
Naked				
TOTAL	1060	21120	580	2080

(continued)

Table 21. (continued)

Other flagellates:				
Cryptomonas sp.	1080	35920	1020	2680
Distephanus speculum	40	80	0	0
Ebria tripartita	0	20	0	40
Eutreptia sp.	20	140	0	0
Unidentified forms	600	260	160	160
TOTAL	1740	36420	1180	2880
TOTAL NUMBERS:	3920	58620	2380	6960

Table 22. Phytoplankton data (October 16, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros convolutum f. trisetosa	140	20	0	40
Melosira moniliformis	0	0	0	80
TOTAL	140	20	0	120
Pennate				
Cocconeis sp.	0	0	20	0
Grammatophora marina	20	20	20	0
Licmophora sp.	40	20	0	860
Nitzschia delicatissima	0	0	100	0
N. seriata	80	60	60	0
Rhoicosphenia curvata	0	0	0	60
Striatella delicatula	0	0	40	60
Unidentified forms	460	360	240	1380
TOTAL	600	460	480	2360
Dinoflagellates:				
Armored				
Arctniscus pentasteria v. arcticus	20	120	0	0
Ceratium fusus	60	20	80	20
C. longipes	40	60	60	0
C. tripos	20	20	20	0
Peridinium curtipes	0	0	20	0
Phalacroma rotundatum	0	20	0	20
TOTAL	140	240	180	40
Naked				
TOTAL	43200	1620	1880	3080
Other flagellates:				
Cryptomonas sp.	7940	1240	1960	6620
Diaphanoeca sp.	0	0	0	80

(continued)

Table 22. (continued)

	0 m	15 m	30 m	Pumphouse
Distephanus speculum	80	200	40	20
Ebria tripartita	120	0	80	0
Eutreptia sp.	180	0	20	20
Unidentified forms	580	380	520	120
TOTAL	8900	1820	2620	6860
TOTAL NUMBERS:	52980	4160	5160	12460

Table 23. Phytoplankton data (November 10, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros convolutum f. trisetosa	0	0	40	0
Rhizosolenia hebetata	20	0	0	0
Unidentified forms	80	0	60	0
TOTAL	100	0	100	0
Pennate				
Licmophora sp.	60	60	0	160
Navicula sp.	40	0	20	0
Nitzschia delicatissima	0	0	60	0
N. longissima	0	0	20	0
Rhoicosphenia curvata	0	0	0	40
Striatella delicatula	20	20	0	0
Unidentified forms	360	640	700	680
TOTAL	480	720	800	880
Dinoflagellates:				
Armored				
Arctiniscus pentasteria v. arcticus	20	0	0	0
Ceratium fusus	40	40	0	0
C. longipes	20	60	0	0
C. tripos	0	20	0	0
Dinophysis norvegica	0	20	0	0
Peridinium sp.	20	20	0	0
TOTAL	100	160	0	0
Naked				
TOTAL	0	60	40	20
Other flagellates:				
Distephanus speculum	60	20	40	0
Unidentified forms	100	180	200	120
TOTAL	160	200	240	120

(continued)

Table 23. (continued)

	0 m	15 m	30 m	Pumphouse
TOTAL NUMBERS:	840	1140	1180	1020

Recorded from net sample only: Peridinium curtipes, P. depressum,
P. pallidum.

Table 24. Phytoplankton data (November 27, 1970).

Location : Logy Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros atlanticum	0	40	0	0
Ch. convolutum f. trisetosa	20	20	0	0
Unidentified forms	0	0	20	40
TOTAL	20	60	20	40
Pennate				
Licmophora sp.	40	20	40	40
Navicula sp.	20	0	0	0
Nitzschia closterium	20	0	20	40
N. delicatissima	40	0	80	0
N. longissima	0	20	0	0
N. seriata	40	20	60	40
Unidentified forms	560	5 20	360	1220
TOTAL	720	580	560	1340
Dinoflagellates:				
Armored				
Actiniscus pentasteria v. arcticus	0	0	0	20
Ceratium arcticum	20	40	0	0
C. fusus	40	20	40	0
C. longipes	40	60	100	80
C. tripos	0	20	0	0
Minuscula bipes	40	0	80	20
Peridinium breve	0	20	20	20
Unidentified forms	0	20	100	100
TOTAL	140	180	340	240
Naked				
TOTAL	16240	2520	6180	8860
Other flagellates:				
Cryptomonas sp.	6060	1140	2460	16480

(continued)

Table 24. (continued)

	0 m	15 m	30 m	Pumphouse
Distephanus speculum	0	40	40	40
Eutreptia sp.	400	0	120	160
Unidentified forms	140	60	0	140
TOTAL	6600	1240	2620	16820
TOTAL NUMBERS:	23720	4580	9720	27300

Table 25. Phytoplankton data (December 3, 1970).

Location : Robin Hood Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Chaetoceros convolutum f. trisetosa	0	20	0	0
Skeletonema costatum	0	40	120	0
Unidentified forms	0	20	0	0
TOTAL	0	80	120	0
Pennate				
Cocconeis sp.	40	0	0	0
Licmophora sp.	0	20	20	920
Nitzschia closterium	100	20	80	100
N. delicatissima	100	40	80	100
N. longissima	0	20	40	0
N. seriata	80	0	60	0
Rhoicosphenia curvata	0	20	0	80
Striatella delicatula	20	20	20	40
Thalassionema nitzschioides	0	20	80	0
Unidentified forms	160	340	380	1920
TOTAL	500	500	760	3160
Dinoflagellates:				
Armored				
Ceratium arcticum	20	0	0	0
C. fusus	0	20	40	0
C. longipes	60	40	80	20
Minuscula bipes	40	20	40	0
Peridinium breve	40	0	0	0
Unidentified forms	60	20	20	40
TOTAL	220	100	180	60
Naked				
TOTAL	15380	15680	4620	6560

(continued)

Table 25. (continued)

	0 m	15 m	30 m	Pumphouse
Other flagellates:				
Cryptomonas sp.	20360	19020	15840	12440
Distephanus speculum	60	40	40	20
Eutreptia sp.	220	160	220	20
Unidentified forms	1700	700	1260	580
TOTAL	22340	19920	17360	13060
TOTAL NUMBERS:	38440	36280	23040	22840

Table 26. Phytoplankton data (January 8, 1971).

Location : Robin Hood Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	30 m	Pumphouse
Diatoms:			
Centric			
Chaetoceros convolutum	100	40	0
Ch. convolutum f. trisetosa	20	0	20
Ch. decipiens	40	40	0
Melosira nummuloides	0	0	180
Skeletonema costatum	60	0	40
Unidentified forms	0	0	20
TOTAL	220	80	260
Pennate			
Asterionella sp.	0	100	0
Cocconeis sp.	20	0	60
Fragilaria oceanica	0	0	320
Licmophora sp.	0	0	460
Nitzschia delicatissima	40	260	0
Striatella delicatula	0	0	120
Thalassiothrix longissima	80	240	520
Unidentified forms	0	160	3020
TOTAL	140	760	4500
Dinoflagellates:			
Armored			
Ceratium arcticum	0	40	0
C. longipes	20	60	0
Minuscula bipes	40	0	0
Peridinium depressum	0	20	0
Unidentified forms	0	40	0
TOTAL	60	180	0
Naked			
TOTAL	620	40	280

(continued)

Table 26. (continued)

	0 m	30 m	Pumphouse
Other flagellates:			
Cryptomonas sp.	340	80	120
Eutreptia sp.	1480	380	20
Unidentified forms	380	120	100
TOTAL	2000	580	240
TOTAL NUMBERS:	3040	1640	5280

Recorded from net sample only: Chaetoceros atlanticum, Ch. breve, Ch. curvisetum, Coscinodiscus centralis, Rhizosolenia shrubsolei, Rh. styliformis, Thalassionema nitzschioides, Ceratium fusus, C. tripos, Peridinium curtipes, P. pallidum.

Table 27. Phytoplankton data (January 28, 1971).

Location : Robin Hood Bay
Volume examined/sample : 50 ml
Population recorded as cells/liter

	0 m	15 m	30 m	Pumphouse
Diatoms:				
Centric				
Bacteriosira fragilis	0	20	0	0
Chaetoceros boreale	0	0	20	0
Ch. ceratosporum	340	1320	400	20
Ch. concavicorne	20	60	0	20
Ch. constrictum	200	260	360	180
Ch. convolutum f. trisetosa	360	280	240	20
Ch. decipiens	160	60	180	0
Ch. sociale	140	0	0	120
Ch. teres	80	620	40	80
Leptocylindrus danicus	160	80	60	0
Melosira sp.	0	0	40	0
Rhizosolenia alata	20	20	0	0
Skeletonema costatum	1020	2240	1860	220
Thalassiosira decipiens	0	40	0	0
Th. nordenskioldii	360	760	500	40
TOTAL	2860	5760	3700	700
Pennate				
Cocconeis sp.	20	0	0	40
Fragilaria oceanica	160	160	20	600
Grammatophora marina	20	0	0	0
Licmophora sp.	0	20	20	540
Navicula sp.	0	0	20	0
Nitzschia closterium	880	440	760	120
N. delicatissima	6040	7180	7540	1960
N. longissima	100	60	140	100
N. seriata	0	80	0	0
Rhoicosphenia curvata	0	80	60	240
Striatella delicatula	0	0	0	240
Thalassionema nitzschioides	160	700	500	760
Thalassiothrix longissima	0	0	20	0
Unidentified forms	1900	340	220	1000
TOTAL	9280	9060	9300	6200

(continued)

Table 27. (continued)

	0 m	15 m	30 m	Pumphouse
Dinoflagellates:				
Armored				
Ceratium longipes	0	0	20	0
Dinophysis acuminata	0	0	20	0
Exuviella baltica	40	40	0	0
Minuscula bipes	120	20	0	0
Peridinium breve	20	40	20	0
Unidentified forms	140	40	0	20
TOTAL	320	140	60	20
Naked				
TOTAL	4360	340	680	2040
Other flagellates:				
Cryptomonas sp.	2440	560	420	2000
Distephanus speculum	0	0	40	0
Eutreptia sp.	660	100	480	100
Unidentified forms	0	20	20	260
TOTAL	3100	680	960	2360
TOTAL NUMBERS:	19920	15980	14700	11320

Recorded from net sample only: Chaetoceros atlanticum, Ch. sp., Coscinodiscus centralis, C. sp., Rhizosolenia shrubsolei, Rh. styliformis, Ceratium arcticum, Peridinium curtipes, P. depressum, P. pallidum.

Table 28. List of species

Diatoms:

Centric forms

Asteromphalus hookeri Ehrenberg
Bacteriosira fragilis Gran
Biddulphia aurita (Lyngbye) de Brebisson
Chaetoceros affine Lauder
Ch. atlanticum Cleve
Ch. boreale Bailey
Ch. ceratosporum Ostenfeld
Ch. concavicorne Mangin
Ch. constrictum Gran
Ch. convolutum Castracane
Ch. convolutum f. trisetosa
Ch. curvisetum Cleve
Ch. debile Cleve
Ch. decipiens Cleve
Ch. simplex Ostenfeld
Ch. sociale Lauder
Ch. teres Cleve
Ch. sp.
Coscinodiscus centralis Ehrenberg
C. curvatulus Grunow
C. oculus-iridis Ehrenberg
C. sp.
Cossinosira polychorda Gran
Detonula confervacea (Cleve) Gran
Eucampia zodiacus Ehrenberg
Lauderia borealis Gran
Leptocylindrus danicus Cleve
Melosira moniliformis (Muller) Agardh
M. nummuloides Agardh
M. sp.
Pleurosigma sp.
Porosira glacilis (Grunow) Jorgensen
Rhizosolenia alata Brightwell
Rh. fragilissima Bergon
Rh. hebetata Bailey
Rh. shrubsolei Cleve
Rh. styliformis Brightwell
Skeletonema costatum (Grunow) Cleve

(continued)

Table 28. (continued)

Thalassiosira decipiens (Grunow) Jorgensen
Th. gravida Cleve
Th. nordenskioldii Cleve
Th. sp.

Pennate forms

Achnanthes taeniata Grunow
Amphiprora hyperborea (Grunow) Gran
Amphora sp.
Asterionella sp.
Cocconeis sp.
Fragilaria cylindrus Grunow
F. islandica Grunow
F. oceanica Cleve
Grammatophora marina (Lyngbye) Kutzing
Gyrosigma sp.
Licmophora sp.
Navicula vanhoffenii Gran
N. sp.
Nitzschia closterium (Ehrenberg) W. Smith
N. delicatissima Cleve
N. longissima (Brebisson) Ralfa
N. seriata Cleve
Rhabdonema minutum Kutzing
Rhoicosphenia curvata (Kutzing) Grunow
Stauroneis quadripedis (Cleve-Euler) comb. nov.
Striatella delicatula (Kutzing) Grunow
Thalassionema nitzschioides Hustedt
Thalassiothrix longissima Cleve & Grunow

(continued)

Table 28. (continued)

Dinoflagellates:

Armored

Arctiniscus pentasteria Ehrenberg v. arcticus Bursa
Ceratium arcticum (Ehrenberg) Cleve
C. fusus (Ehrenberg) Dujard
C. longipes (Bailey) Gran
C. tripos (Muller) Nitzsch
C. sp.
Dinophysis acuminata Claparede & Lachmann
D. lenticula Pavillard
D. norvegica Claparede & Lachmann
D. punctata Jorgensen
Exuviella baltica Lachmann
Glenodinium sp.
Minuscula bipes (Paulsen) Lebour
Oxytoxum sp.
Peridinium breve (Paulsen) Paulsen
P. cerasus Paulsen
P. conicoides Paulsen
P. curtipes Jorgensen
P. depressum Bailey
P. ovatum (Pouchet) Schutt
P. pallidum Ostenfeld
P. pellucidum (Bergh) Schutt
P. punctulatum Paulsen
P. pyriforme (Paulsen) Paulsen
P. saltans Meunier
P. sp.
Phalacroma rotundatum Claparede & Lachmann

Other flagellates:

Coccolithus pelagicus (Wallich) J. Schiller
Cryptomonas sp.
Diaphanoeca sp.
Distephanus speculum (Ehrenberg) Haeckel
Ebria tripartida (Schumann) Lemmermann
Eutreptia sp.
Halosphaera viridis Schmitz