SOME ASPECTS OF THE ECOLOGY OF BENTHIC INVERTEBRATES IN LONG POND, CONCEPTION BAY, NEWFOUNDLAND

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SOME ASPECTS OF THE ECOLOGY OF BENTHIC INVERTEBRATES IN LONG POND, CONCEPTION BAY, NEWFOUNDLAND

by

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ABSTRACT

The benthos of part of Long Pond, a lagoon separated by a barachois from Conception Bay, was studied quantitatively. Most of the bottom was covered by silt of high organic content. Six stations in differing substrata were sampled intensively and three communities described in the Petersen concept were recognized. The infaunistic Macoma-Mya and the epifaunistic Mytilus-Littorina communities, characterized by high biomass estimates, occupied about 5% of the study area. The infaunistic Polycirrus-Mya community covered an estimated 95% of the bottom and was characterized by a low biomass. The distribution of individual species was examined in relation to the sediment and substratum preferences correlated with particle size, organic content, compactness and depth of water were demonstrated in a number of species. The population of one station was sampled periodically over a year without detecting a gross seasonal change. The populations of individual species did fluctuate, balancing each other out over the year, and fluctuations were related to life cycles where possible. The temperature in the surface and bottom water of one station in Long Pond and in the surface water of Conception Bay followed a normal annual pattern whereas the dissolved oxygen, always near saturation, followed a pattern inverse to that of temperature. The salinity fluctuated widely in the surface water of Long Pond, especially during spring, but varied to a small extent in the bottom water and in the surface water of Conception Bay.

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I. INTRODUCTION

In the early part of this century, C. G. Joh. Petersen first put marine benthic investigations on a quantitative basis when he attempted to determine the quantity of fish food available for bottom fish in Danish waters. He observed regularly recurring combinations of certain animal types on wide areas of the sea bottom, and on this basis developed a concept of bottom communities. Each of these communities consists of a particular combination of macrofaunal species inhabiting an area of the sea floor. Areas characterized by different depths and sediments are inhabited by other combinations of species and the species which are most numerous, most conspicuous and most "characteristic" of the area in question are used to designate the community found therein. Petersen's communities must be regarded as statistical-descriptive units but whether they are ecological units is a point which is in dispute.

Petersen's community concept has since developed into the theory of "parallel level-bottom animal communities" as stated by Thorson (1955, 1956). Communities which are characteristic of particular depths and substrata occur in investigations from arctic to tropical waters forming chains of similar communities. In these "chains", the dominant genera usually remain the same but species within the same genus replace each other in accordance with latitude and temperature. In some cases, a genus may be replaced by another but they are both ecologically similar.

Since Petersen's pioneering efforts, there has been a considerable amount of work done in the field of marine benthic communities; however most of these investigations have been undertaken in European waters. A number of European workers have extended their studies to include the coastal waters of Iceland and East Greenland (Thorson, 1933; Spärck, 1933, 1937; Einarsson, 1941). Little work of this nature has been done on the North American side of the Atlantic. The investigation by Lee (1944) in the Menemsha Bight on the western end of Martha's Vineyard, Massachusetts, represents the first quantitative study of marine benthos on the east coast of North America. Hedgpeth (1954) reported a survey of bottom communities in the Gulf of Mexico but it was of a qualitative nature and dealt only with selected community types. It was not until the efforts of Sanders (1956, 1958, 1960) that the first truly comprehensive studies of marine benthos were undertaken on a quantitative basis on the western side of the Atlantic. Ellis (1959, 1960) has added information on benthic communities in arctic North America and McNulty et al (1962a, b) have commenced intensive investigations in the tropical waters about Florida. Peer (1963) has published a preliminary report on the benthos of the Magdalen Shallows in the Gulf of St. Lawrence. Nevertheless, our knowledge of the benthos in the waters about North America remains in a totally inadequate state.

All the above mentioned investigations have been concerned with more or less open waters. As will be shown at a later point, the present study deals with a sheltered environment similar to a lagoon. This type of environment figures in a small fraction of the quantitative benthic work that has been done. The study by Smidt (1951) of the Danish Waddensea stands out as an excellent example.

The substratum has been considered to play the role of a master factor in influencing many benthic animals, particularly infaunal species. This is especially true at times when the larvae settle out of the pelagic environment (Thorson, 1950, 1964). It has even been stated that because of our coarse methods, the animals may tell us more about the substratum than the substratum can tell us about the animals. It is not necessarily the texture of the soil per se that is of such paramount importance for the soil may merely be the expression of other factors. Nevertheless, the importance of this element cannot be underestimated and it is unfortunate that so many benthic investigations should have neglected an accurate description of the sediment when reporting on the community under study. Its importance is obvious from the fact that benthic species are, to varying degrees, limited in the sediment types in which they are found. In the literature, the variety of sediments in which individual species occur is frequently reported but little information is available on the sediment preferences of benthic species. It is not surprising that Petersen's communities are closely associated with sediment type.

Another facet of benthic study that has received little attention is possible seasonal changes in benthos. Although many individual species have been studied, especially those of commercial importance, few attempts have been made to consider an entire community from this point of view. The works of Steven (1930), Shimadzu and Yamane (1948), Kitamori (1950), Thorson (1950, 1964) and Blegvad (1951) have provided useful information on this subject.

Marine benthic communities in North American waters are poorly known. There is a general lack of information on the geographical distribution of community types with no records from Newfoundland waters. This study therefore attempts to describe in accordance with the Petersen concept the communities at one locality and to determine the position they occupy in the parallel level-bottom community hypothesis. Particular attention is paid to the relation of the communities as well as the individual species to the substratum. In addition, the population at one station is studied with regard to possible seasonal changes.

II. THE AREA INVESTIGATED

Long Pond was selected for the purpose of this study and is located approximately 12 miles west by south-west of the city of St. John's, Newfoundland. Figure 1 illustrates its position in relation to St. John's and Conception Bay. As evident from figure 2, Long Pond consists of two small bodies of water which are connected by means of a narrow channel. The entire complex opens into Conception Bay via a short channel at the extreme north-west end of the pond where a Texaco bulk depot is situated. Dredging operations in this channel and its immediate vicinity are periodically enlisted by the Texaco concern and the channel has been dredged in March, 1966, the fall of 1964 and in 1962.

Investigations were restricted to the eastern basin of Long Pond with the exclusion of the extreme north-east arm, for in the time available it was not feasible to study the entire area. A small stream emptied into this basin at its southern most end. However, this did not constitute a major and constant influx of fresh water insofar as the stream remained dry except in the spring and after periods of prolonged rain. On the other hand, the stream which emptied into the western basin did represent a significant and constant influx of fresh water. The eastern basin serves as a harbour for the Royal Newfoundland Yacht Club whose members moor boats over the north west half of the pond during the spring, summer and fall months. This group has undertaken dredging operations in the area but only of a limited nature. Dredging services

FIGURE 1. The Avalon Peninsula

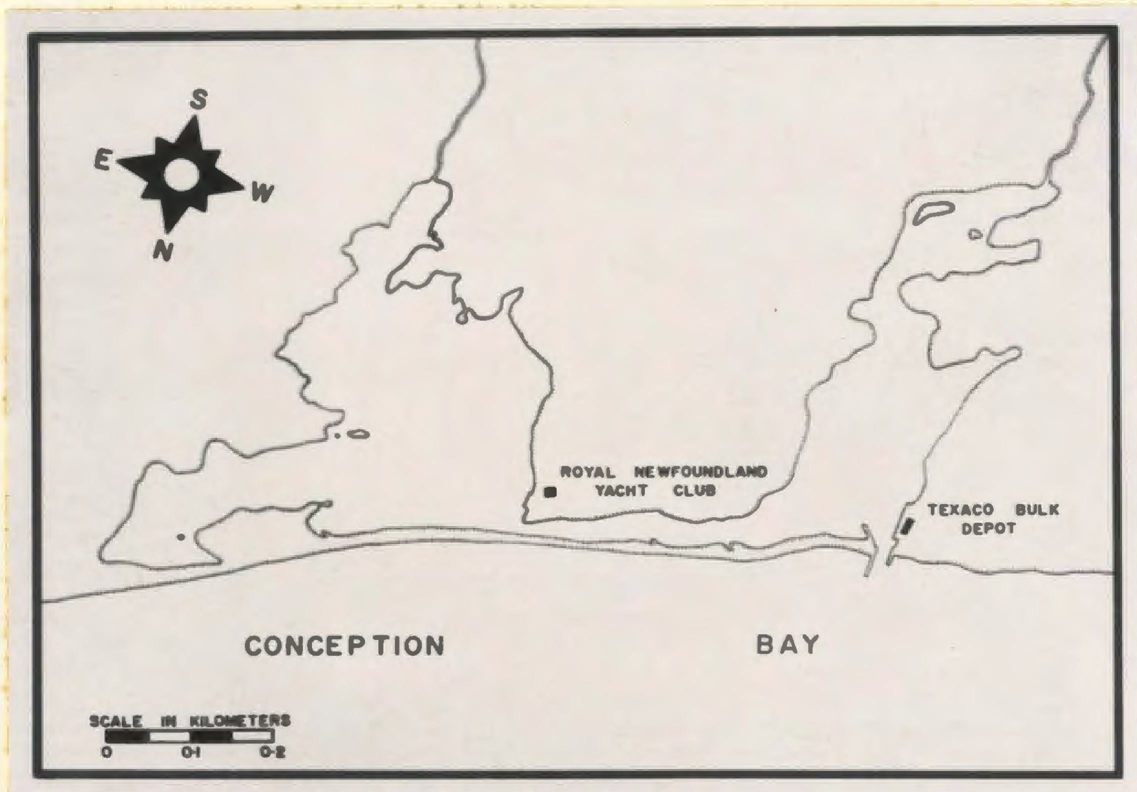

FIGURE 2. Long Pond.

were enlisted at the same time as those of the Texaco concern but they were restricted to the immediate vicinity of the pier by the club house and the channel connecting the two basins.

III. METHODS AND MATERIALS

1. Description of Long Pond

A chart of the area was constructed by tracing an enlarged projection of an aerial photograph (R. C. A. F., A 17079-13) of that part of the shore of Conception Bay in which Long Pond is located. To ascertain its scale, a distance of one hundred meters was measured and marked out along a straight portion of the north west shore of the pond. At a known reference point, the angle between the ends of the hundred meters was determined by means of a pocket sextant in order that the measured distance might be transferred to the chart. To fix the location on the chart, the angle between one of the ends of the hundred meters and a second known reference point was also measured.

A chart of the depth contours of Long Pond was drawn up from depth soundings taken at the fifty stations indicated in figure 3. The sounding line was marked off in twenty-five cm. intervals and was calibrated to compensate for "stretch" when wet. The stations were selected at intervals which varied from about 50 to about 150 meters depending upon whether a change in depth was suspected. As each sounding was taken, the time was recorded and the station was marked with a buoy. After a number of soundings were taken, the angle between each buoy and a shore reference point was determined at two shore reference points with a pocket sextant. This procedure enabled the positions of the stations to be plotted accurately and was adhered to in all sub-

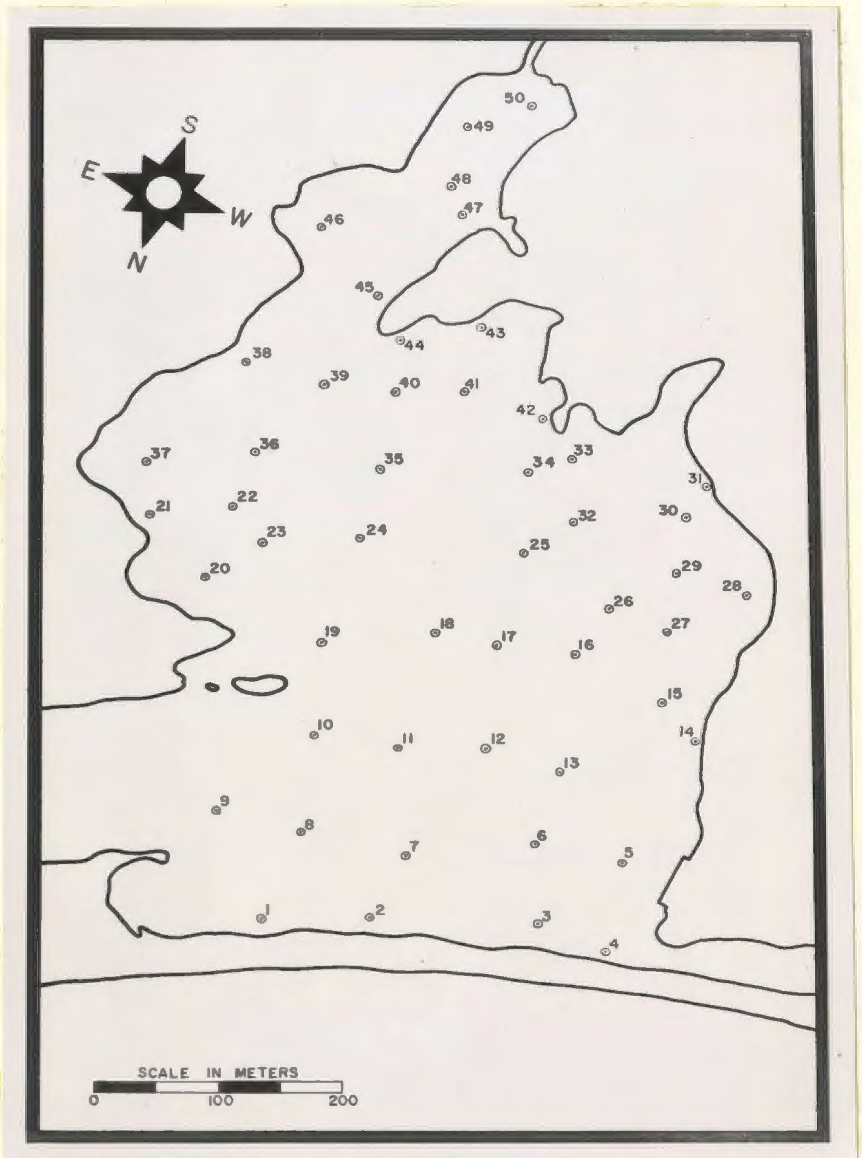

Figure 3. Location of sounding sites

sequent determinations of the positions of sampling sites. A tidal correction factor to be applied to the tidal data for St. John's in order to render it applicable to Long Pond was obtained from the Canadian Hydrographic Service. Tidal data for St. John's, Newfoundland, was obtained from "Tide and Current Tables, Atlantic Coast - Canada". Since the time and date of each sounding was recorded, it was then possible to correct them by calculation to depths at average high tide for 1965. The data could then be transferred to a chart to permit the drawing of depth contours.

The area of the part of Long Pond that was under study was determined by tracing the chart on graph paper and summing the squares within the area in question. This procedure was also adopted to calculate areas enclosed by depth contours.

At approximately monthly intervals, measurements of the environmental parameters of temperature, dissolved oxygen concentration, salinity and density were taken in both Long Pond and Conception Bay. In Long Pond, measurements were made at station 4, see figure 6, in both surface and bottom water; in Conception Bay, they were taken at the shore across the spit from the pond.

Bottom water samples were obtained with a standard modified Kemmerer water sampler which is illustrated by Welch (1948 p. 200). Water samples for dissolved oxygen concentration determinations were fixed in the field by adding the prescribed amounts of manganous sulphate reagent and alkaline iodide solution followed by concentrated sulphuric acid. This procedure stabilized the samples for transport to the laboratory where they were immediately analysed by means of the Winkler titration as described by Strickland and

Parsons (1960). Salinity samples were returned to the laboratory where they were sealed with parafin and stored until it was convenient to analyse them by the high precision method outlined by Strickland and Parsons (1960). Density measurements of the surface water at the two stations were obtained by means of a hydrometer.

It was intended to take samples of the sediment of Long Pond by means of a vertical corer in order that the sediment could be sampled uniformly to a pre-determined depth. For this purpose, the vertical core sampler described by Welch (1948, p. 182) was constructed by the Technical Services Department. However, the sediment was too soft to be retained by the sampler upon its withdrawal from the bottom and samples were therefore obtained by means of the Ekman dredge figured by Welch (1948, p. 176). This increased the incidence of sampling error insofar as the sediment could not be sampled uniformly to a known depth. Therefore, if the sediment varied with depth, results of analyses could be expected to be distorted to a certain degree. This is especially true with respect to the organic content of the sediment. The recently deposited organic detritus of surface sediments would not have had as much time to decompose as that of deeper sediments and therefore, the organic content of the surface sediments could be expected to be higher than that of deeper sediments. Under such sampling circumstances, all sediment analyses should be repeated a number of times and the results averaged; however, the time factor rendered such a procedure impractical.

Forty sediment samples were taken at the stations indicated in figure 4. Each time sediment was recovered from a station,

Figure 4. Sediment sampling sites

the dredge was emptied into an enamel pan where its contents usually retained the shape of the inside of the sampler. Sufficient sediment to fill an eight ounce jar was then removed from the side of the sample, care being taken to collect the sediment uniformly throughout the entire depth of the sample. This procedure was followed to minimize the error introduced by sampling different depths to varying degrees. All samples were returned to the laboratory to be dried at 60°C prior to storage.

Two analyses were carried out on each sample, a determination of the organic content and a determination of the particle size fractions. The dried samples were crushed with a mortar and pestle and approximately ten grams were removed from each for organic content determination, the remainder being set aside for the second analysis. The ignition loss at 500°C was taken as an estimate of the organic content of the sediment. This technique was employed largely as a matter of convenience insofar as it was far less time-consuming than the standard titration methods such as the one refined by Schollenberger (1927, 1931, 1945) and it did not require specialized apparatus. Ignition methods for organic content determination are commonly preceded by the removal of inorganic carbonates with acid (Cummins, 1962). However a temperature of 500°C was not high enough to break down carbonates although sufficient to oxidize all but negligible amounts of organic matter (Ellis, 1960). The most serious error inherent in the technique lies in the fact that ignition is accompanied by loss of constitutional water from silts and clays (Cummins, 1962).

The grades used in the analysis of particle size fractions are essentially those of the Wentworth Size Classification which are presented by Krumbein and Pettijohn (1938). Due to the distribution of the sediment types, it was found necessary to modify this classification as shown in table 1. The grades medium sand to pebble were incorporated into one grade because the transition of the sediment through these classes took place over a small part of the area studied. Furthermore, since such a large area of the bottom was covered with sediment that fell into the "silt" category, this grade was sub-divided into coarse, medium and fine silts.

TABLE 1

Wentworth's classification of soil particle grades with modifications

Grade Limits (mm.)	Wentworth's Classification	Modifications
above 256	boulder	boulder
64 to 256	cobble	cobble
4 to 64	pebble	medium sand to pebble
2 to 4	granule	
1 to 2	very coarse sand	
0.5 to 1	coarse sand	
0.25 to 0.5	medium sand	
0.125 to 0.25	fine sand	fine sand
0.0625 to 0.125	very fine sand	very fine sand
0.0312 to 0.0625	silt	coarse silt
0.0156 to 0.0312	silt	medium silt
0.0078 to 0.0156	silt	medium silt
0.0039 to 0.0078	silt	fine silt
0.00195 to 0.0039	clay	clay
0.00098 to 0.00195	clay	clay

The determination of particle size fractions of sediment samples was carried out in two phases, a sieve analysis of particles with diameters greater than 0.0625 mm. using the procedure outlined by Krumbein and Pettijohn (1938) and a pipette analysis of particles with diameters less than 0.0625 mm. employing the technique presented by Olmstead et al (1930) and Krumbein and Pettijohn (1938).

In preparation for analysis, each dried sample was crushed, mixed and divided into two portions of approximately 25 gm. each which were then heated to constant weight at 60°C. The samples were weighed and placed in beakers. One hundred ml. of 0.01N sodium oxalate solution, used as a dispersing reagent, was added to each beaker and the samples were allowed to stand for a period of 48 hours. To effect complete dispersion, each sample was placed in a Waring Blender for a length of time that depended upon whether the sediment was a silt or a sand. Bouyoucos (1932) recommends the use of a mechanical stirrer but cautions that too long stirring tends to break down sand particles. He advises that sand be kept in a blender for not longer than five minutes and silts and clays for not less than ten minutes; however, if the latter possess a high organic content, he recommends twenty minutes or longer. Therefore, sands were dispersed in the blender for five minutes and silts for thirty minutes. Following this treatment, portions of the samples were examined under a binocular microscope to check whether dispersion was complete.

In the sieve analysis, sieves of the series prescribed by the American Society for Testing Materials with mesh diameters corresponding to the grade limits of Wentworth's size classification were used. A dispersed sample was washed through the series of sieves with tap water and the washing was continued until the water running through the sieves was clear. The residue in each sieve was removed, washed with distilled water and dried at 60°C to constant weight. The percent of the total that each fraction represented could then be calculated.

For thepipette analysis, a sample was removed from the blendor, placed in a cylinder and its volume made up to 1 liter with 0.01N sodium oxalate solution. After an initial stirring, 20 ml. aliquots were removed from the prescribed depths at the prescribed times in accordance with the procedure outlined by Krumbein and Pettijohn (1938). The aliquots were heated to constant weight and the percent of the total that each fraction represented was calculated. By staggering the time at which analyses were started, it was possible to run four analyses concurrently.

The size fractions in percentages were plotted in histograms such as the example shown in figure 5. A sediment was classified by the grade in which the mode of its percentage distribution fell. When the difference between the amount of material in the "mode" grade and that in either of the two adjacent grades was equal to or greater than 3% of the total amount of sediment, the sediment was classified by one grade. However, where the difference between the "mode" grade and an adjacent grade was less than 3%, the sediment was classified by both grades. Such samples represented transitions between two grades and were described as such.

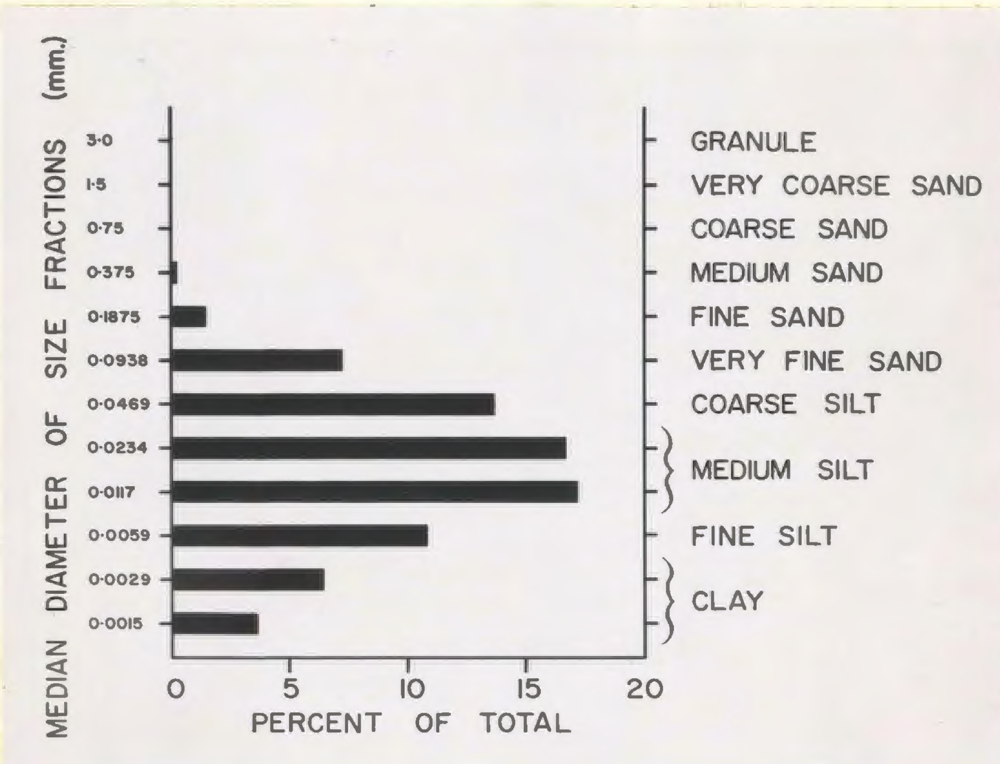

FIGURE 5. The results of a size fraction analysis of a sample from station 14 and its classification as a medium silt.

2. Sampling of Benthos

Two aspects of the benthos of Long Pond were investigated in the course of this work. One was the relation of benthos to sediment and the other, possible seasonal changes in the benthic fauna of one station.

All benthic sampling was conducted by means of the Ekman dredge which sampled a square area of 225 $cm.^2$ and retained a maximum volume of 4 liters. To avoid the hazard of sieving under field conditions which greatly reduce efficiency, all samples were placed in plastic bags in their entirety and immediately upon return to the laboratory, sufficient formaldehyde was added to produce a concentration of approximately 10%. Samples could then be sieved at leisure through a single screen possessing 7 meshes per cm. with the spaces between the meshes being approximately 0.5 mm. in diameter. The residue on the screen was then sorted and all animals found, identified, recorded and preserved in 70% ethyl alcohol.

Quantitative benthic sampling is greatly impaired by uneven penetration of the commonly used samplers to all depths of the substratum (Birkett, 1958) and by differences in the depth of penetration due to differences in the hardness of the sediment (Ellis, 1960; Peer, 1963). Samplers of the Van Veen and Petersen types remove from the substratum a sample which is approximately semicircular in cross-section; therefore, within the limits of the depth of penetration, they sample the surface sediment to a greater extent than the deeper sediment (Birkett, 1958). This error is reduced by the use of an Ekman dredge insofar as when it is full, the cubical body of the apparatus recovers 85% of the sample whereas the jaws, which are the source of the error, only 15%.

Although Thorson (1957) recommends the use of $0.1m^2$ ($1000\ cm^2$) units in benthic sampling at all depths from 0 to 200 m, the Ekman dredge which sampled a square area of only $225\ cm^2$ was found to be adequate. The distribution of the animals in the area investigated was exceptionally uniform and therefore, it was not necessary to sample a larger area. Brady (1943) maintains that benthic samples in intertidal muds and sands be taken to a depth of 12 in. (30.5 cm.) in order that all deeply burrowing forms might be included. However, in this study, few deeply burrowing forms were encountered. Mya arenaria is one such form but large individuals which would burrow to the greatest depths were never found despite efforts to locate them by digging beyond the depth of penetration of the dredge. Macoma balthica, another frequently encountered burrowing form that might range below the depth sampled, appears to inhabit depths of 7 to 12 cm. (Emery et al, 1957, after Thamdrup, 1935) which are well within the range of the apparatus used. Nereis virens constitutes perhaps the most serious source of error in this regard for it has been reported to inhabit depths from 7 to 45 cm. (Pettibone, 1963). Therefore, it might be concluded that the Ekman dredge was adequate to sample the environments studied.

To study the relation of the benthos to sediment, six stations whose positions are indicated in figure 6 were selected to represent different substrata. Station 1 which was occasionally exposed by exceptionally low tides was situated in a coarse silt containing a considerable amount of poorly decomposed organic matter.

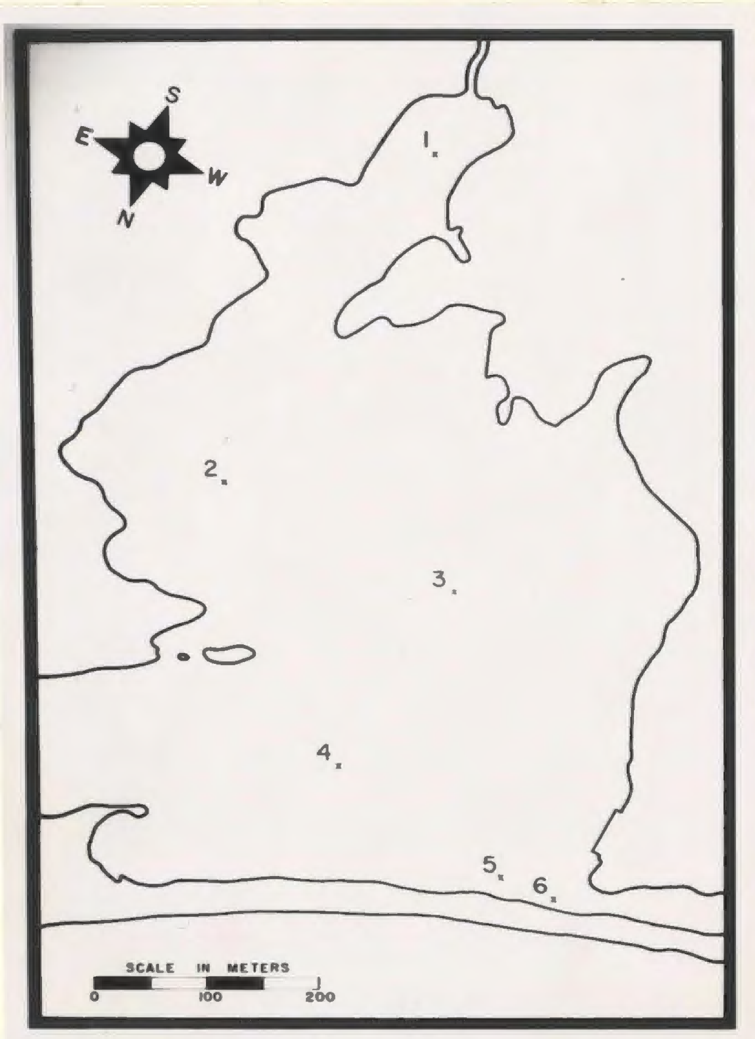

FIGURE 6. Location of benthic sampling sites

Stations 2 and 3 were both located in medium silt; however, station 2 was situated in a bed of Zostera marina; whereas no noticeable vegetation was observed in the vicinity of station 3. The sediment of station 4 was classed as a very fine sand. Station 5 was located in fine sand and station 6 in cobble.

A total of ten random samples were taken at each station. All samples were taken by diving to the bottom with the dredge rather than by lowering the dredge from a boat and tripping it with a messenger. This was done to insure that the dredge took the maximum amount of sample thereby eliminating the error introduced by variation in the depth of penetration with hardness of sediment. The samples were processed in the above outlined manner but in addition to taxonomic and numerical data, the dry weight of each species was recorded. This was obtained by cleaning the animals of all adhering detritus and heating them to constant weight at 60°C.

The area selected for a benthic study on a seasonal basis was that of station 4 in figure 6. Samples were taken at approximately monthly intervals commencing in October, 1964, and concluding in November, 1965. However, there was a six week period through February and part of March, 1965, during which ice conditions prohibited field work. On each occasion, five samples were taken and processed in the above outlined manner although dry weight determinations were not undertaken. Due to weather conditions in winter, diving for samples was not practical; therefore, all samples were taken by lowering the dredge from a boat which resulted in the dredge's not taking a maximum volume of sample.

This increased the error arising from uneven penetration at all depths in that the amount of sample in the jaws was then proportionally greater in relation to the total recovered than in cases when the sampler took the maximum volume of sample. This procedure also increased the variation in the total amount of sediment taken per sample. However, the latter source of error was minimized by the fact that samples were taken from the same area and by the same person throughout the program. Furthermore, since most of the species live near the surface of the sediment, the error was not considered to be serious.

IV. RESULTS AND DISCUSSION

1. Description of Long Pond

a) Geological Background

Long Pond is situated over a precambrian bedrock of the Avalon Granite Complex (Nfld. Dept. Mines and Resources, geological map). Overlying the bedrock in the immediate area are Pleistocene outwash deposits of gravel, sand and silt (Geological Survey of Canada, map of surficial geology).

The bar formation or barachois which separates Long Pond from Conception Bay consists of boulder and cobble which grade down to the water line to cobble, pebble, granule and sand. Geologically this formation is a combination spit and barrier beach (H. D. Lilly, pers. com.) which superficially resembles the Nehrungen that Williams (1960) describes from the Baltic. It originated from a deposition of glacial moraine which blanketed the area and consisted of Holyrood granites, Harbour Main volcanics and some rocks of the sedimentary Conception group. This material was unsorted consisting of all size groups but wave action commenced to remove the finer fractions depositing them in the deeper parts of the bay. It is believed that some of this fine material was deposited along the shore by currents acting in a north west direction resulting in sandy spit development. Heavy storms from the north east are thought to have moved in the coarser material piling it up to form the barrier on top of the spit.

b) Morphometry and Tide

Morphometric data for that part of Long Pond that was under study was calculated in accordance with the methods and definitions outlined by Welch (1948) and is presented in table II. Maximum and mean depths and volume were calculated to be those at both average high and average low tides.

TABLE II

Morphometric Data for Long Pond

MORPHOMETRIC CHARACTERISTIC		EVALUATION
maximum length		890 m
maximum width		755 m
mean width		346.5 m
area		261,636 m^2
maximum depth	high tide	4.6 m
	low tide	3.8 m
mean depth	high tide	2.7 m
	low tide	2.2 m
volume	high tide	705,280 m^3
	low tide	509,527 m^3

A chart of the depth contours of the pond is presented in figure 7 in which isobaths are drawn at one meter intervals and depths are given with respect to the average high tide for the year 1965. From figure 7, it is evident that the greater part of the bottom of the pond is level and lies between the 3 and 4 meter isobaths. Along the north and west shores, the bottom drops to this level rapidly; however, along the east and south shores, the bottom levels off more gradually to the 3 to 4 meter "plain". The south arm of this basin is shallow with the result that a large part of its extreme south end is exposed at low tide.

FIGURE 7. Depth contours of Long Pond drawn at one meter intervals with respect to mean high tide.

The average tidal difference in the pond over the year 1965 was calculated to be 0.8 meters. This difference in water level represents a change of 198,753 m^3 in the volume of water in the basin which constitutes 28% of the total volume at average high tide. A prime implication of such a large change in volume over a single tidal cycle is the fact that brackish water conditions of very low salinity will not be able to be established. Four tidal cycles flush out a volume of water which is greater than the volume within the pond. Therefore, fresh water influx into the basin will be rapidly replaced by more saline water. Furthermore, such a large change in volume will obviously be accompanied by strong tidal currents particularly in the region of the channel which drains the basin. The current is strongest in the channel and diminishes as the channel opens out into the basin. The manner in which the strength of the current diminishes is expected to be reflected by the sediment map of the area insofar as current velocities determine the size of particles that will settle out to the bottom.

c) Seasonal Variation in some Environmental Factors

A detailed account of the measurements of temperature, dissolved oxygen, salinity and density which were taken from October 1964 to November 1965 is presented in appendix I.

Figure 8 summarizes the results of temperature and dissolved oxygen determinations. Although the number of observations is quite limited, they nevertheless indicate trends and differences that would be expected in a comparison between a large and a small body of water. The surface water of Long Pond, the small body of

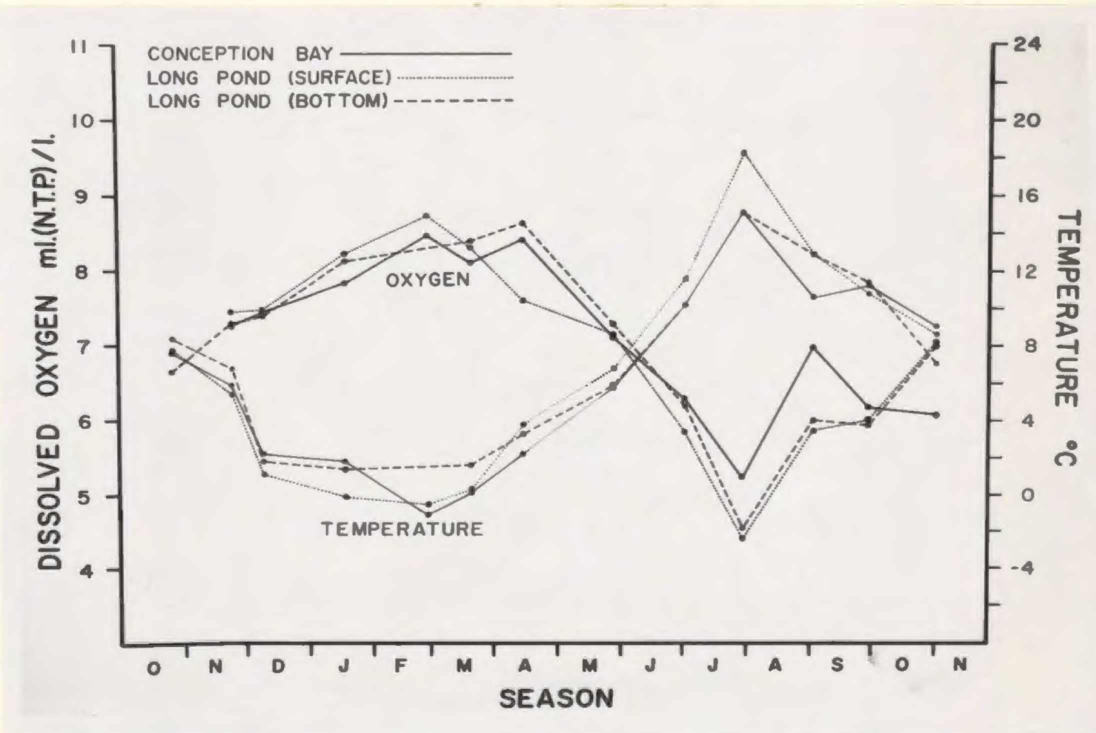

FIGURE 8. Seasonal trends in the dissolved oxygen content and temperature of the surface and bottom waters of Long Pond and the surface water of Conception Bay.

water, warms more rapidly in the spring and cools more rapidly in the fall. In following air temperatures more closely than the surface water of the bay, the surface water of Long Pond reaches higher temperatures in the summer and falls to lower temperatures in the winter. Surface waters are expected to show greater seasonal ranges than deeper waters (Sverdrup et al, 1942) and Long Pond conforms with a range of 18.75 C° in the surface water and one of 13.7 C° in the bottom water. The temperature range of the surface water of Conception Bay, 16.1 C°, was less than that of the surface water of the pond but greater than that of the bottom water of the pond.

Dissolved oxygen determinations yielded results that followed seasonal trends which were inverse to those observed for temperature. When compared with data presented by Sverdrup et al (1942), it was found that the results of the titrations closely approximated those of saturated sea water. This indicates that both the bottom and the surface water at station 4 in Long Pond and the surface water of Conception Bay are normally saturated or almost saturated with oxygen. Therefore, the inverse relationship is a product of the effect of temperature on the solubility of oxygen in water, solubility decreasing with increasing temperature. The differences in the dissolved oxygen content of the three water strata that were sampled may be ascribed primarily to differences in both temperature and salinity since salinity as well as temperature control the solubility of oxygen in water (Sverdrup et al, 1942).

Figure 9 summarizes the results of the salinity measurements. The greatest variation in salinity was observed in the surface

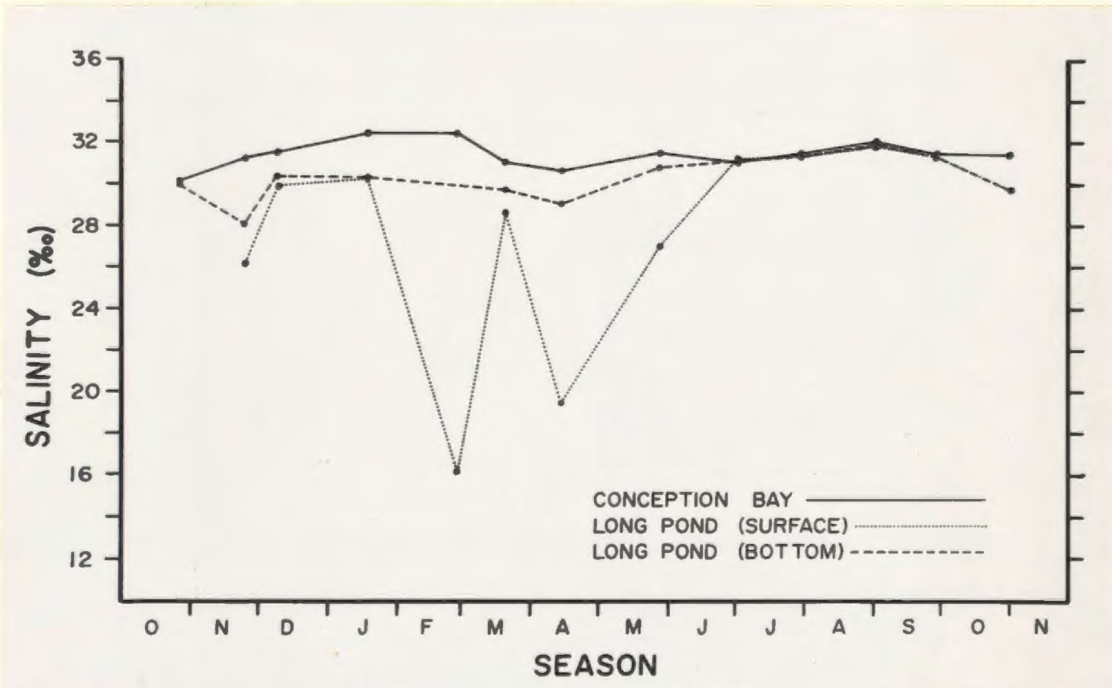

FIGURE 9. Seasonal trends in the salinity of the surface and bottom water of Long Pond and the surface water of Conception Bay.

water of Long Pond. Such a result was expected because the salinity of this water was subject to reduction through dilution by not only precipitation but also run-off from the land. The salinity of the surface water of Conception Bay also varied through the action of these two agencies. In the case of the latter factor, terrestrial run-off was not concentrated into a small area as in Long Pond; therefore the influence of this factor can be expected to be less severe. Changes in the salinity of the bottom water of Long Pond and, to a certain degree, its temperature followed a pattern which was more akin to that observed in the surface water of Conception Bay than that in the surface water of Long Pond. At station 4, the bottom water may be said to be similar to that of Conception Bay. Fresh water added to Long Pond either by precipitation or terrestrial run-off may be expected to affect primarily the surface water in that by its reduction of the salinity of this water, the fresh water also reduces its density and hence, renders it all the less likely to mix with deeper water. However, that there was some mixing between these two layers is attested to by the fact that the salinity of the bottom water tended to be less than that of the surface water of Conception Bay.

As was expected, the greatest fluctuations in salinity were observed during the spring, a time at which fresh water influx is greatest due to the melting of snow. During the summer, no marked changes in salinity were observed and analyses of samples taken on the same day from the three positions yielded results which were very close to each other. The lack of fluctuation and the similarity of the salinities of the three positions is attributed to the fact that precipitation was abnormally low during the summer in which observations were made.

The density of the sea water could be more accurately determined by calculation from temperature and salinity than by measurement with the instrument that was available, especially since the observations were made under field conditions. However, salinity samples were kept for a considerable length of time before titration and therefore, the measurements were useful as a rough corroboration of the titrations. The density measurements, presented in table 4 of appendix I, are in agreement with the results of the salinity titrations.

d) Sediment

The results of the sediment analyses are presented in figures 10 and 11. Figure 10 shows a low organic content in the sediment of the channel and a rapid increase as the channel opens into the basin with the greater part of the bottom being covered by sediment of high organic content. This pattern reflects the currents in the basin insofar as strong tidal currents such as those in the channel and the immediate area about its mouth prevent organic detritus from settling to the bottom and in so doing preclude the accumulation of a sediment with a high organic content. The increase in the organic content of the sediment in a south-easterly direction reflects a decrease in the strength of the currents.

Similarily as evident in figure 11, changes in the sediment as regards to particle size composition reflect diminishing current strength over the basin in a south-easterly direction. The fact

FIGURE 10. The organic content of the sediment of Long Pond as estimated by ignition loss.

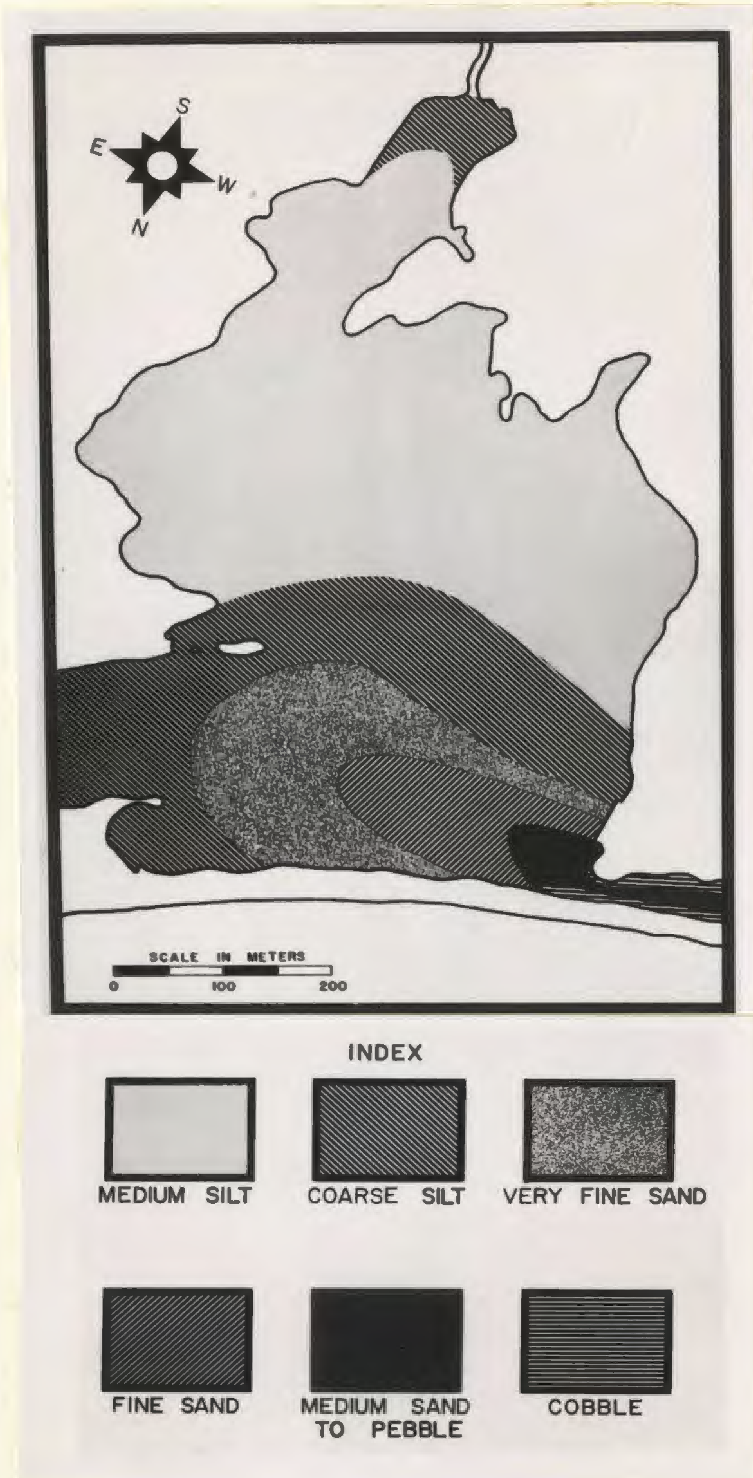

FIGURE 11. The distribution in Long Pond of sediments classified with respect to particle size.

that coarse sediments are located in the channel and the immediate area of its mouth indicates strong currents in that area. Since in the order of three quarters of the basin is covered with silt and most of it medium silt, it is safely assumed that only weak currents prevail over most of the area studied.

e) The Flora of the Area Studied

The distribution of the predominant floral form, Zostera marina, as illustrated in figure 12 was charted in an approximate manner insofar as the limits of the eel grass beds were not determined with a sextant. The pattern of this plant's distribution was observed in the course of snorkel and scuba diving over the entire basin throughout the summer of 1965 and on the basis of such observations, figure 12 was drawn. With the exception of Zostera, the flora of the basin was observed to be sparse. An occasional Laminaria sp. was noted in the north west end of the pond; however, most of these were not attached to the substratum and therefore believed to have been washed in by the tide. Small clumps of filamentous algae were not infrequently found on the bottom. Scirpus americanus (?) was abundant along the shore about the mouth of the stream that emptied into the south arm of the basin.

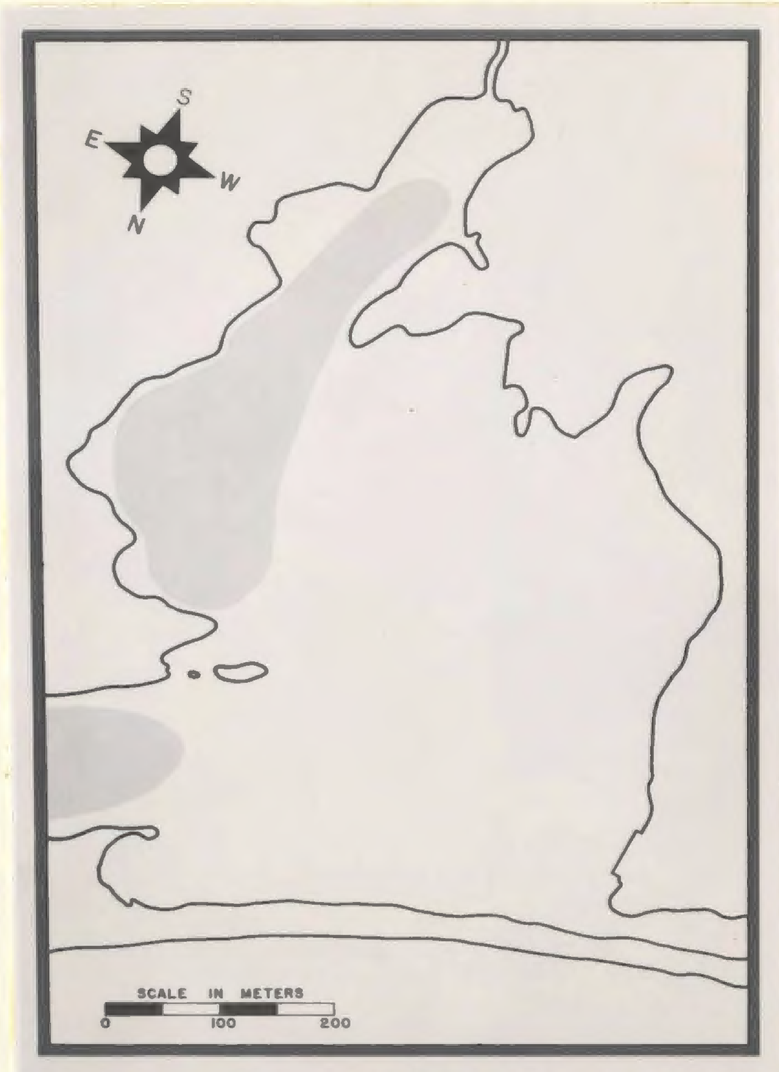

FIGURE 12. The distribution of <u>Zostera marina</u> in Long Pond.

2. Distribution of Benthos in Relation to Sediment

a) Stations Sampled and an Evaluation of Sampling

The sediment class, ignition loss and macro-vegetation at each of the six stations that were sampled are presented in table III. Also included are the dates on which the stations were sampled.

TABLE III

Sediment and vegetation characteristics of the stations sampled and dates of sampling

STATION	SEDIMENT CLASS	IGNITION LOSS %	MACRO-VEGETATION	SAMPLING DATE 1965
1	coarse silt	15 - 20	nil	16 Aug.
2	medium silt	20 - 25	*Zostera marina*	18 Aug.
3	medium silt	20 - 25	nil	16 Aug.
4	very fine sand	10 - 15	nil	26 Aug.
5	fine sand	5 - 10	nil	23 Aug.
6	cobble	0 - 5	nil	11 Sept.

The sediment at station 1 to 4 was soft which enabled the dredge to take a maximum volume with each sample. However at station 5, the sediment was hard and although every attempt was made to manually push the dredge into the substratum to a point where it would recover its maximum volume, an efficiency of 80% was the greatest that could be obtained for the sampler. Station 6, located in a substratum of cobble, was extremely difficult to sample. Despite the fact that scuba was used to provide the author with more time to work the dredge into the bottom, an efficiency of only about 40% was the highest that could be obtained for the apparatus.

In an attempt to determine whether a sufficient number of samples had been taken to capture all the characteristic species at each station, the cumulative total of species collected was plotted against the number of samples taken at each station. Such a curve is expected to rise rapidly and level off at a point where all the common species have been taken, rising more gradually thereafter as rare species are included. Figure 13 presents the curves obtained for the six stations and indicates that all the common species had been taken in each case. Such a measure of the sampling is applicable only to species which are susceptible to capture by the technique used. However, it may be safely assumed that all infaunal species could be captured since they inhabited depths within the sampling range of the dredge and were not sufficiently mobile to avoid the sampler. Most epifaunal species were also susceptible to capture since they lived attached to the substratum or moved too slowly to be able to avoid the dredge. However, some crustaceans, particularly amphipods and the decapod _Crago septemspinosus_ were sufficiently mobile to escape the dredge.

b) Classification of Benthic Communities

Two principal and ecologically different groups of benthic marine animals are commonly recognized, the epifauna living upon the substratum and the infauna living within the substratum. In the literature, benthic communities are commonly referred to as epifaunal and infaunal; therefore the classification of benthos must begin with a division of the fauna into epifaunal and infaunal types and proceed by treating each group separately.

Thorson (1957), reviewing the literature on the bottom communities

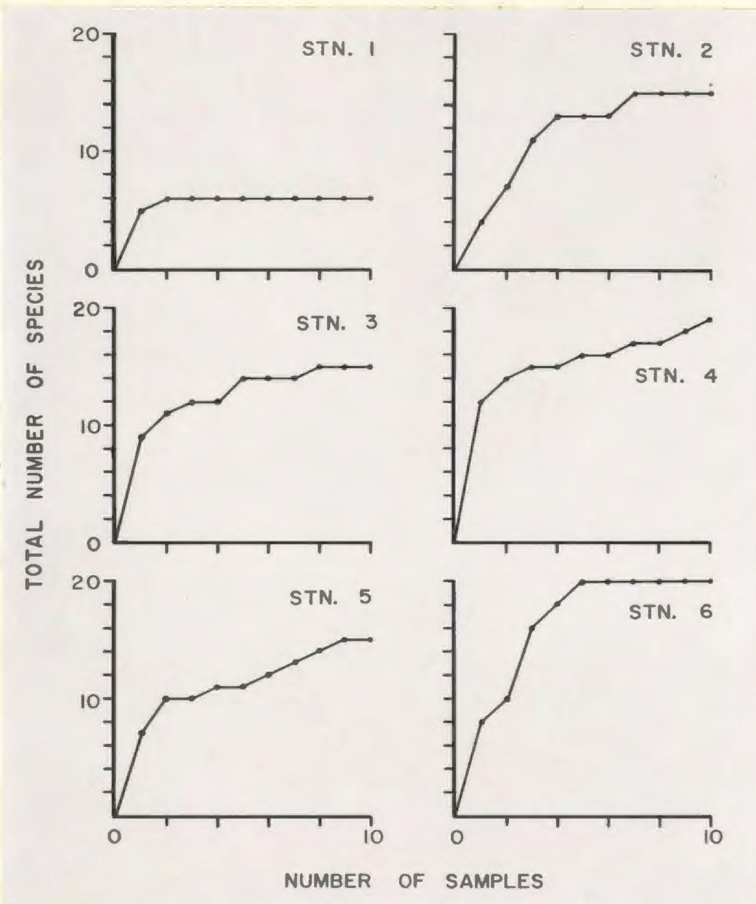

FIGURE 13. The effectiveness of the sampling at each station as measured by plotting the cumulative total of species collected against the number of samples taken.

of the Petersen concept, states that their characterization must be based upon a combination of species of different taxonomic groups and preferably of different feeding types. Characterizing species must be immediately conspicuous, a fact which imposes size limitations on the organisms. They must be present in at least 50% of the samples and comprise no less than 5% of the total biomass. Ideally, a community is described by the two most characteristic species, but in fact they are commonly designated by the dominant species and a list of associated species is included in the description. Animals which are predatory, short-lived, highly mobile or ubiquitous in their distribution must be avoided as characterizing species insofar as they cannot be readily identified with one community (Thorson, 1957).

A summary of the epifaunal species collected at the six stations is presented in tables IV and V which tabulate the means of both numbers and dry weights for each species collected. A more detailed tabulation of the epifauna is presented in appendix II.

The epifauna of stations 1 to 4 was impoverished being represented by only six species. The amphipod, *Gammarus lawrencianus*, was the only epifaunal species collected at station 1 but only one individual was taken. The epifauna of station 2 consisted of three species, the polychaetes *Harmothoë imbricata* and *Pholoë minuta* and the amphipod *Corophium bonelli*; however, their combined average dry weight represented less than 1% of the total average dry weight of the fauna at that station. In addition to the three species collected at station 2, the epifauna of station 3 included *Nereis pelagica*; however only one individual was collected in the ten samples taken at that station. The polychaetes *H. imbricata* and *P. minuta*, the

TABLE IV

Epifauna - Mean Numbers per sample with standard error given in brackets

SPECIES	STATION 1		2		3		4		5		6	
POLYCHAETA												
Lepidonotus squamatus	0		0		0		0		0		0.2	(0.14)
Harmothoë sp.	0		0		0		0		0		0.4	(0.23)
Harmothoë extenuata	0		0		0		0		0		0.3	(0.15)
Harmothoë imbricata	0		0.1	(0.10)	0.8	(0.42)	0.1	(0.10)	1.8	(0.51)	5.0	(1.04)
Pholoë minuta	0		0.5	(0.17)	0.4	(0.22)	2.9	(1.71)	0.3	(0.15)	0.3	(0.15)
Nereis pelagica	0		0		0.1	(0.10)	0		0		0.6	(0.31)
CRUSTACEA												
Balanus balanoides	0		0		0		0		0		0.3	(0.22)
Gammarus lawrencianus	0.1	(0.10)	0		0		0		0		0	
Corophium bonelli	0		0.3	(0.22)	19.7	(4.18)	11.1	(1.56)	30.0	(3.75)	23.1	(4.96)
GASTROPODA												
Acmaea testudinalis	0		0		0		0		0.5	(0.31)	13.3	(1.20)
Littorina littorea	0		0		0		0		0.6	(0.27)	2.9	(0.31)
PELECYPODA												
Mytilus edulis	0		0		0		0		0.1	(0.10)	6.9	(1.26)
Anomia simplex	0		0		0		0		0		2.2	(0.66)
Anomia aculeata	0		0		0		0		0		0.3	(0.15)
Hiatella arctica	0		0		0		0.1	(0.10)	0		8.5	(2.86)
ECHINODERMATA												
Strongylocentrotus droebachiensis	0		0		0		0		0		0.2	(0.14)
ASCIDIACEA												
Ascidiacea	0		0		0		0		0		0.1	(0.10)

TABLE V

Epifauna - Mean Weights per Sample

SPECIES	STATION 1	2	3	4	5	6
POLYCHAETA						
Lepidonotus squamatus	0	0	0	0	0	0.0002
Harmothoë sp.	0	0	0	0	0	0.0028
Harmothoë extenuata	0	0	0	0	0	0.0023
Harmothoë imbricata	0	0.0001	0.0005	<0.0001	0.0030	0.0361
Pholoë minuta	0	0.0004	0.0002	0.0005	0.0002	0.0007
Nereis pelagica	0	0	0.0003	0	0	0.0471
CRUSTACEA						
Balanus balanoides	0	0	0	0	0	0.0111
Gammarus lawrencianus	0.0001	0	0	0	0	0
Corophium bonelli	0	<0.0001	0.0033	0.0021	0.0048	0.0030
GASTROPODA						
Acmaea testudinalis	0	0	0	0	0.0016	0.1240
Littorina littorea	0	0	0	0	1.8877	6.6640
PELECYPODA						
Mytilus edulis	0	0	0	0	0.0006	8.3610
Anomia simplex	0	0	0	0	0	0.0800
Anomia aculeata	0	0	0	0	0	0.0110
Hiatella arctica	0	0	0	0.0001	0	0.2307
ECHINODERMATA						
Strongylocentrotus droehbachiensis	0	0	0	0	0	2.2106
ASCIDIACEA						
Ascidiacea	0	0	0	0	0	0.0031

amphipod C. bonelli and the pelecypod Hiatella (Saxicava) arctica were the only epifaunal species collected at station 4. In view of the paucity of the epifauna of these stations, it was considered pointless to attempt any classification of it. This impoverished state of the epifauna is in good agreement with the nature of the sediment insofar as a soft substratum does not lend itself to colonization by epifaunal species.

The epifauna of station 5 was also somewhat impoverished in that it was represented by only six species most of which were not numerically abundant. Despite the fact that it occurred in only 40% of the samples, the gastropod Littorina littorea was the most conspicuous epifaunal species insofar as it constituted over 95% of the biomass in the samples in which it was taken. Harmothoë imbricata was an important member of the epifauna in that it was a very constant species, occurring in 80% of the samples taken at this station. Corophium bonelli was also constant and was well represented numerically in each sample; however the fact that its abundance varies markedly with season precludes its use as a characterizing species.

All the epifaunal species collected at station 5 were also encountered at station 6. Furthermore, with the exception of C. bonelli and P. minuta, they were collected in greater numbers at station 6. Littorina littorea, the most conspicuous epifaunal element of station 5, was the second most characteristic species of station 6. Therefore, it would appear that station 5 is located along the limit of the epifaunal community that is present at station 6.

The epifauna of station 6 is readily identified as the Mytilus community first recognized by Petersen (1913). Although not the most abundant in terms of numbers, Mytilus edulis was the predominant epifaunal species in terms of dry weight. Furthermore, it satisfied Thorson's (1957) criterion of constancy in that it occurred in 90% of the samples. Littorina littorea was the second most conspicuous species with regard to constancy, numerical abundance and dry weight. The dry weight of both species includes their shell weight which does not represent living matter. However, the dry organic matter of both species comprises approximately 5% of their wet weights (Thorson, 1957) and on the basis of this figure, it is reasonable to assume that the dry organic matter constitutes at least and probably more than 10% of the total dry weight of each species. Correcting in this manner for shell weight, both species will represent the greatest fraction of the animal material at this station. Therefore, in keeping with the convention of describing bottom communities with the two most "dominant" species, the epifauna of station 6 may be categorized as a Mytilus-Littorina community.

Acmaea testudinalis and Anomia simplex which are important characterizing species of a Mytilus community (Newcombe, 1935) were both constant and well represented numerically; however in terms of dry weight, they ranked far behind both M. edulis and L. littorea. Harmothoë imbricata was an important associated animal in that it was both constant and well represented numerically although ubiquitous in its distribution, being found in a wide variety of sediments (Pettibone, 1963).

Hiatella arctica was found in large numbers at station 6, 8.5 animals per sample, and although the individual animals were small, the species did comprise a significant portion of the biomass. This organism's presence in numerical abundance is noteworthy in view of the fact that a _Hiatella arctica_ epifauna is described from the Franz Joseph Fjord in East Greenland (Thorson, 1933). Spärck (1935) regards this epifaunistic community as corresponding to the infaunistic _Macoma calcarea_ community in arctic waters just as the _Mytilus_ epifauna corresponds to the _Macoma balthica_ infauna of boreal waters. Newcombe (1935) working in the more southern waters of the Bay of Fundy, found _Saxicava rugosa_ as the only representative of this genus in the _Mytilus_ communities of that region but he reported it not to be common.

Only one epifaunal community was found at the six stations that were investigated and it was readily identified as the _Mytilus_ epifauna. The community was most pronounced at station 6; however, several of its member species were collected at the other stations, particularly station 5. Although considerably poorer than that of station 6, the epifauna of station 5 was much richer than that found at stations 1 to 4. This is attributed to the compact nature of the station's substratum which renders it much more suitable to colonization by epifaunal species than the soft sediments found at stations 1 to 4.

The results of the infaunal analyses of the six stations are summarized in tables VI and VII in which the number of individuals and the dry weight of each species are presented as averages per sample for each station. A more detailed tabulation of these results is to be found in appendix II.

TABLE VI

Infauna - Mean Numbers per Sample with standard error given in brackets

SPECIES	STATION 1	2	3	4	5	6
NEMERTEA						
Cephalothrix linearis	0	4.9 (0.77)	0.6 (0.51)	0.3 (0.15)	0	0
POLYCHAETA						
Eteone heteropoda	2.1 (0.58)	0.1 (0.10)	0.4 (0.23)	0.1 (0.10)	0	0
Eteone longa	0	1.1 (0.39)	0.9 (0.35)	1.0 (0.34)	0.4 (0.31)	0.1 (0.10)
Phyllodoce mucosa	0	0.5 (0.31)	0	0.2 (0.14)	0.4 (0.31)	0
Eulalia viridis	0	0	0	0	0.2 (0.14)	0
Nereis virens	5.8 (0.58)	0.3 (0.15)	0.7 (0.22)	0.3 (0.22)	1.8 (0.33)	0.7 (0.30)
Nephthys caeca	0	0.1 (0.10)	0	0.1 (0.10)	0	0
Scoloplos sp.	0	0.2 (0.14)	1.3 (0.37)	1.4 (0.41)	0	0
Pygospio elegans	0	0.7 (0.50)	0.4 (0.31)	0.9 (0.48)	0	0
Capitellidae	0	0	0	0.5 (0.17)	0	0
Pectinaria sp.	0	0	0.1 (0.10)	0	0	0
* *Polycirrus phosphoreus* (?)	0	8.4 (0.68)	3.9 (0.37)	7.9 (0.79)	0.2 (0.14)	2.0 (0.62)
OLIGOCHAETA						
Oligochaeta	26.7 (1.84)	5.3 (0.97)	3.6 (0.92)	0.8 (0.25)	0.1 (0.10)	0
CRUSTACEA						
Diastylis rugosa	0	0.1 (0.10)	1.8 (0.71)	1.3 (0.40)	0.3 (0.22)	0
Phoxocephalus holboli	0	0	0	0	0.1 (0.10)	0
ECHURIDIA						
Echuridia	0	0	0	0	0	0.1 (0.10)
PELECYPODA						
Crenella faba	0	0	0	0.5 (0.27)	0	0
Macoma balthica	3.7 (0.65)	0	0	0.1 (0.10)	0	0
Mya arenaria	6.7 (1.04)	0.8 (0.37)	1.7 (0.66)	2.8 (0.48)	0.2 (0.14)	0

* The species of *Polycirrus* could not be identified with certainty insofar as the genus is in a state of disorder and the identity of species is based on colour and luminescence which are impossible to detect in a preserved specimen (Pettibone, pers. com.).

TABLE VII

Infauna - Mean Weights per sample

SPECIES	STATION 1	2	3	4	5	6
NEMERTEA						
Cephalothrix linearis	0	0.0096	0.0020	0.0011	0	0
POLYCHAETA						
Eteone heteropoda	0.0008	<0.0001	0.0002	0.0001	0	0
Eteone longa	0	0.0006	0.0004	0.0005	0.0002	0.0001
Phyllodoce mucosa	0	0.0004	0	0.0001	0.0003	0
Eulalia viridis	0	0	0	0	0.0001	0
Nereis virens	0.0216	0.0022	0.0290	0.0094	0.0449	0.0036
Nephthys caeca	0	0.0050	0	0.0022	0	0
Scoloplos sp.	0	0.0001	0.0011	0.0028	0	0
Pygospio elegans	0	0.0002	0.0001	0.0001	0	0
Capitellidae	0	0	0	0.0002	0	0
Pectinaria sp.	0	0	0.0015	0	0	0
Polycirrus phosphoreus (?)	0	0.0570	0.0266	0.0612	0.0005	0.0153
OLIGOCHAETA						
Oligochaeta	0.0685	0.0114	0.0054	0.0018	0.0001	0
CRUSTACEA						
Diastylis rugosa	0	<0.0001	0.0004	0.0002	0.0001	0
Phoxocephalus holboli	0	0	0	0	<0.0001	0
ECHURIDIA						
Echuridia	0	0	0	0	0	0.0009
PELECYPODA						
Crenella faba	0	0	0	0.0021	0	0
Macoma balthica	1.8761	0	0	0.0519	0	0
Mya arenaria	0.6893	0.0654	0.0601	0.0766	0.0007	0

The infauna of station 1 is readily classified as Petersen's boreal *Macoma balthica* community which is well described by Spärck (1935) and Thorson (1957). At this station, *Macoma balthica* was the most conspicuous animal by virtue of its large individual size. Although not as numerous as *Mya arenaria*, the average dry weight of *M. balthica* per sample was approximately three times as great. Furthermore, it was present in all samples taken. *Mya arenaria* was also present in all samples from station 1 but on the average, it represented a smaller fraction of the total biomass. Nevertheless, it is an important characterizing species of this community as in previously described *M. balthica* communities. Both *Eteone heteropoda* and the Oligochaeta are also important characterizing animals for despite the fact that they comprise only a small fraction of the total biomass, they were both constant and numerous at station 1 and more poorly represented at the remaining stations.

Stations 2, 3 and 4 possessed infaunal communities which were similar to each other with regard to the species present but they differed in the proportion that each species comprised of the total average infaunal dry weight at each station. Of the 16 infaunal species collected at these sites, 10 were common to all three stations. Two species, *Phyllodoce mucosa* and *Nephthys caeca*, were common only to stations 2 and 4; however, *N. caeca* was represented by only one individual in the ten samples at each of the stations. Each of the four remaining infaunal species were collected at only one station and of these, two were represented by only one individual in the ten samples taken at the station. Therefore, stations 2, 3 and 4 were obviously situated within what is basically one community.

At stations 2 and 4, Polycirrus phosphoreus (?) is readily seen to be the most conspicuous infaunal element. Its average dry weight per sample is somewhat less than that of M. arenaria in each case; however, the dry weight of the mollusc includes its shell weight. From data provided by Ellis (1960) it was calculated that approximately 30% of the total dry weight of Mya truncata consisted of dry flesh with the remaining 70% representing dry shell. When the ratio of dry flesh weight to total dry weight for M. truncata is applied to M. arenaria to obtain the dry flesh weight of the latter, it is reasonable to expect results which are at least within the correct order of magnitude for we are dealing with congeneric organisms. This procedure was followed and the average dry weight of Polycirrus phosphoreus (?) proved to be greater than that of Mya arenaria at not only stations 2 and 4 but also station 3. Furthermore, the polychaete was not only more constant but also more numerous than the pelecypod at all three stations. At station 3, the average dry weight of Nereis virens was found to be greater than that of Polycirrus phosphoreus (?). The fact that the former organism is a carnivore is sufficient to disqualify it as a characterizing species, let alone that it was less numerous, less constant and is notoriously ubiquitous (Pettibone, 1963). In view of the above, P. phosphoreus (?) must be selected as the primary characterizing species of the infaunal communities of stations 2, 3 and 4.

Although these three stations were similar with respect to their primary characterizing species, they differed somewhat with regard to their secondary characterizing species. The nemertean worm, Cephalothrix linearis, is the organism which most distinguishes the infauna of station 2 as being different from that of stations 3 and 4. This organism was constant, occurring in all the samples at the station, and numerically abundant. It was also present at stations 3 and 4 but in far less abundance. The low average dry weight imparts a false inconspicuousness to this species for by visual estimate, the average volume of one individual was observed to be not much less than that of P. phosphoreus (?). Although it is unfortunate that wet weight as well as dry weight measurements were not taken to substantiate this, it would appear that such a low dry weight is due to a greater proportion of water in the living C. linearis than in P. phosphoreus (?). Nevertheless, the organism was far more conspicuous than its average dry weight indicates. Neither Mya arenaria nor the Oligochaeta contribute to rendering this community different from the others insofar as both species were found at all three stations as well as at station 1 and in the case of the latter station they were much more abundant. Nevertheless, they were both important associated species, Mya by virtue of its comparatively high average dry weight per sample and the Oligochaeta by both dry weight and constancy.

Station 3 is distinguished by its lack of any species which are sufficiently abundant and constant to render it different from stations 2 and 4. Mya arenaria was an important associated species in that it was quite constant, occurring in 60% of the samples, and it comprised a large fraction of the total dry weight of the infauna.

At station 4, Mya arenaria was again an important associated species of Polycirrus phosphoreus (?). It was very constant, occurring in 90% of the samples, and comprised a large portion of the average total dry weight of the infauna. The polychaete identified to the family Capitellidae and the pelecypod Crenella faba, both represented a small fraction of the average infaunal dry weight. Five individuals of each organism were collected at this station and neither was found at any of the other stations; therefore, both serve as distinguishing organisms of station 4.

The infaunal community of stations 2, 3 and 4 has strong affiliations with Macoma communities in general and Macoma balthica communities in particular. This is evident from the fact that populations of Mya arenaria which is commonly associated with Macoma balthica communities were found at all three stations. Furthermore, a single specimen of M. balthica was collected at station 4. Soft substrata situated in shallow waters, particularly estuarine waters, commonly support Macoma communities in arctic and boreal regions (Spärck, 1935; Thorson, 1957). Despite this evidence, it is not logical to describe the infauna of stations 2, 3 and 4 as that of a Macoma balthica community. In this instance, M. balthica does not meet even the minimum requirements of a characterizing species. Macoma is a deposit feeder and is expected to be found in great abundance on bottoms containing a great amount of silt or mud (Blegvad, 1914; Thorson, 1957) and this is certainly not the case with these stations. That there was a source of larvae for the colonization of the area is evident from the proximity of station 1 supporting a dense population of Macoma balthica. The fact that these stations did not support populations of Macoma indicates that environmental conditions were such as to preclude the establishment of a population and therefore, the infauna must be referred to another community.

Polycirrus phosphoreus (?) and Mya arenaria were the most characteristic and conspicuous species of the infauna of these stations and therefore, the community must be designated by these two organisms as a Polycirrus-Mya community. The choice of Polycirrus as a characterizing organism might be questioned in view of the fact that it is found in considerable abundance at station 6 which is located over an entirely different substratum. However, this is only an apparent discrepancy as will be discussed shortly. This community could not be equated to any found in the literature. Since it is not feasible to describe a new community on the basis of observations from one locality, this description must remain tentative and its validity as a community in the Petersen community concept must remain in question.

The infauna of station 5 is represented by nine species, all but two of which are common to station 2, 3 and 4. The polychaete Eulalia viridis and the amphipod Phoxocephalus holboli are unique to this station but are poorly represented with only two individuals of the former species being collected and one of the latter. This community may therefore be considered to be an impoverished condition of that found at stations 2, 3 and 4.

The infauna of station 6 was in an even more impoverished state than that of station 5 in that only four infaunal species were collected. However, one of these, Polycirrus phosphoreus (?), was comparatively abundant and this fact is immediately striking because the substratum is so different from that of stations 2, 3 and 4.

However, it must be noted that the substratum did not consist solely of clean cobble. The spaces between stones were filled with silt and sand which may have provided micro-habitats similar to the environment of stations 2, 3 and 4. The remaining infaunal species were poorly represented. One specimen of each of Eteone longa and Echuridia as well as seven specimens of Nereis virens were collected in the ten samples from the station. The infauna of station 6 may be considered to be that of the Polycirrus-Mya community although it is present in a reduced and fragmented state.

Two distinct infaunal communities were recognized from the six stations in Long Pond. The community of station 1 was identified to be Petersen's boreal Macoma balthica infauna; however the Polycirrus-Mya community of stations 2, 3 and 4 could not be equated to any in the literature. The latter community was also found at stations 5 and 6. It was in a comparatively impoverished state at station 5 and this might be correlated with the more compact nature of the substratum. At station 6, the same community is believed to be associated with pockets of silt and sand in the coarse cobble of that station.

c) Gross Considerations

A comparison of the results of this study with those of other investigations is complicated by the fact that no single mesh size has been adhered to in the previous work. A wide variety of sieves with apertures ranging from 0.5 mm to 2.5 mm have been used and furthermore, the occasional report does not mention the size of the mesh employed. The use of sieves with mesh apertures no greater than 1 mm is imperative in order that serious error which results through the loss of small organisms might be avoided. Mare (1942) reported that small macrobenthos, the organisms passing through a 2.2 mm. sieve but retained on a 1.0 mm. sieve represented about 30% of the total fresh weight of the macrobenthos in the Rame mud. Holme (1953) estimated that dry weight figures he obtained with a 2.2 mm. sieve had to augmented by 10% to correct for the loss of small organisms. Therefore in comparing the results of various workers, it is necessary to bear in mind the sizes of the sieves that were used.

From station 1 to station 6, there is a change in the benthic fauna from one that is predominantly infaunal to one that is predominantly epifaunal. This change is readily correlated with changes in the hardness of the substratum. The soft substratum of stations 1 to 4 is most suited to infaunal species whereas the hard sand of station 5 permits colonization by an increased number of epifaunal species and the cobble of station 6 is highly suited to epifaunal species. The change from a predominantly infaunal to a predominantly epifaunal community is evident in terms of the number of species, the number of individuals and the biomass of each type at each station. Table VIII illustrates this change with regard to the number of infaunal and epifaunal species at each station.

The number of species at any one of the stations is somewhat low when compared with localities situated in waters of more oceanic salinity. A station in a marine mud near Plymouth has been reported to support over 48 benthic macrofaunal species (Mare, 1942). Sanders (1956) collected an average of 27.5 species from six stations in the Long Island Sound area. Investigating five stations in the Magdalen Shallows, Peer (1963) collected an average of at least 24 species for he grouped a number of organisms together under orders and families which would indicate that the average is even higher. Mare's results are directly comparable insofar as she sieved her samples through a mesh with aperture diameters of 0.5 mm. Both Sanders and Peer used 1.0 mm. sieves; however it is unlikely that they would have collected any more than a few extra species had 0.5 mm. sieves been used.

TABLE VIII

Number of infaunal and epifaunal species at each station

	STATION					
SPECIES	1	2	3	4	5	6
Epifaunal	1	3	4	4	6	16
Infaunal	5	12	11	15	9	4
Total	6	15	15	19	15	20

The number of organisms per square meter for each of the stations in Long Pond was calculated from the mean number per sample and the results are presented in table IX. In arriving at these figures, a distinction was made between epifaunal and infaunal organisms to show the change from an infaunal to an epifaunal community between stations 1 and 6. Hence the progressive increase in epifaunal and decrease in infaunal organisms is also demonstrated in table IX. Furthermore, the results were tabulated with and without the amphipod Corophium bonelli for because of its small size but large numbers,

TABLE IX

Number of epifaunal and infaunal animals per square meter at the six stations in Long Pond. The figures enclosed by brackets exclude the amphipod Corophium bonelli.

	STATION						
	1	2	3	4	5	6	Average
Epifauna	4.4 (4.4)	39.9 (26.6)	932.4 (57.7)	630.4 (137.6)	1478.4 (146.4)	2819.3 (1793.7)	984.1 (361.1)
Infauna	1878.0	994.1	621.8	808.0	164.3	128.7	765.8
Total	1882.4 (1882.4)	1034.0 (1025.7)	1554.2 (679.5)	1438.4 (945.6)	1642.7 (310.7)	2948.0 (1922.4)	1745.0 (1127.7)

this organism contributed little to the biomass although it represented a considerable fraction of the number of animals that were collected.

In terms of the number of organisms per square meter, the results from Long Pond are higher than most reported from arctic and sub-arctic localities. Data from 59 samples taken in Faxa Bay, Iceland, show a range of 20 to 2095 individuals per square meter with an average of 275 (Einarsson, 1941). This average represents a difference of over six fold and although Einarsson used a 1.5 mm. sieve, it is doubtful whether such a discrepancy is due entirely to difference in mesh sizes. Ellis (1960) using mesh sizes of 1.0, 1.5 and 2.0 mm. obtainedan average of 936 organisms per square meter in 202 samples taken at 16 stations in the Canadian arctic. At Solitairbugt, East Greenland, Thorson (1933) obtained an average of 385 organisms per square meter in 31 samples and Spärck (1937) collected an average of 680 in 96 samples from 25 stations around Iceland. However, neither of the latter two authors reported the mesh size that was used in their investigations.

The above mentioned investigations were made in areas which are not characterized by especially high populations and the populations observed at Long Pond compared favourably with them on a numerical basis. However, comparisons were less favourable when they were made with the results of investigations in areas characterized by high populations. For example, Smidt (1951) conducted an intensive study of the benthos in the Danish Waddensea and observed a mean of 31,000 organisms per square meter with a range of 7,000 to 74,650. He used mesh sizes of 1.0 and 1.9 mm. but nevertheless, his minimum observation is considerably higher than the maximum at Long Pond. Using a 1.0 mm. sieve, Sanders (1956) obtained a mean of 16,446 in a range of 5,566 to 46,404 at Long Island Sound. With a 0.5 mm. sieve, he obtained a lower mean, 4,430 organisms per square meter, at Buzzards Bay (Sanders, 1958).

More meaningful comparisons are those made on a community basis. In this respect, the Macoma community at station 1 supported a large population with regard to the number of organisms per square meter. A Macoma balthica community in Dybsø Fjord was sampled intensively and displayed an average density of 876.6 organisms per square meter (Larsen, 1936). Spärck (1937) found 1565, 1520 and 597 organisms per square meter in the Macoma communities in Isafjördur, Hesteyrarfjördur and Eyjafjördur in Iceland. Einarsson (1941) collected 584 animals per square meter in a Macoma community in Faxa Bay. Seven of the stations sampled by Ellis (1960) were in Macoma calcarea communities and yielded an over-all weighted average of 1439 animals per square meter.

The Polycirrus-Mya community of stations 2, 3 and 4 could not be compared with others insofar as no similar community has been previously described. Therefore, comparisons were made with communities which were reported from substrata of mud excluding Macoma communities. The number of animals per square meter in mud communities is highly variable. Low averages such as 177 in seven samples taken off the Cumberland coast (Jones, 1952) and 163 in five samples from the Plymouth area (Holme, 1953) have been reported. On the other hand, high results have been reported by Mare (1942) who found 2,356 organisms per square meter in the Rame mud of the Plymouth area and Sanders (1956) who collected 2,669 animals per square meter at one station in Long Island Sound. The observations from stations 2, 3 and 4 in Long Pond are therefore seen to be intermediate.

The population of the Mytilus community at station 6 may also be regarded as intermediate with respect to number of organisms per square meter. Larsen (1936) reported an average of 955 animals per square meter from ten samples taken at one station in Dybsó Fjord, Denmark. Spärck (1937) reported averages of 831 in Skardsfjördur and 4,000 in Eyjafjördur.

Numerically, the populations observed at the six stations in Long Pond were neither especially high nor low when compared to littoral, benthic communities in general. Furthermore, with the exception of the Macoma community, this was also the case in a comparison on a community basis. The Macoma community of station 1 did possess a population which was comparatively high for Macoma communities.

For purposes of comparing biomass determinations with those of other workers, it was found necessary to correct for shell weights of molluscs and tests of echinoderms. Factors that would convert total dry weight, which included shell weight, to dry tissue weight were determined from data provided by Thorson (1957) and Ellis (1960). In arriving at these figures, the organisms that were to be treated were borne in mind. Since Macoma, Mya and Mytilus were the principal pelecypods of concern, a factor of 0.3 which was biased towards these organisms was used for Pelecypods in general. Littorina littorea possessed a heavy shell and was the predominant gastropod and therefore, a lower factor of 0.2 was used for the gastropods. Strongylocentrotus droehbachiensis was the only echinoderm in this series of collections and a factor of 0.1 was used to convert its total dry weight to dry tissue weight. These factors of course, cannot be expected to yield results of high precision insofar as there is variation between species within the same group and between individuals within the same species. However as evident from table X, there was considerable variation in the biomass of the samples taken at any one of the stations. It is reasonable to expect such variations, would contribute far more to the error than the correction factors and therefore, for approximate comparative purposes, the factors may be considered to be adequate.

For the sake of brevity and to avoid confusion, it is necessary at this point to clarify the terminology that will be used henceforth with regard to biomass. "Biomass" and "standing crop" are to be used synonymously to refer to the quantity of animal material present on the sea floor at one time and expressed as "fresh" or "dry tissue" weight per unit area. It must be emphasized that these terms are not a measure of productivity which would require the integration of a host of variables such as turn-over rates, growth rates, etc., before it could be derived from expressions of biomass. The term "fresh tissue" will be taken to mean the total weight of undehydrated organisms including the shells of molluscs and the tests of echinoderms. The term "dry tissue" will refer to the weight of the dehydrated residue excluding the shells and tests of molluscs and echinoderms.

TABLE X

The total dry weights excluding shells and tests of the organisms in each sample taken at the six stations in Long Pond.

	SAMPLE									
	1	2	3	4	5	6	7	8	9	10
Station 1										
Epifauna	-	0.0008	-	-	-	-	-	-	-	-
Infauna	1.8014	0.8615	0.7964	1.0122	0.8749	0.6572	0.4087	0.8398	0.6097	0.7432
Total	1.8014	0.8623	0.7964	1.0122	0.8749	0.6572	0.4087	0.8398	0.6097	0.7432
Station 2										
Epifauna	-	0.0007	0.0002	0.0004	-	-	0.0009	0.0006	0.0002	0.0018
Infauna	0.0993	0.1374	0.2613	0.0857	0.0987	0.0700	0.0825	0.0905	0.0526	0.0827
Total	0.0993	0.1381	0.2615	0.0861	0.0987	0.0700	0.0834	0.0911	0.0528	0.0845
Station 3										
Epifauna	0.0052	0.0005	0.0053	0.0020	0.0088	0.0046	0.0013	0.0030	0.0104	0.0017
Infauna	0.0593	0.0635	0.1923	0.0328	0.0792	0.0810	0.0216	0.0867	0.0816	0.1491
Total	0.0645	0.0640	0.1976	0.0348	0.0880	0.0856	0.0229	0.0897	0.0920	0.1508
Station 4										
Epifauna	0.0033	0.0032	0.0034	0.0013	0.0024	0.0030	0.0037	0.0003	0.0029	0.0033
Infauna	0.3389	0.0856	0.1190	0.0573	0.0744	0.0665	0.1314	0.0967	0.1106	0.1086
Total	0.3422	0.0888	0.1224	0.0586	0.0768	0.0695	0.1351	0.0970	0.1135	0.1119
Station 5										
Epifauna	0.0094	0.4980	0.0030	1.0960	0.0040	0.0163	1.7269	0.0051	0.4963	0.0043
Infauna	0.0088	0.0048	0.0092	0.0068	0.0078	0.2072	0.1891	0.0058	0.0042	0.0197
Total	0.0182	0.5028	0.0122	1.1028	0.0118	0.2235	1.9160	0.0109	0.5005	0.0240
Station 6										
Epifauna	1.1080	0.9264	2.0936	0.6995	4.3673	2.3512	1.8289	10.1293	16.1869	3.1180
Infauna	0.0029	0.0105	0.0131	0.0200	0.0552	0.0082	0.0153	0.0452	-	0.0286
Total	1.1109	0.9369	2.1067	0.7195	4.4225	2.3594	1.8442	10.1745	16.1869	3.1466

Table XI tabulates the mean of the biomass determinations at each of the six stations and draws a distinction between epifaunal and infaunal components to illustrate the change from an infaunal to an epifaunal community. These results have been corrected to exclude shell and test weights and converted to weights per square meter. From table XI, it is evident that the biomass at Long Pond ranged from a low of 3.95 g. per square meter at station 3 to a high of 190.96 g. per square meter at station 6. These figures represent dry tissue weights and if they are multiplied by a factor of 10, they may be converted back to approximate fresh tissue weights.

The lowest standing crops, 10 to 35 g. of fresh tissue per square meter, have been recorded from the Mediterranean Sea, the White Sea and some East Greenland fjords (Spärck, 1935). Holme (1953) has reported equally low standing crops at various points in the English Channel and Sanders' publication (1956) includes data on a low biomass determination at Long Island Sound. The highest biomass determinations that have been recorded range from 623 g. fresh tissue per square meter in the Danish Waddensea (Smidt, 1951) and 157.87 g. dry tissue per square meter at Long Island Sound (Sanders, 1956) to 1931.5 g. and 3858.8 g. fresh tissue per square meter in Icelandic waters (Spärck, 1937). From this data, it is readily seen that the standing crop at Long Pond ranged from among the lowest recorded to among the highest recorded. However, to fully appreciate the observations from Long Pond, it is necessary to deal with each community separately and to draw comparisons with similar communities.

TABLE XI

The mean biomass (dry tissue per square meter)

at the six stations in Long Pond

	STATION					
	1	2	3	4	5	6
Epifauna	0.0036	0.0213	0.1901	0.1190	17.1353	190.0724
Infauna	38.2062	4.7095	3.7611	5.2792	2.0575	0.8836
Total	38.2098	4.7308	3.9512	5,3982	19.1928	190.9560

The *Macoma* community of station 1 was determined to have a biomass of 38.21 g. dry tissue per square meter or approximately 380 g. fresh tissue per square meter. Such a result is not a low figure for *Macoma* communities in general. Data published on *Macoma calcarea* communities in arctic North America indicate a mean of approximately 23.7 g. dry tissue per square meter with a range of 5 to 44 (Ellis, 1960). Investigations in Icelandic waters have yielded standing crop determinations for *Macoma calcarea* communities which range from 75.15 g. fresh tissue in Eyjafjördur (Spärck, 1937) to 869.5 g. fresh tissue in Faxa Bay (Einarsson, 1941). Larsen (1936) conducted an intensive investigation on the benthos of Dybsø Fjord in Denmark and of the 26 bottom sampler stations he studied, all but stations 2, 3, 8, 12 and 18 were in *Macoma balthica* communities. The mean biomass of the *Macoma* stations was calculated to be 64.58 g. fresh tissue per square meter which is considerably lower than the Long Pond observation.

With regard to the *Polycirrus*-*Mya* community of stations 2, 3 and 4, most biomass determinations made in substrata of mud have yielded low results which are in keeping with the observations from Long Pond. Average fresh tissue weights of 34.8 g. per square meter from the Isle of Man (Jones, 1951) and 18.6 g. per square meter from the Cumberland coast (Jones, 1952) have been reported. These results represent approximately 3.5 and 1.9 g. dry tissue per square meter which are lower than any of the observations from Long Pond. However, Jones used 1.0 and 2.0 mm. sieves and therefore, part of the discrepancies may stem from the fact that a smaller mesh size was used in obtaining the Long Pond estimates. Five of the stations reported by Holme (1953) were from substrata of mud and yielded a mean dry tissue weight of 9.6 g. per square meter with a range of 5.0 to 12.8. These figures are higher than the Long Pond observations despite the fact that a 2.2 mm. sieve was used by Holme which indicates that the discrepancies are even larger. Using a 1.0 mm. sieve, Sanders (1956) reported a biomass of 1.419 g. dry tissue per square meter from one station at Long Island Sound. All the above mentioned figures are roughly similar to those obtained at Long Pond. However, there is one considerably larger observation from Plymouth waters (Mare, 1942) of a standing crop of 215.5 g. fresh tissue or approximately 21.6 g. dry tissue per square meter. In this instance, a 0.5 mm. sieve was used and therefore, the observation is directly comparable with those from Long Pond.

A mean biomass of 190.96 g. dry tissue per square meter or approximately 1,900 g. fresh tissue was calculated from the ten samples taken in the Mytilus-Littorina epifauna of station 6. This mean is high when compared with those obtained by Larsen (1936) and Spärck (1937). One of Larsen's bottom sampler stations in the Dybsø Fjord was clearly in a Mytilus community and it yielded a mean biomass of only 134 g. fresh tissue per square meter. From Mytilus epifaunas in Icelandic waters, Spärck (1937) reported mean biomasses per square meter of 588 g. fresh tissue in Eyjafjördur, 758 g. fresh tissue in Hornafjördur and 432 g. fresh tissue in Skardsfjördur.

The Macoma-Mya community of station 1 appeared to be restricted to the south end of the south arm which was calculated to represent about 2.1% of the total area studied. Multiplying area by the mean standing crop observed at station 1 indicates that the area inhabited by the Macoma community supported a total standing crop which was in the order of 209.9 kg. dry tissue. Similarly, the Mytilus-Littorina community, being found only in a narrow zone along the north shore and occasionally elsewhere in patches on suitable substrata, also occupied a small area which represented approximately 2.3% of the total area investigated. The mean of the biomass determinations at stations 5 and 6 when multiplied by area indicates that the total standing crop of the Mytilus-Littorina community was in the order of 637.8 kg. dry tissue.

Most of the bottom of Long Pond, 95.6% in area, supported the Polycirrus-Mya community which was characterized by a low standing crop when compared to benthic communities in general. The biomass estimates for the three stations within the Polycirrus-Mya community differed and this may be correlated to a certain degree with the presence and absence of macro-vegetation. Stations 2 and 3 are most suited to a comparison in this regard insofar as both possessed similar sediments in terms of particle size and ignition loss. Their obvious difference was the presence of Zostera marina at station 2 and its absence at station 3. The mean biomass at station 2 was determined to be 4.73 g. dry tissue per square meter and that at station 3, 3.95 g. dry tissue per square meter. The difference between the two estimates is significant at the 95% confidence level. It has been previously suggested for fresh water environments (Gerking, 1957) that an area with submerged vegetation would support about twice as many benthic organisms as a non-vegetated area. Holme (1949) found the greatest abundance and variety of life in and near the Zostera regions of the intertidal areas he studied and this, to a certain degree, appears to be the case at Long Pond.

The standing crop at station 4 was observed to be greater than that at either station 2 or 3; however this station differed considerably from the others with regard to substratum, being situated in a very fine sand. Sanders (1958) found that populations of infaunal filter-feeders at Long Island Sound and Buzzards Bay increased as the median grain size of the sediment approached 0.18 mm. and decreased as the median grain size exceeded 0.18 mm. McNulty et al (1962b) found a similar correlation at Biscayne Bay, Florida, but at a larger median grain size. Such correlations might be applicable to stations 2, 3 and 4; however sampling at several additional stations would be required to establish this.

In order to obtain an estimate of the total standing crop of the Polycirrus-Mya community, the part of the pond that the community occupied was divided into three regions and the area of each was calculated. On the basis of the mean standing crop at station 2, the region inhabited by Zostera marina was estimated to have a total standing crop of 225.6 kg. dry tissue. The mean biomass at station 3 was assumed to be indicative of the medium and coarse silt areas exclusive of those inhabited by Zostera and therefore, the total biomass of the region was determined to be in the order of 600.2 kg. dry tissue. The total biomass of the very fine sand and fine sand areas was estimated from the mean observed at station 4 to be 272.4 kg. dry tissue. The total for the _Polycirrus_-_Mya_ community is 1098.2 kg. dry tissue which represents only 56.4% of the standing crop of the entire area.

The total standing crop estimates for each of the communities are only rough approximations at best; nevertheless they are useful as an appreciation of the quantity of the benthos in the area investigated. From table XII which summarizes these estimates, it is readily seen that the _Macoma_ and _Mytilus_ communities constituted 43.6% of the total standing crop although they occupied only 4.4% of the total area. On the other hand, the _Polycirrus_-_Mya_ community which occupied 95.6% of the area studied supported only 56.3% of the total standing crop. Despite the error inherent in the method of obtaining these figures, Long Pond is readily seen to support a small standing crop over most of its area.

Blegvad (1928) categorized benthic invertebrates according to their suitability as fish food. He regarded as first class plaice food all polychaetes, lesser crustacean forms such as amphipods, cumacea and isopods and all lamellibranchs which are less than 3 cm. in length. According to such a classification, the entire fauna of stations 2, 3 and 4 must be regarded as first class fish food. However, the benthos of stations 1, 5 and 6, which represented 43.6% of the total, can be only partially exploited by fish because a great portion of the fauna consists of lamellibranchs which are too large to be ingested. Despite the fact that most of the benthos is suitable for fish food, it is not present in sufficient quantity to support a large fish population. In view of the fact that a fish consumes approximately 5% of its body weight in food each day (Thorson, 1956) and that the abundance of ground fish has been

TABLE XII

Estimates of the areas inhabited by and the total standing crops of the benthic communities at Long Pond. The calculations for the Polycirrus-Mya community are presented for the community as a whole and in brackets, for the sub-divisions of the community.

Community	Area Inhabited (square meters)	Area Inhabited (% of total)	Total Standing Crop (kg.)	Total Standing Crop (%)
Macoma-*Mya*	5,494	2.10	209.9	10.79
Polycirrus-*Mya*	250,072	95.58	1,098.2	56.43
Zostera marina	(47,696)	(18.23)	(225.6)	(11.59)
Medium-Coarse silt	(151,906)	(58.06)	(600.2)	(30.84)
Very fine-Fine sand	(50,470)	(19.29)	(272.4)	(14.00)
Mytilus-*Littorina*	6,070	2.32	637.8	32.78
Totals	261,636	100.00	1945.9	100.00

previously correlated with the quantity of benthic food animals (Lee, 1944; Blegvad, 1951), Kennedy's (1964) argument that inadequate food supply is responsible for the small population of winter flounder, Pseudopleuronectes americanus, in Long Pond appears to be well founded.

In summary, the fauna at each of the six stations was divided into broad taxonomic groups and the mean dry tissue weight per sample of each was calculated. These data are presented in table XIII and illustrated on a percentage basis in figure 14. The dominance of pelecypods, primarily Macoma balthica, at station 1 is evident. The biomass of this station was high in comparison to other Macoma communities and to benthic communities in general. The fauna of stations 2, 3 and 4 consisted primarily of polychaetes with Polycirrus phosphoreus (?) of prime importance; nevertheless pelecypods comprised a large fraction in each case. The standing crop at these stations was not unusually high or low when compared to mud communities excluding shell-fish communities; however it was very low when compared to benthic communities in general. The biomass of stations 5 and 6 consisted primarily of gastropod and pelecypod elements and was comparatively high, especially that of station 6 which was high in comparison to previously reported Mytilus communities and to benthic communities in general. The echinoderm Strongylocentrotus droehbachiensis represented a significant fraction of the fauna at station 6 and although not collected in the samples, the sea-star Asterias vulgaris was occasionally observed while diving in the immediate vicinity of the station.

TABLE XIII

The composition by mean dry tissue weight per sample of the fauna at each station. The figures enclosed by brackets indicate percentage composition.

FAUNAL GROUP	STATION 1	2	3	4	5	6
Polychaetes	0.0224	0.0659	0.0599	0.0772	0.0491	0.1081
	(2.60)	(61.80)	(67.27)	(63.46)	(11.36)	(2.51)
Crustaceans	0.00008	0.00004	0.0037	0.0023	0.0048	0.0052
	(0.01)	(0.04)	(4.13)	(1.86)	(1.12)	(0.12)
Gastropods	0	0	0	0	0.3779	1.3576
					(87.41)	(31.57)
Pelecypods	0.7696	0.0196	0.0180	0.0392	0.0004	2.6048
	(89.43)	(18.42)	(20.26)	(32.25)	(0.09)	(60.57)
Echinoderms	0	0	0	0	0	0.2211
						(5.14)
Others	0.0685	0.0210	0.0074	0.0030	0.00007	0.0040
	(7.96)	(19.74)	(8.34)	(2.43)	(0.02)	(0.09)
Total	0.8606	0.1066	0.0890	0.1216	0.4323	4.3008

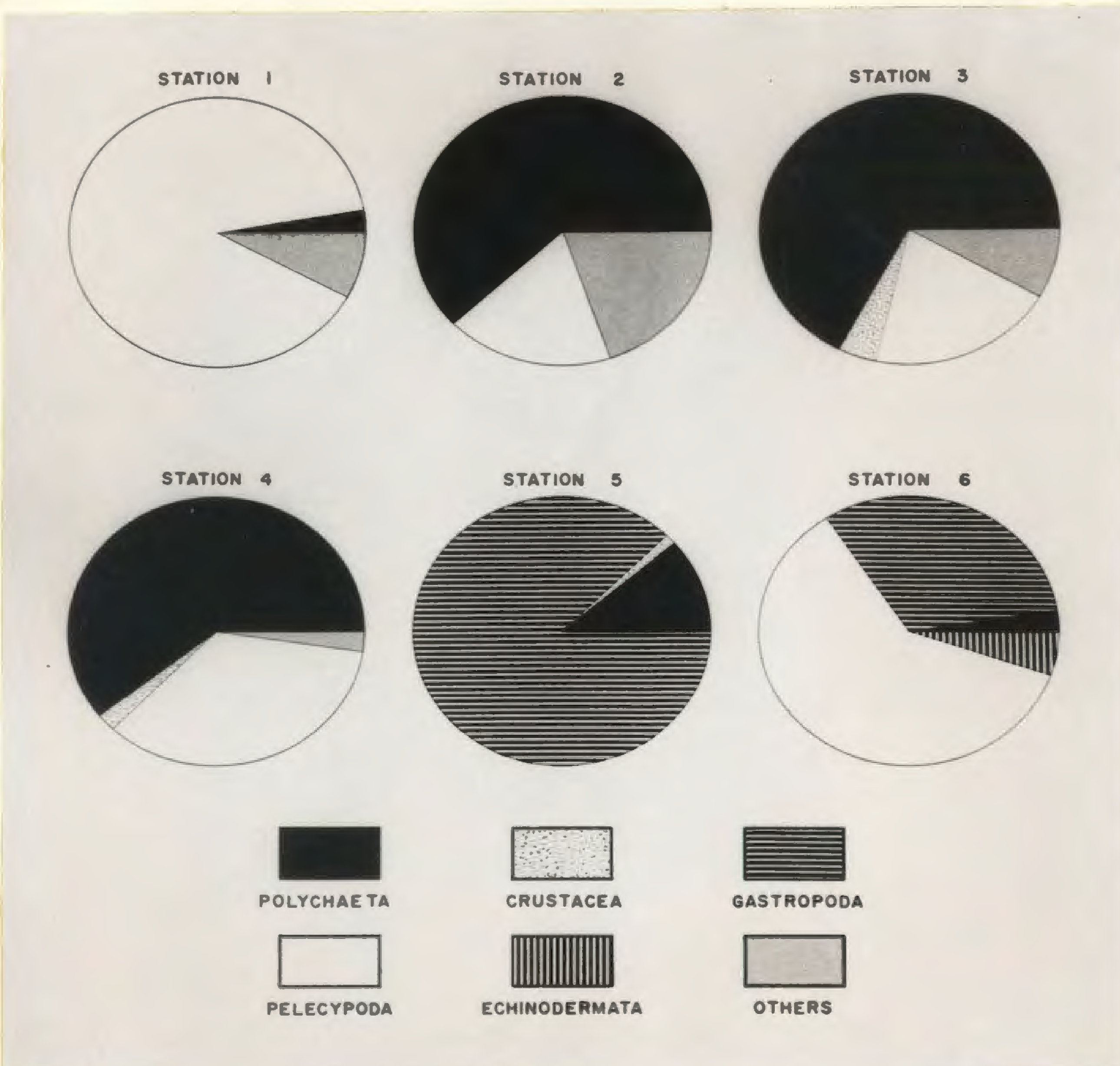

FIGURE 14. The percentage composition by dry tissue weight of the fauna at each station. The area of the circles is proportional to the total biomass.

d) Individual Species Considerations

The species that were collected at the six stations were readily divided into three groups when considering their abundance and distribution in relation to sediment types. Group I included the abundantly collected species which possessed a distribution such that they were collected at only one or two stations. Group II consisted of the species which were found at no less than three stations and which were numerically well represented. Group III consisted of the species which were not collected in sufficient numbers to warrant an analysis of their distribution. Table XIV presents the fauna divided into these three categories and tabulates the stations at which each species was collected.

The group I organisms were collected in sufficient numbers to be considered indicative of one station or community and therefore, of its substratum. Macoma balthica is one such species found in great abundance at station 1. The peculiarity of its absence at stations 2 and 3 and its low density at station 4 has already been discussed. At station 4, the polychaete Capitellidae and the pelecypod Crenella faba were found in comparative abundance. However, little can be concluded about the polychaete since its identification could be established only to family. The geographical distribution of Crenella faba has been documented (Abbott, 1954; Bousfield, 1960) but information pertaining to its ecology which might explain its distribution in Long Pond could not be located.

Most of the species in group I were collected on the rocky substratum of station 6 as members of the Mytilus-Littorina community. Lepidonotus squamatus and Harmothoë extenuata are commonly

TABLE XIV

Division of the benthic invertebrates of the six stations into three groups for discussion purposes and a tabulation of the stations at which each species was collected.

GROUP I

SPECIES	STATIONS OF COLLECTION
POLYCHAETA	
Lepidonotus squamatus	6
Harmothoë sp.	6
Harmothoë extenuata	6
Nereis pelagica	3 6
Capitellidae	4
CRUSTACEA	
Balanus balanoides	6
GASTROPODA	
Acmaea testudinalis	5, 6
Littorina littorea	5, 6
PELECYPODA	
Crenella faba	4
Mytilus edulis	5, 6
Anomia simplex	6
Anomia aculeata	6
Macoma balthica	1 4
Hiatella arctica	4 6

TABLE XIV CONTINUED

GROUP II

SPECIES	STATIONS OF COLLECTION
NEMERTEA	
Cephalothrix linearis	2, 3, 4
POLYCHAETA	
Harmothoë imbricata	2, 3, 4, 5, 6
Pholoë minuta	2, 3, 4, 5, 6
Eteone heteropoda	1, 2, 3, 4
Eteone longa	2, 3, 4, 5, 6
Nereis virens	1, 2, 3, 4, 5, 6
Scoloplos sp.	2, 3, 4
Pygospio elegans	2, 3, 4
Polycirrus phosphoreus (?)	2, 3, 4, 5, 6
OLIGOCHAETA	
Oligochaeta	1, 2, 3, 4, 5
CRUSTACEA	
Diastylis rugosa	2, 3, 4, 5
Corophium bonelli	2, 3, 4, 5, 6
PELECYPODA	
Mya arenaria	1, 2, 3, 4, 5

TABLE XIV CONTINUED

GROUP III

SPECIES	STATIONS OF COLLECTION
POLYCHAETA	
Phyllodoce mucosa	2 4, 5
Eulalia viridis	5
Nephthys caeca	2 4
Pectinaria sp.	3
CRUSTACEA	
Phoxocephalus holboli	5
Gammarus lawrencianus	1
ECHURIDIA	
Echuridia	6
ECHINODERMATA	
Strongylocentrotus droehbachiensis	6
ASCIDIACEA	
Ascidiacea	6

found in association with *H. imbricata* in *Mytilus edulis* beds (Pettibone, 1963). One polynoid listed as *Harmothoë* sp. could not be identified to species but might be a member of the same association. *Nereis pelagica* is commonly found among rocks and is a frequent associate of mussel beds (Miner, 1950). It is characteristic of circulating water and is rarely collected in mud (Pettibone, 1963); therefore its presence at station 6 is in agreement with what is known of its biology. The presence of *Balanus balanoides* at station 6 and its absence at the other stations is obviously correlated with substratum for this cirriped requires a hard surface for attachment. This also appears to be the case for the pelecypods *Anomia simplex* and *A. aculeata* for these species were found firmly attached to rocks and shells. Similarly the occurrence of *Mytilus edulis* and *Hiatella arctica* in large numbers at only station 6 is due to the requirement of these species for solid objects to which byssal threads may be attached. *Acmaea testudinalis* and *Littorina littorea* were found at station 5 as well as at station 6. The substratum at stations 5 and 6 was hard and could support such comparatively heavy organisms. On the other hand, the soft sediments of stations 1 to 4 could not be expected to support these two epifaunal species and therefore, their absence at these stations is to be anticipated.

The distribution of the group II species was analysed statistically to assess the significance of the differences between the stations. For this purpose, a "t-test" was applied to the differences between the number of individuals of a species per sample in all combinations of two stations. The difference between any two stations was considered significant when the probability of it being the product of chance was equal to or less than 0.05 (ie. 95% confidence level). In some instances, confidence levels of 94% and 93% were obtained. In such cases, the statistics may be considered to break down for the differences are, for all intents and purposes, meaningful. The results of the analyses are tabulated in detail in appendix III and only significant differences are discussed below.

Cephalothrix linearis was collected in greatest numbers at station 2 where a mean of 4.9 individuals per sample was obtained. It was also found at stations 3 and 4 although not in significant numbers but was absent in the samples taken at the remaining stations. Such results indicate a preference for a muddy Zostera bed. In intertidal areas, Holme (1949) found this species in mud with Zostera but collected it in greatest abundance in well-drained and in moist clean sand, habitats which were not to be found at Long Pond.

Harmothoë imbricata is a ubiquitous species and the adaptability in habitat of this animal is stressed by Pettibone (1963) who documents the great variety of bottoms in which it may be collected. Its ubiquitous nature is indicated by the fact that it was collected at all stations in Long Pond except station 1. It was most abundant at station 6 where not only was the densest population found but also the largest individuals were collected. Furthermore, H. imbricata was also present at station 5 in large numbers. These results indicate that although this species will colonize soft substrata, it has a marked preference for hard substrata and thrives best on them.

Pholoë minuta is also found on a wide variety of bottoms ranging from mud to stones with all intermediate combinations (Pettibone, 1963). At Long Pond, it was most abundant in the very fine sand of station 4 where a mean of 2.9 individuals per sample was found. Although this observation indicates a preference for very fine sand, it must be interpreted with caution insofar as the high mean obtained at this station is largely due to one sample's containing eighteen individuals.

Eteone heteropoda and E. longa are morphologically similar species and difficulty was experienced in distinguishing between them. This was especially true in the case of fragmented individuals in which the anal cirri, the main diagnostic character used to separate the species, were missing. Nevertheless, identifications are believed to have been made accurately. The distribution of these two species in Long Pond was found to over-lap. E. heteropoda was found to be most abundant at station 1 where 2.1 individuals per sample were collected; however it was also collected at stations 2, 3 and 4. E. longa was comparatively abundant at stations 2, 3 and 4 and the differences between the means of these stations were not significant. It was also present at stations 5 and 6 and was absent at station 1. Both species are found intertidally on a wide variety of substrata (Pettibone, 1963). At Long Pond, only E. heteropoda was collected at station 1, the station bordering on the intertidal, whereas E. longa was conspicuous by its absence. Holme (1949) collected E. longa in sand, sandy mud and mud but found the species in greatest abundance in mud which is in agreement with the observations at Long Pond. These results indicate that in Long Pond, E. heteropoda prefers silt in very shallow water while E. longa thrives best in silt in somewhat deeper water. Both species appear to avoid hard substrata in Long Pond.

Nereis virens is another widely distributed species and the variety of bottoms it can inhabit has been well documented (Miner, 1950; Pettibone, 1963). It is especially common in flats bordering the mouths of rivers (Pettibone, 1963) which may account for its being collected in greatest abundance at station 1. N. virens was significantly abundant at station 5 and this, in conjunction with its low densities at stations 2, 3 and 4, indicates an inability to successfully colonize especially soft substrata in deeper water. It was not highly successful in colonizing the cobble of station 6.

It is unfortunate that the identity of Scoloplos sp. could not be established to the species level for this precludes comparison with other work. This organism was collected only in the medium silt of stations 2 and 3 and in the very fine sand of station 4. It was most abundant at stations 3 and 4.

Pygospio elegans was also collected only at stations 2, 3 and 4 but it was found in large numbers only at stations 2 and 4. This organism is common on sandy bottoms in shallow water (Thorson, 1946). In the intertidal, Holme (1949) found it to be abundant in sand but rare in mud. At Long Pond, P. elegans was present in mud, station 2, and in very fine sand, station 4, and although it was slightly more abundant at station 4, the difference was not significant.

The distribution of Polycirrus phosphoreus (?) in Long Pond indicates that it is a soft sediment organism which does not thrive in the intertidal. This is supported by its absence in the samples taken at station 1 and its low density at station 5. Its presence in the cobble of station 6 has been previously explained. P. phosphoreus (?) was present in far greater abundance at station 4 than at station 3 and the difference was significant at the 95% confidence level. This indicates that the species prefers very fine sand to silt. However, this appears to be modified to a considerable degree by the presence of Zostera for the density of P. phosphoreus (?) at station 2 did not differ significantly from that of station 4.

The oligochaeta are primarily a fresh water and terrestrial group but marine species can be found in great abundance particularly in the intertidal of sounds and estuaries (Barnes, 1963). Larsen (1936) collected oligochaetes in abundance at fresh water out-falls in the Dybsø Fjord which is in keeping with the Long Pond observation of large numbers at station 1. The density of oligochaetes dropped off rapidly through stations 2 to 5 and the organisms were not to be found in the samples taken at station 6. Such a decline is correlated with a decrease in the organic content of the sediment, an increase in the coarseness of the sediment and an increase in depth.

Diastylis rugosa was collected at stations 2 to 5 but was significantly most abundant at stations 3 and 4. Dixon (1945) maintains that the size of soil particles is vitally important in the distribution of cumacea as it determines whether the animals breathe properly for too small particles interfere with respiratory mechanisms. The presence of D. rugosa at stations 2 and 3 indicates that its respiratory apparatus is able to cope with very fine particles. The attractiveness of the substratum also depends upon the amount and kind of food available (Wieser, 1956) which may possibly account for the abundance of D. rugosa at stations 3 and 4 rather than station 2. The compaction of bottom materials may influence the degree of burrowing as has been suggested for shrimps (Williams, 1958) and hence render a substratum suitable or unsuitable. This may be the cause of the low density of the cumacea at station 5 at which the sediment was highly compacted.

The distribution of Corophium bonelli at Long Pond is unusual insofar as this species has been previously reported to build tubes of mud on solid objects (Crawford, 1937). Therefore, with regard to substratum, it would be expected to be absent from samples taken at stations 1 to 5 and most abundant at station 6. C. bonelli was taken in larger numbers at station 5 than at station 6 although the difference was not significant. Such a result would indicate that a well-packed sand is just as suitable for colonization as the cobble of station 6. However, the species was also collected in large numbers at stations 3 and 4. The mean of the samples from station 3 did not differ significantly from the means obtained for stations 5 and 6 although in the case of station 5, a confidence level of 93% which is close to significance was obtained. This indicates that even a soft silt is suitable for colonization. It also indicates that C. bonelli is capable of inhabiting sediments of high organic content which is not the case in a closely related species C. volutator (Hart, 1930).

Mya arenaria was collected in greatest abundance at station 1 where a mean of 6.7 individuals per sample was obtained. This mean is greater than that observed at any of the remaining five stations indicating a preference for the sub-tidal in Long Pond. Although a significant difference was found only between stations 2 and 4 of the next three stations, there was an increase from stations 2 to 4 in the number of individuals collected per sample. The organic content and its decomposition have been implicated in the control of pelecypod densities. Bader (1954) maintains that as the organic content and hence, food supply increases, the pelecypod population increases until bacterial decomposition and its resulting toxic by-products becomes a limiting factor; then the population decreases. _M_. _arenaria_ is a suspension-feeder and not a deposit-feeder (Blegvad, 1914) and organic detritus is of no nutritive value (Matthiessen, 1960). Nevertheless, a decrease in organic material accompanied by a decrease in the toxic by-products of bacterial activity might be responsible for the increase in the density of _M_. _arenaria_ from stations 2 to 4. Another possible correlation may be made with the increasing strength of the water currents. As the strength of the currents increases, larger amounts of organic material can be expected to be retained in suspension rather than allowed to settle out and therefore, the organism's food supply would be greater. The low mean observed at station 5 and the absence of the species in the samples from station 6 might be accounted for by the compact nature of the substratum for this animal is known to grow better in softer sediments (Swan, 1952).

The species that were assigned to group III were not collected in sufficient numbers to justify any conclusions. However, the echinoderm, Strongylocentrotus droehbachiensis is a well-known inhabitant of hard surfaces which explains its presence at station 6. The ascidian was found firmly attached to the undersurface of a rock at station 6. This fact renders it highly unlikely that the organism could have been collected in the substrata of any of the other stations.

The benthic invertebrates of Long Pond are divided into three groups with regard to their distribution. The first group included the species whose environmental requirements were such that they were limited to the substrata of only one or two stations. The second group consisted of the species which were seen to be ubiquitous in their distribution and although they were found in a variety of substrata, they did indicate preferences for those of particular stations. In the third group were placed the species that were sampled insufficiently to obtain an indication of their sediment preferences.

3. Seasonal Variation in Population at One Station

The results of the investigation into the change in the population at station 4 over a year were strongly influenced by the paucity of the fauna insofar as many species could not be collected in sufficient numbers to make trends conclusive. To sample all species adequately would have required taking an unmanageably large number of samples and therefore, conclusions must be reserved for a few species. The results of the program are tabulated in detail in appendix IV.

The most striking feature of the results of the program is the lack of any consistent gross change in the population. As evident from table XV, the total number of species fluctuated but not in a manner which would indicate a seasonal trend. The table does indicate a seasonal trend in the total population with the population rising to a maximum in late summer and declining thereafter. However, this trend is due entirely to the seasonal abundance of one organism, Corophium bonelli, and if this species is removed from the results, fluctuations in the population lose all seasonal character. These results are in keeping with earlier investigations which have been unable to detect gross seasonal changes in benthic communities (Steven, 1930; Sanders, 1956).

Although the population as a whole does not show any consistent seasonal changes, a number of species did appear in the samples in such a manner as to indicate annual trends in abundance. All the species which appeared consistently in the samples throughout the program or through part of it are listed in table XVI together with the mean number collected per sample of each at the various sampling dates.

TABLE XV

The total number of species and the mean number of animals per sample collected at the various sampling dates. The figures in brackets present the mean number of animals per sample excluding *Corophium bonelli*.

DATE	TOTAL NUMBER OF SPECIES	MEAN NUMBER OF ANIMALS/SAMPLE	
26 Oct., 64	8	4.6	(4.6)
24 Nov.	10	11.2	(11.2)
9 Dec.	16	13.0	(13.0)
18 Jan.	13	11.0	(10.8)
20 March	12	15.2	(15.2)
14 April	19	23.8	(20.4)
28 May	10	25.0	(8.4)
2 July	14	24.8	(15.2)
30 July	13	28.4	(9.4)
2 Sept.	15	28.0	(14.6)
29 Sept.	14	19.6	(18.4)
1 Nov., 65	15	12.0	(11.8)

A list of the species that were collected consistently throughout the seasonal program and the mean number per sample of each taken at the sampling dates.

DATE	SPECIES							
	Cephalothrix linearis	*Harmothoë imbricata*	*Pholoë minuta*	*Eteone longa*	*Phyllodoce mucosa*	*Nereis virens*	*Nephthys caeca*	*Scoloplos* sp.
26 Oct.	0.2	-	-	-	-	-	0.4	0.2
24 Nov.	-	-	-	0.4	1.0	0.2	0.4	1.2
9 Dec.	-	-	0.6	0.4	0.6	0.2	0.2	2.0
18 Jan.	0.2	-	0.2	0.6	-	0.2	0.4	1.4
20 March	0.2	-	0.6	1.2	-	0.4	0.2	1.0
14 April	0.4	-	1.2	1.0	0.2	0.4	0.2	1.8
28 May	-	-	0.6	0.6	-	0.8	-	1.0
2 July	-	1.4	0.2	1.0	0.4	-	-	1.2
30 July	0.4	1.2	0.2	0.6	0.2	-	-	0.8
2 Sept.	0.2	1.6	0.4	2.0	1.0	1.0	-	0.8
29 Sept.	0.4	0.2	0.6	1.4	1.6	2.4	-	0.4
1 Nov.	0.2	0.8	2.2	1.6	0.8	0.6	0.6	0.8

TABLE XVI CONTINUED

DATE				SPECIES			
	Pygospio elegans	*Polycirrus phosphoreus* (?)	*Euchone elegans*	*Diastylis rugosa*	*Dexamine spinosa*	*Corophium bonelli*	*Mya arenaria*
26 Oct.	-	0.8	0.4	1.0	-	-	0.4
24 Nov.	1.2	5.0	-	0.4	-	-	1.2
9 Dec.	0.2	2.6	-	1.0	-	-	4.0
18 Jan.	0.4	4.4	-	1.6	-	0.2	0.8
20 March	0.4	7.4	0.6	0.6	-	-	2.2
14 April	0.8	8.8	0.6	2.4	-	3.4	1.2
28 May	-	2.6	1.0	0.2	-	16.6	1.2
2 July	0.8	3.8	0.6	0.8	1.0	9.6	3.6
30 July	-	2.2	0.8	1.4	0.2	19.0	1.2
2 Sept.	-	3.0	-	2.2	1.4	13.4	0.4
29 Sept.	3.6	4.0	-	1.4	-	1.2	2.0
1 Nov.	-	1.6	-	-	-	0.2	0.8

The occurrence of Harmothoë imbricata in the samples was in an unusual manner insofar as this species was absent in all samples taken from October to May but appeared in comparatively large numbers in early July and continued to be collected for the rest of the sampling program. This immediately suggests that the species colonized an area in which it was previously absent. Larvae of H. imbricata have their maximum occurrence in the plankton in spring, summer and fall and although they are rare in winter, they may occur at any month of the year (Thorson, 1946). Hence the animal's reproductive cycle would allow colonization at the time indicated in the samples from Long Pond.

Pholoë minuta, Eteone longa and Phyllodoce mucosa were usually collected in small numbers but did appear consistently in the samples. P. minuta (figure 15) showed an irregular pattern throughout most of the year and increased in numbers sharply in late summer. This species is believed to reproduce all year round but there is evidence that maximum reproduction takes place in mid-summer for in Danish waters, small individuals are collected in great numbers in July and August (Thorson, 1946). If the increase in the population at Long Pond is to coincide with the species' period of maximum reproduction, this period must have occurred in late summer in these waters rather than mid-summer. Eteone longa (figure 16) appeared to increase in abundance throughout the sampling program and this could not be related to its reproductive cycle. The species is known to spawn in Danish waters in March and April (Thorson, 1946) and larvae have been collected in the plankton as late as August (Smidt, 1951). In figure 16, the slight dip in the curve in April

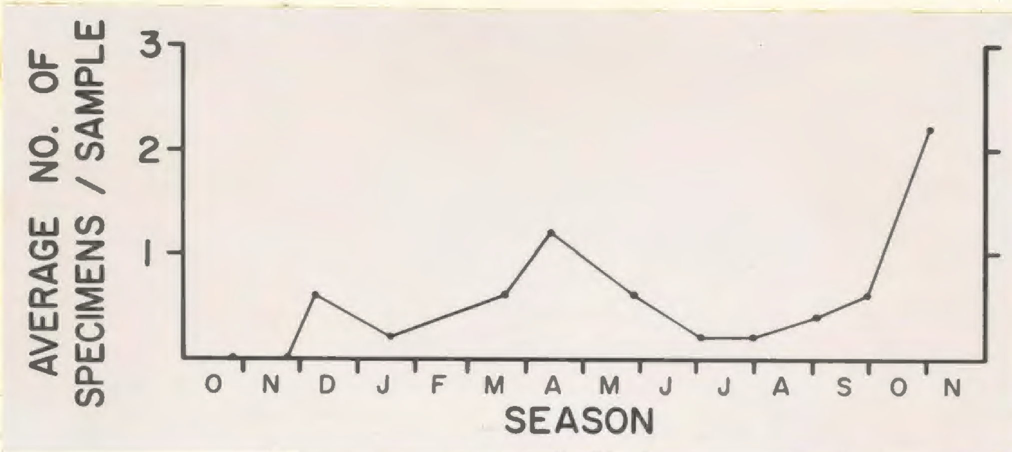

FIGURE 15. Seasonal abundance of *Pholoë minuta* at station 4 in Long Pond.

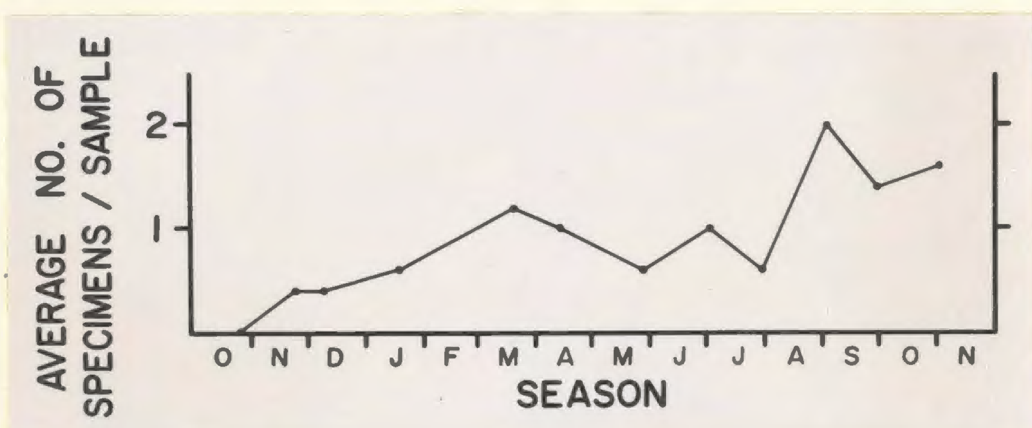

FIGURE 16. Seasonal abundance of *Eteone longa* at station 4 in Long Pond.

and May might correspond to the death of spawned adults and the sharp rise in September, to the settlement of young but the numbers of individuals and samples involved are hardly sufficient to substantiate this. Figure 17 indicates the two peaks that appeared in the abundance of Phyllodoce mucosa and it must be noted that the 1965 peak occurred about two months earlier than the 1964 peak. These peaks probably follow the time at which the settlement of young of this species is at a maximum. Adults laden with eggs have been collected in New England waters in July (Pettibone, 1963) which would indicate a mid-summer spawning. Two closely related species, P. groenlandica and P. maculata are known seasonal spawners (Thorson, 1946).

Scoloplos sp. (figure 18) occurred in the samples both consistently and in comparatively large numbers. The population showed an initial sharp rise to a peak in December and declined slowly thereafter to a low in September. Although there was a slight increase again in November, it was not sufficient to indicate that the pattern was to be repeated. In Danish waters, Scoloplos armiger spawns primarily in spring but minor spawnings may take place in the fall; the species does not undergo a pelagic larval life (Thorson, 1946; Smidt, 1951). The time of the sharp increase in abundance of the Long Pond species would lead one to suspect a major fall spawning in 1964.

Polycirrus phosphoreus (?) (figure 19) showed a very marked peak in late winter and the large number of individuals involved renders it highly conclusive. Euchone elegans (figure 20) was collected in small numbers; however it was consistent in its

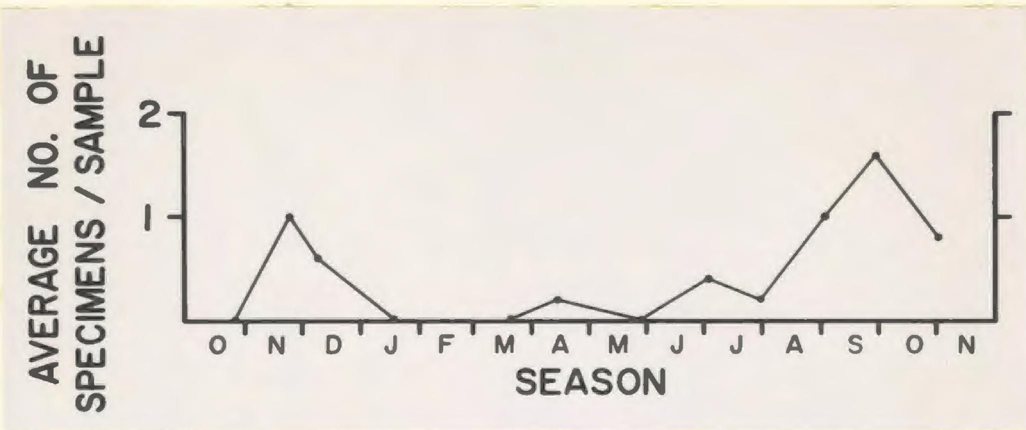

FIGURE 17. Seasonal abundance of Phyllodoce mucosa at station 4 in Long Pond.

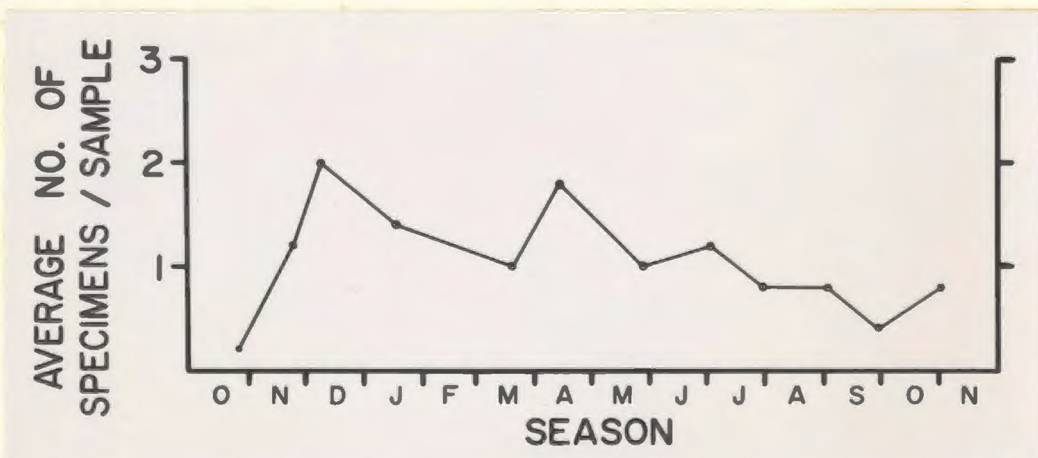

FIGURE 18. Seasonal abundance of Scoloplos sp. at station 4 in Long Pond.

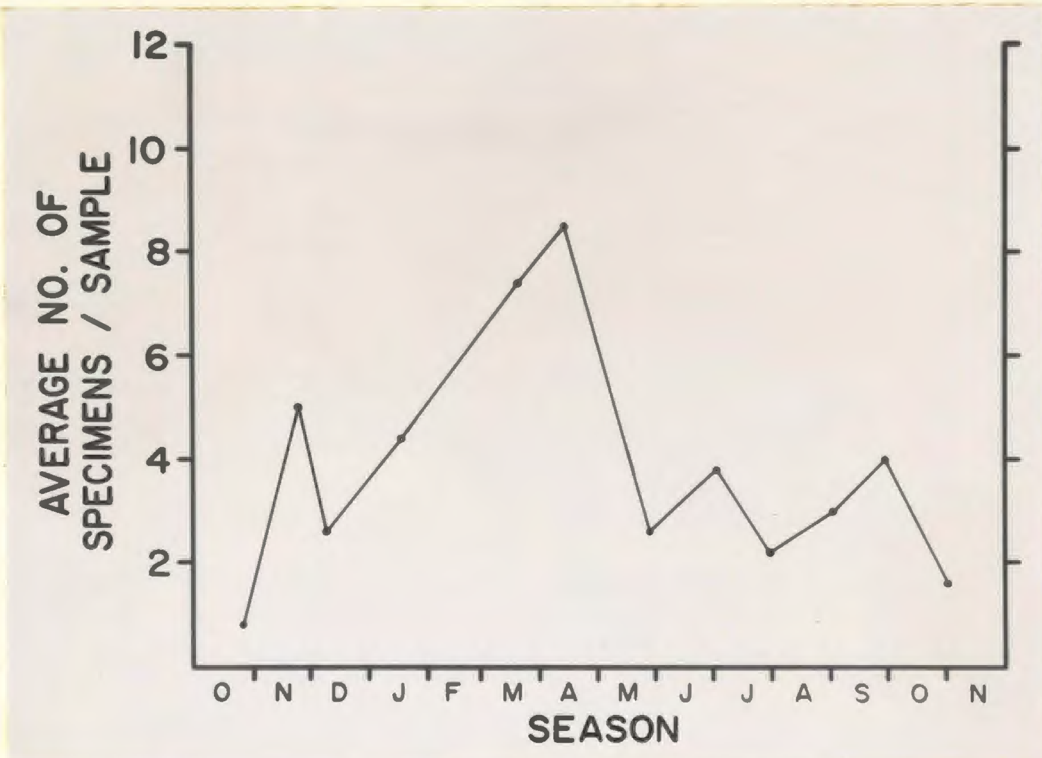

FIGURE 19. Seasonal abundance of Polycirrus phosphoreus (?) at station 4 in Long Pond.

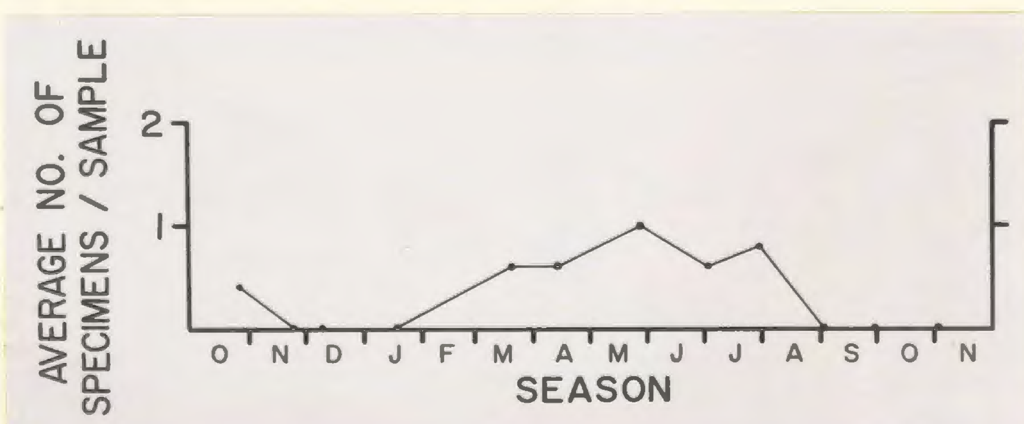

FIGURE 20. Seasonal abundance of Euchone elegans at station 4 in Long Pond.

appearance over a limited season and its absence for the remainder of the year which indicates that the observation is a valid one and not the product of sampling error. Literature pertaining to the reproductive cycle of *Polycirrus* could not be located and reproduction in *Euchone* is apparently unknown. Therefore, these observations could not be interpreted in the light of the reproductive cycles of these species.

The amphipods *Dexamine spinosa* and *Corophium bonelli* were both seen to be highly seasonal in their abundance. *D. spinosa* was collected in small numbers but only in the summer. *C. bonelli* (figure 21) occurred in large numbers in the samples taken in the summer but was also collected in the spring and in the fall. Many littoral amphipods of widely differing genera follow a life cycle in which several broods are hatched each year with the last brood maturing slowly through the winter to breed in the spring; most of the adults die off in the winter (Blegvad, 1922; Hart, 1930). The results indicate that *D. spinosa* follows this pattern and *C. bonelli* is known to do so (Crawford, 1937). It is difficult to explain the absence of *C. bonelli* in the majority of the samples taken in the winter; only one specimen was recorded in January. The young are small and most can be expected to be lost through the screens when sieving samples. However, it is doubtful that all would have been lost in this manner. Either the species must have been present in the winter at station 4 in such small numbers that it was not collected or the entire population died off and the station was recolonized by immigration from another locality.

The observations on the remaining species listed in table

FIGURE 21. Seasonal abundance of Corophium bonelli at station 4 in Long Pond.

XVI are inconclusive. The majority of these species did not appear in the samples in sufficient numbers and were highly irregular in their abundance. Diastylis rugosa and Mya arenaria were collected in large numbers but both were highly irregular. Furthermore, it is felt that there was considerable error in the sampling of the latter species. That the Ekman dredge does sample the species adequately in Long Pond when a maximum volume of sample is recovered has been previously explained. In the seasonal program, 100% sampling efficiency could not be obtained and it is strongly suspected that the sediment was not sampled to all depths inhabited by M. arenaria.

Most of the species that comprised the benthic fauna at station 4 were present in such small numbers that they could not be sampled adequately to demonstrate seasonal changes in the population. A number of species did show indications of seasonal abundance despite the fact that only several specimens were usually collected at any sampling date. Harmothoë imbricata, Scoloplos sp. Polycirrus phosphoreus (?) and Corophium bonelli were collected in large numbers and therefore, changes that were observed in the populations of these species were highly meaningful. Changes in the abundance of species were related to their life cycles where possible.

V. SUMMARY AND CONCLUSIONS

The environment in Long Pond is similar to that of a lagoon. The pond consisted of two small basins which were connected by a channel and separated from Conception Bay by a barachois. The complex drained into Conception Bay via a short channel through the barachois at the extreme north west end of the pond. The eastern basin, which was chosen for this study, was a shallow body of water with a mean depth of 2.7 m. at average high tide and covered an area of approximately 260,000 sq. m. or about 65 acres.

As would be expected in a small, shallow body of water, environmental parameters were found to fluctuate greatly in the course of a year. The temperature was seen to vary greatly in the water at the bottom as well as in the surface water. The range of temperature fluctuations in sediment has been demonstrated to decrease rapidly with depth (Johnson, 1965). The benthic invertebrates collected at Long Pond are believed to inhabit the upper-most layers of the sediment and therefore, can be expected to experience a temperature regime which approximates that of the bottom water.

The salinity was found to fluctuate widely in the surface water but to a much smaller extent in the bottom water. Fluctuations in the salinity of the surface water were greatest during the spring when terrestrial run-off was highest and an annual range of 16.18‰ to 31.85‰ was recorded. A much smaller range, 28.03‰ to 31.89‰, was observed in the bottom water. Salinity was therefore of particular concern to the shallow water communities at stations 1 and 6. In tropical areas, mass mortality of littoral organisms through severe reduction of salinity is known to occur after unusually heavy rainfalls (Goodbody, 1961). However north-boreal, littoral animals are generally eurybiontic, able to tolerate wide ranges of temperature and salinity (Mokyevsky, 1960) which is obviously applicable to the fauna of Long Pond. There are limits to this eurybionty and in areas of extreme and repeated reduction of salinity such as in some of the fjords of Greenland (Thorson, 1933) and bays of the Canadian arctic (Ellis, 1955), the littoral fauna is permanently reduced.

The oxygen concentration was always found to be near saturation in the bottom water as well as in the surface water. The seasonal trend in the oxygen concentration was related to the seasonal trend in the temperature and ascribed to the effect of temperature on the solubility of oxygen in water. The benthic invertebrates are more concerned with the oxygen concentration of the interstitial water in the sediment unless they are in a position to draw oxygen from the overlying water. The sediment covering most of the pond's bottom has been shown to be very fine which would impede the circulation of water necessary to replenish the oxygen supply. Drainage, the most significant factor influencing the oxygen content of the interstitial water of intertidal substrata (Brafield, 1964), obviously cannot occur. Furthermore, the high organic content of the sediment indicates an abundance of oxidizable material, the decomposition of which would deplete the available oxygen in the sediment. The odour of hydrogen sulphide was frequently detected when benthic samples were taken attesting to the fact that the oxygen content of the interstitial water was extremely low. This condition limits the depth of penetration of the benthos to strata in which they can maintain contact with the overlying water and therefore, most of the animals can be expected to be found only in the surface sediments.

A further aspect of the high organic content is the extensive bacterial activity known to take place in such sediments. Zobell and Feltham (1942) suggest this as an important source of food for mud-dwelling animals and illustrate by estimating a production rate of 11 g. of bacteria (dry weight) per cubic foot of mud per day in a California mud flat. Bader (1954) points out that bacterial activity and its resulting toxic by-products act as a limiting factor on pelecypod densities in sediments of high organic content. This correlates favourably with the low pelecypod densities at stations 2, 3 and 4 but is contradicted by the high pelecypod density observed at station 1. However, station 1 differed from the former three insofar as it was situated in very shallow water, being exposed by especially low tides, and the organic matter was of a different nature, being poorly decomposed.

Three benthic communities were recognized from Long Pond: the infaunal Macoma-Mya and Polycirrus-Mya communities and the epifaunal Mytilus-Littorina community. Both the Macoma and Mytilus communities were seen to be characterized by high standing crops when compared to benthic communities in general. In comparisons on a community basis, the biomass of the Macoma community was seen to be high and that of the Mytilus community, approximately average.

Considering the geographical area, the high standing crops are not unusual insofar as north-boreal, littoral communities are generally characterized by high biomasses although low productivities (Mokyevsky, 1960). On the other hand, the Polycirrus community was characterized by a low standing crop. The estimates approximated those of other mud communities excluding Macoma communities but nevertheless, they are low in comparison to benthic communities in general. Since this community occupied over 95% of the area under study, the biomass estimates substantiate Kennedy's (1964) hypothesis that inadequate food supply is responsible for the small winter flounder population in Long Pond.

Except for the Macoma community of station 1, the benthic populations of Long Pond were numerically neither especially high nor especially low when compared to benthic communities in general. The Macoma community however, was found to have a high population when compared to previously reported Macoma communities. The number of species collected in Long Pond was low in comparison to those obtained in benthic investigations in more oceanic waters; however this is to be anticipated insofar as estuarine localities are known to harbour fewer species than oceanic areas (Gunter, 1961).

The distribution of the species that were collected was examined in relation to the substratum. Most of the species were found to be restricted to the substrata of one or two stations and therefore, were considered to be indicative of the environmental conditions that these substrata reflected. A number were found to be more widely distributed but did show preferences for certain sediments. Where possible, these preferences were correlated with the sediment class and hence the particle size, the organic content and the degree of compaction of the sediment and the depth of the water. Several species were not collected in sufficient numbers to justify conclusions regarding their distribution.

In attempting to demonstrate the seasonal changes in the benthos of station 4, it was found that the fauna was so poor that most species were not sampled adequately to give any indication of seasonal changes in their populations. However, sufficient numbers of some species were obtained to indicate seasonal trends and a few species were represented well enough for these trends to be conclusive. Where possible, the population changes that were observed were related to the life cycles of the species concerned. A gross seasonal change in the benthic population was not detected which is in agreement with the results of Steven (1930) and Sanders (1956). This may be ascribed to the fact that what changes did occur balanced each other out over the year. On the other hand, Shimadzu and Yamane (1948) were able to demonstrate two seasonal peaks in the numbers of benthic individuals in Tokyo Bay and related these peaks to the spawning of molluscs and annelids.

Of the three benthic communities recognized in Long Pond, the *Macoma* community is the most important to be considered with respect to the theory of parallel level-bottom animal communities insofar as this theory deals primarily with infaunal communities. The distribution of *Macoma* communities in European, Icelandic and Greenland waters has been well documented (Petersen, 1914; Spärck, 1935; Thorson, 1957). Ellis (1959, 1960) reported *Macoma* communities in arctic North America. On the Pacific coast of North America, a *Macoma* community has been described from the San Juan Channel (Wismer and Swanson, 1935). The above mentioned reports point out that *Macoma* communities are characteristic of shallow water, soft substrata particularly in estuarine localities. *M. calcarea* is the arctic species of *Macoma* communities and is replaced to the south by *M. balthica*. *Mya truncata* is found with *M. calcarea* as an important characterizing species of the community and is replaced in the *M. balthica* community by *Mya arenaria*. This north to south transition within the *Macoma* community has been well demonstrated in the eastern Atlantic and adjacent seas. Although *M. calcarea* communities have been reported in the Canadian arctic and in Greenland, descriptions of *M. balthica* communities in western waters could not be located. The range of *M. balthica* in the western Atlantic is known to extend to arctic waters (Abbott, 1954; Bousfield, 1960). The community can therefore be expected to be found and this study describes one example.

The *Polycirrus*-*Mya* community could not be examined in the light of the theory of parallel level-bottom animal communities insofar as a previous record of it could not be located. Its description must be regarded as tentative for on the basis of an investigation into only one locality, it is not feasible to consider it a valid community in the Petersen concept. Furthermore, because of its affinities with *Macoma* communities, it must be viewed with even more caution.

The *Mytilus* community is a widely distributed, shallow water, epifaunistic community of rocks and stones. Newcombe (1935) details the animal associations of this community in the Bay of Fundy area. The northern limits of the range of this species in eastern arctic

North America are reviewed by Lubinsky (1958). The *Mytilus* community is distributed along the northern and western coasts of Europe where it appears to correspond to the infaunistic *Macoma balthica* community (Spärck, 1935). Spärck (1935) regards the *Hiatella arctica* community described by Thorson (1933) from the Franz Joseph Fjord as corresponding to the *M. calcarea* infauna and postulates that the community may have a wide distribution in the arctic. *Mytilus edulis* extends far into the arctic (Lubinsky, 1958; Ellis & Wilce, 1961) and *Hiatella arctica* is found from the Arctic Ocean to the West Indies (Bousfield, 1960). Although there is complete over-lap in the distribution of these two species, whether their relative abundance is such as to give rise to two communities which replace each other from north to south must await the accumulation of more information.

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APPENDICES

APPENDIX I

TABLE 1

Seasonal variation in temperature (°C)

DATE	Long Pond Surface	Long Pond Bottom	Conception Bay
26 October, 1964	7.8	8.4	7.6
24 November	5.4	6.8	5.9
9 December	1.1	1.8	2.2
18 January	-0.1	1.4	1.8
27 February	-0.5		-1.1
20 March	0.3	1.6	0.1
14 April	3.8	3.3	2.2
28 May	6.8	5.9	5.8
2 July	11.6	10.15	10.2
30 July	18.25	15.1	15.1
2 September	12.9	12.9	10.6
29 September	10.8	11.4	11.2
1 November, 1965	8.6	7.0	9.0

APPENDIX I

TABLE 2

Seasonal variation in dissolved oxygen concentration (ml.(N.T.P.)/l.)

DATE	Long Pond Surface	Long Pond Bottom	Conception Bay
26 October, 1964		6.65	
24 November	7.45	7.30	7.27
9 December	7.48	7.40	7.43
18 January	8.23	8.14	7.83
27 February	8.74		8.47
20 March	8.32	8.40	8.10
14 April	7.61	8.65	8.42
28 May	7.16	7.29	7.11
2 July	5.84	6.19	6.28
30 July	4.40	4.54	5.22
2 September	5.87	6.00	6.98
29 September	6.00	5.93	6.17
1 November	7.05	7.02	6.07

APPENDIX I

TABLE 3

Seasonal variation in salinity (‰)

DATE	Long Pond Surface	Long Pond Bottom	Conception Bay
26 October, 1964		29.99	30.11
24 November	26.20	28.03	31.24
9 December	29.92	30.37	31.58
18 January	30.25	30.34	32.45
27 February	16.18		32.45
20 March	28.62	29.74	31.04
14 April	19.47	29.05	30.67
28 May	27.02	30.81	31.51
2 July	31.22	31.17	31.11
30 July	31.35	31.38	31.49
2 September	31.85	31.89	32.09
29 September	31.38	31.38	31.46
1 November, 1965	29.70	29.72	31.44

APPENDIX I

TABLE 4

Seasonal variation in density

DATE	Long Pond (Surface)	Conception Bay
26 October, 1964	1.0240	
24 November	1.0200	1.0240
9 December	1.0237	1.0250
18 January	1.0240	1.0255
27 February	1.0200	1.0250
20 March	1.0220	1.0245
14 April	1.0145	1.0240
28 May	1.0220	1.0240
2 July	1.0230	1.0238
30 July	1.0229	1.0233
2 September	1.0233	1.0245
29 September	1.0240	1.0240
1 November, 1965	1.0240	1.0240

APPENDIX II

The infaunal and epifaunal organisms collected at the six stations in Long Pond presented with the number and dry weight of the species in each sample and the percentage composition of the biomass of each sample.

Table 1

Station 1 - Infauna

Number of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone heteropoda	2	1	-	1	5	4	4	3	1	-
Nereis virens	4	6	5	5	8	3	7	6	5	9
OLIGOCHAETA										
Oligochaeta	29	28	20	30	29	18	26	36	31	20
PELECYPODA										
Macoma balthica	8	4	5	4	5	2	1	4	2	2
Mya arenaria	11	4	7	6	5	11	10	1	5	7

Table 2

Station 1 - Epifauna

Number of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
CRUSTACEA										
Gammarus lawrencianus	-	1	-	-	-	-	-	-	-	-

APPENDIX II

Table 3

Station 1 - Infauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone heteropoda	0.0012	0.0005	-	0.0003	0.0022	0.0019	0.0011	0.0006	0.0002	-
Nereis virens	0.0054	0.0226	0.0251	0.0124	0.0170	0.0284	0.0230	0.0210	0.0313	0.0296
OLIGOCHAETA										
Oligochaeta	0.0637	0.0440	0.0570	0.0707	0.0802	0.0448	0.0734	0.0867	0.0903	0.0741
PELECYPODA										
Macoma balthica	4.3189	1.8963	2.0395	2.7643	2.1311	0.8769	0.3153	2.3840	0.8270	1.2078
Mya arenaria	1.4515	0.7516	0.3415	0.3317	0.4540	1.0634	0.7221	0.0542	0.7993	0.9240

Table 4

Station 1 - Epifauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
CRUSTACEA										
Gammarus lawrencianus	-	0.0008	-	-	-	-	-	-	-	-

APPENDIX II

Table 5

Station 1 - Infauna

Percentage composition of the biomass of each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone heteropoda	0.02	0.01	-	0.01	0.08	0.09	0.09	0.02	0.01	-
Nereis virens	0.09	0.83	1.01	0.39	0.63	1.40	2.02	0.82	1.79	1.32
OLIGOCHAETA										
Oligochaeta	1.09	1.62	2.31	2.22	2.98	2.22	6.46	3.40	5.16	3.31
PELECYPODA										
Macoma balthica	73.94	69.82	82.80	86.94	79.38	43.50	27.78	93.61	47.30	54.02
Mya arenaria	24.85	27.67	13.86	10.43	16.91	52.76	63.62	2.12	45.72	41.33

Table 6

Station 1 - Epifauna

Percentage composition of the biomass of each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
CRUSTACEA										
Gammarus lawrencianus	-	0.02	-	-	-	-	-	-	-	-

APPENDIX II

Table 7

Station 2 - Infauna

Number of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	5	3	5	7	1	8	3	8	6	3
POLYCHAETA										
Eteone heteropoda	-	-	-	-	-	-	1	-	-	-
Eteone longa	4	-	-	2	1	1	1	1	1	-
Phyllodoce mucosa	-	-	-	-	-	-	1	3	-	1
Nereis virens	-	-	1	1	-	-	-	1	-	-
Nephthys caeca	-	1	-	-	-	-	-	-	-	-
Scoloplos sp.	-	1	-	1	-	-	-	-	-	-
Pygospio elegans	-	-	3	-	-	-	-	4	-	-
Polycirrus phosphoreus (?)	7	10	8	12	9	7	5	11	7	8
OLIGOCHAETA										
Oligochaeta	7	3	6	4	7	5	12	1	3	5
CRUSTACEA										
Diastylis rugosa	-	-	-	1	-	-	-	-	-	-
PELECYPODA										
Mya arenaria	-	-	3	-	1	-	-	2	-	2

APPENDIX II

Table 8

Station 2 - Infauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	0.0106	0.0087	0.0099	0.0115	0.0037	0.0108	0.0063	0.0160	0.0126	0.0063
POLYCHAETA										
Eteone heteropoda	-	-	-	-	-	-	0.0003	-	-	-
Eteone longa	0.0014	-	-	0.0021	0.0004	0.0006	0.0008	0.0002	0.0002	-
Phyllodoce mucosa	-	-	-	-	-	-	0.0005	0.0015	-	0.0018
Nereis virens	-	-	0.0170	0.0013	-	-	-	0.0032	-	-
Nephthys caeca	-	0.0500	-	-	-	-	-	-	-	-
Scoloplos sp.	-	0.0010	-	0.0004	-	-	-	-	-	-
Pygospio elegans	-	-	0.0008	-	-	-	-	0.0007	-	-
Polycirrus phosphoreus (?)	0.0729	0.0724	0.0611	0.0611	0.0750	0.0428	0.0503	0.0500	0.0333	0.0509
OLIGOCHAETA										
Oligochaeta	0.0144	0.0053	0.0129	0.0092	0.0102	0.0158	0.0243	0.0034	0.0065	0.0120
CRUSTACEA										
Diastylis rugosa	-	-	-	0.0001	-	-	-	-	-	-
PELECYPODA										
Mya arenaria	-	-	0.5321	-	0.0314	-	-	0.0518	-	0.0390

APPENDIX II

Table 9

Station 2 - Infauna

Percentage composition of the biomass of each sample

	SAMPLE									
SPECIES	1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	10.67	6.30	1.56	13.36	3.07	15.43	7.55	12.56	23.86	5.72
POLYCHAETA										
Eteone heteropoda	-	-	-	-	-	-	0.36	-	-	-
Eteone longa	1.41	-	-	2.44	0.33	0.86	0.96	0.16	0.38	-
Phyllodoce mucosa	-	-	-	-	-	-	0.60	1.18	-	1.63
Nereis virens	-	-	2.68	1.51	-	-	-	2.51	-	-
Nephthys caeca	-	36.21	-	-	-	-	-	-	-	-
Scoloplos sp.	-	0.72	-	0.46	-	-	-	-	-	-
Pygospio elegans	-	-	0.13	-	-	-	-	0.55	-	-
Polycirrus phosphoreus (?)	73.41	52.43	9.64	70.96	62.14	61.14	60.31	39.25	63.07	46.23
OLIGOCHAETA										
Oligochaeta	14.50	3.84	2.03	10.69	8.45	22.47	29.14	2.67	12.31	10.90
CRUSTACEA										
Diastylis rugosa	-	-	-	0.12	-	-	-	-	-	-
PELECYPODA										
Mya arenaria	-	-	83.93	-	26.01	-	-	40.66	-	35.42

APPENDIX II

Table 10

Station 2 - Epifauna

Number of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	-	1	-	-	-	-	-	-	-	-
Pholoë minuta	-	-	-	1	-	-	1	1	1	1
CRUSTACEA										
Corophium bonelli	-	-	2	-	-	-	-	1	-	-

Table 11

Station 3 - Epifauna

Number of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	-	-	-	-	1	-	-	1	4	2
Pholoë minuta	1	-	-	-	-	2	-	1	-	-
Nereis pelagica	1	-	-	-	-	-	-	-	-	-
CRUSTACEA										
Corophium bonelli	19	2	33	12	38	15	7	14	41	16

APPENDIX II

Table 12

Station 2 - Epifauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	-	0.0007	-	-	-	-	-	-	-	-
Pholoë minuta	-	-	-	0.0004	-	-	0.0009	0.0005	0.0002	0.0018
CRUSTACEA										
Corophium bonelli	-	-	0.0002	-	-	-	-	0.0001	-	-

Table 13

Station 3 - Epifauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	-	-	-	-	0.0005	-	-	0.0003	0.0039	0.0005
Pholoë minuta	0.0004	-	-	-	-	0.0016	-	0.0004	-	-
Nereis pelagica	0.0025	-	-	-	-	-	-	-	-	-
CRUSTACEA										
Corophium bonelli	0.0023	0.0005	0.0053	0.0020	0.0083	0.0030	0.0013	0.0023	0.0065	0.0012

APPENDIX II

Table 14

Station 2 - Epifauna

Percentage composition of the biomass of each sample

SPECIES	1	2	3	4	5	6	7	8	9	10
					SAMPLE					
POLYCHAETA										
Harmothoë imbricata	-	0.51	-	-	-	-	-	-	-	-
Pholoë minuta	-	-	-	0.46	-	-	1.08	0.39	0.38	0.18
CRUSTACEA										
Corophium bonelli	-	-	0.03	-	-	-	-	0.08	-	-

Table 15

Station 3 - Epifauna

Percentage composition of the biomass of each sample

SPECIES	1	2	3	4	5	6	7	8	9	10
					SAMPLE					
POLYCHAETA										
Harmothoë imbricata	-	-	-	-	0.57	-	-	0.33	2.02	0.19
Pholoë minuta	0.62	-	-	-	-	0.95	-	0.45	-	-
Nereis pelagica	3.88	-	-	-	-	-	-	-	-	-
CRUSTACEA										
Corophium bonelli	3.57	0.41	2.17	5.74	9.43	1.79	3.22	2.56	3.37	0.45

APPENDIX II

Table 16

Station 3 - Infauna

Number of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	5	-	-	1	-	-	-	-	-	-
POLYCHAETA										
Eteone heteropoda	-	1	-	-	-	-	-	1	-	2
Eteone longa	-	-	-	-	2	1	1	3	2	-
Nereis virens	1	1	2	1	-	-	-	1	-	1
Scoloplos sp.	1	2	3	1	3	-	-	1	2	-
Pygospio elegans	-	-	-	-	-	-	-	3	-	1
Pectinaria sp.	-	-	1	-	-	-	-	-	-	-
Polycirrus phosphoreus (?)	4	3	3	4	5	5	2	7	4	2
OLIGOCHAETA										
Oligochaeta	2	3	-	4	3	8	1	9	2	4
CRUSTACEA										
Diastylis rugosa	1	1	2	1	-	7	4	2	-	-
PELECYPODA										
Mya arenaria	-	1	2	-	-	3	1	-	6	4

APPENDIX II

Table 17

Station 3 - Infauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	0.0129	-	-	0.0074	-	-	-	-	-	-
POLYCHAETA										
Eteone heteropoda	-	0.0010						0.0002	-	0.0003
Eteone longa	-	-	-	-	0.0012	0.0004	0.0003	0.0005	0.0019	-
Nereis virens	0.0176	0.0062	0.1356	0.0092	-	-	-	0.0384	-	0.0834
Scoloplos sp.	0.0006	0.0010	0.0033	0.0002	0.0032	-	-	0.0003	0.0026	-
Pygospio elegans	-	-	-	-	-	-	-	0.0007	-	0.0002
Pectinaria sp.	-	-	0.0145	-	-	-	-	-	-	-
Polycirrus phosphoreus (?)	0.0236	0.0277	0.0188	0.0108	0.0711	0.0324	0.0105	0.0300	0.0315	0.0093
OLIGOCHAETA										
Oligochaeta	0.0042	0.0018	-	0.0048	0.0037	0.0120	0.0028	0.0157	0.0024	0.0065
CRUSTACEA										
Diastylis rugosa	0.0004	0.0003	0.0005	0.0004	-	0.0010	0.0006	0.0009	-	-
PELECYPODA										
Mya arenaria	-	0.0851	0.0652	-	-	0.1174	0.0248	-	0.1439	0.1647

APPENDIX II

Table 18

Station 3 - Infauna

Percentage composition of the biomass of each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	20.00	-	-	21.26	-	-	-	-	-	-
POLYCHAETA										
Eteone heteropoda	-	0.80	-	-	-	-	-	0.22	-	0.49
Eteone longa	-	-	-	-	1.36	0.24	0.74	0.56	0.99	-
Nereis virens	27.29	5.01	55.75	26.43	-	-	-	42.81	-	31.22
Scoloplos sp.	0.93	0.80	1.35	0.57	3.64	-	-	0.33	1.35	-
Pygospio elegans	-	-	-	-	-	-	-	0.78	-	0.07
Pectinaria sp.	-	-	5.96	-	-	-	-	-	-	-
Polycirrus phosphoreus (?)	36.59	22.41	7.73	31.03	80.80	19.31	26.05	33.44	16.35	3.48
OLIGOCHAETA										
Oligochaeta	6.51	1.45	-	13.79	4.20	7.15	6.94	17.50	1.25	2.43
CRUSTACEA										
Diastylis rugosa	0.62	0.24	0.20	1.14	-	0.60	1.48	1.00	-	-
PELECYPODA										
Mya arenaria	-	68.85	26.80	-	-	69.96	61.53	-	74.60	61.66

APPENDIX II

Table 19

Station 4 - Infauna

Numbers of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	-	-	-	-	-	-	1	-	1	1
POLYCHAETA										
Eteone heteropoda	-	-	-	-	-	-	-	-	1	-
Eteone longa	1	1	-	3	1	2	-	-	-	2
Phyllodoce mucosa	-	1	-	-	-	-	-	1	-	-
Nereis virens	2	1	-	-	-	-	-	-	-	-
Nephthys caeca	-	-	-	-	-	-	-	-	-	1
Scoloplos sp.	3	-	3	3	1	1	-	1	-	2
Pygospio elegans	4	-	1	1	1	-	-	-	1	1
Capitellidae	1	-	1	1	-	-	1	-	-	1
Polycirrus phosphoreus (?)	9	10	6	3	9	11	8	9	5	9
OLIGOCHAETA										
Oligochaeta	-	2	-	-	1	2	1	1	1	-
CRUSTACEA										
Diastylis rugosa	1	-	-	4	2	-	2	2	1	1
PELECYPODA										
Crenella faba	-	-	-	-	2	-	1	2	-	-
Macoma balthica	1	-	-	-	-	-	-	-	-	-
Mya arenaria	5	3	4	3	1	4	3	2	3	-

APPENDIX II

Table 20

Station 4 - Infauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	-	-	-	-	-	-	0.0031	-	0.0054	0.0029
POLYCHAETA										
Eteone heteropoda	-	-	-	-	-	-	-	-	0.0010	-
Eteone longa	0.0005	0.0003	-	0.0017	0.0004	0.0007	-	-	-	0.0016
Phyllodoce mucosa	-	0.0010	-	-	-	-	-	0.0003	-	-
Nereis virens	0.0746	0.0188	-	-	-	-	-	-	-	-
Nephthys caeca	-	-	-	-	-	-	-	-	-	0.0220
Scoloplos sp.	0.0061	-	0.0093	0.0019	0.0005	0.0035	-	0.0006	-	0.0059
Pygospio elegans	0.0007	-	0.0002	0.0001	0.0001	-	-	-	0.0001	0.0002
Capitellidae	0.0006	-	0.0004	0.0002	-	-	0.0005	-	-	0.0003
Polycirrus phosphoreus (?)	0.0569	0.0484	0.0609	0.0297	0.0568	0.0451	0.0975	0.0674	0.0736	0.0756
OLIGOCHAETA										
Oligochaeta	-	0.0034	-	-	0.0006	0.0042	0.0047	0.0029	0.0023	-
CRUSTACEA										
Diastylis rugosa	0.0001	-	-	0.0004	0.0002	-	0.0005	0.0002	0.0001	0.0001
PELECYPODA										
Crenella faba	-	-	-	-	0.0106	-	0.0044	0.0060	-	-
Macoma balthica	0.5194	-	-	-	-	-	-	-	-	-
Mya arenaria	0.1451	0.0458	0.1606	0.0778	0.0419	0.0432	0.0791	0.0782	0.0938	-

APPENDIX II

Table 21

Station 4 - Infauna

Percentage composition of the biomass in each sample

SPECIES	1	2	3	4	5	6	7	8	9	10
NEMERTEA										
Cephalothrix linearis	-	-	-	-	-	-	1.60	-	3.01	2.59
POLYCHAETA										
Eteone heteropoda	-	-	-	-	-	-	-	-	0.56	-
Eteone longa	0.06	0.25	-	1.50	0.44	3.51	-	-	-	1.43
Phyllodoce mucosa	-	0.83	-	-	-	-	-	0.19	-	-
Nereis virens	9.23	15.55	-	-	-	-	-	-	-	-
Nephthys caeca	-	-	-	-	-	-	-	-	-	19.66
Scoloplos sp.	0.75	-	3.96	1.68	0.44	3.51	-	0.38	-	5.27
Pygospio elegans	0.09	-	0.09	0.09	0.09	-	-	-	0.06	0.18
Capitellidae	0.07	-	0.17	0.18	-	-	0.26	-	-	0.27
Polycirrus phosphoreus (?)	7.03	40.03	25.94	26.26	50.04	45.24	50.39	43.23	41.07	67.56
OLIGOCHAETA										
Oligochaeta	-	2.81	-	-	0.53	4.21	2.43	1.86	1.28	-
CRUSTACEA										
Diastylis rugosa	0.01	-	-	0.35	0.18	-	0.26	0.13	0.06	0.09
PELECYPODA										
Crenella faba	-	-	-	-	9.34	-	2.27	3.85	-	-
Macoma balthica	64.28	-	-	-	-	-	-	-	-	-
Mya arenaria	17.96	37.88	68.40	68.79	36.92	43.33	40.88	50.16	52.33	-

APPENDIX II

Table 22

Station 4 - Epifauna

Numbers of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	-	-	1	-	-	-	-	-	-	-
Pholoë minuta	18	2	3	-	1	2	2	-	-	1
CRUSTACEA										
Corophium bonelli	12	15	14	5	6	12	15	2	14	16
PELECYPODA										
Hiatella (*Saxicava*) *arctica*	1	-	-	-	-	-	-	-	-	-

Table 23

Station 5 - Epifauna

Numbers of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	4	1	1	2	-	4	4	1	1	-
Pholoë minuta	1	-	-	1	-	-	1	-	-	-
CRUSTACEA										
Corophium bonelli	33	25	15	41	25	18	37	25	55	26
GASTROPODA										
Acmaea testudinalis	-	1	-	-	-	1	3	-	-	-
Littorina littorea	-	1	-	2	-	-	2	-	1	-
PELECYPODA										
Mytilus edulis	-	-	-	-	-	1	-	-	-	-

APPENDIX II

Table 24

Station 4 - Epifauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	-	-	0.0003	-	-	-	-	-	-	-
Pholoë minuta	0.0017	0.0003	0.0013	-	0.0001	0.0007	0.0008	-	-	0.0003
CRUSTACEA										
Corophium bonelli	0.0013	0.0029	0.0018	0.0013	0.0023	0.0023	0.0029	0.0003	0.0029	0.0030
PELECYPODA										
Hiatella (Saxicava) arctica	0.0011	-	-	-	-	-	-	-	-	-

Table 25

Station 5 - Epifauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	0.0037	0.0003	0.0005	0.0013	-	0.0112	0.0107	0.0016	0.0003	-
Pholoë minuta	0.0007	-	-	0.0005	-	-	0.0005	-	-	-
CRUSTACEA										
Corophium bonelli	0.0050	0.0033	0.0025	0.0080	0.0040	0.0030	0.0065	0.0035	0.0075	0.0043
GASTROPODA										
Acmaea testudinalis	-	0.0045	-	-	-	0.0015	0.0096	-	-	-
Littorina littorea	-	2.4677	-	5.4308	-	-	8.5383	-	2.4423	-
PELECYPODA										
Mytilus edulis	-	-	-	-	-	0.0061	-	-	-	-

APPENDIX II

Table 26

Station 4 - Epifauna

Percentage composition of the biomass of each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	-	-	0.13	-	-	-	-	-	-	-
Pholoë minuta	0.21	0.25	0.55	-	0.09	0.70	0.41	-	-	0.27
CRUSTACEA										
Corophium bonelli	0.16	2.40	0.77	1.15	2.03	2.31	1.50	0.19	1.62	2.68
PELECYPODA										
Hiatella (Saxicava) arctica	0.14	-	-	-	-	-	-	-	-	-

Table 27

Station 5 - Epifauna

Percentage composition of the biomass of each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Harmothoë imbricata	20.33	0.01	4.10	0.02	-	4.88	0.12	14.68	0.01	-
Pholoë minuta	3.85	-	-	0.01	-	-	0.01	-	-	-
CRUSTACEA										
Corophium bonelli	27.47	0.13	20.49	0.15	33.90	1.31	0.07	32.11	0.31	15.47
GASTROPODA										
Acmaea testudinalis	-	0.18	-	-	-	0.65	0.11	-	-	-
Littorina littorea	-	99.46	-	99.70	-	-	97.53	-	99.47	-
PELECYPODA										
Mytilus edulis	-	-	-	-	-	2.66	-	-	-	-

APPENDIX II

Table 28

Station 5 - Infauna

Numbers of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone longa	1	-	-	-	-	-	-	-	-	3
Phyllodoce mucosa	-	-	-	-	-	-	1	3	-	-
Eulalia viridis	-	-	-	1	-	-	-	1	-	-
Nereis virens	2	4	1	1	1	2	3	1	1	2
Polycirrus phosphoreus (?)	1	-	-	-	-	-	1	-	-	-
OLIGOCHAETA										
Oligochaeta	-	1	-	-	-	-	-	-	-	-
CRUSTACEA										
Diastylis rugosa	-	-	-	-	-	-	-	2	1	-
Phoxocephalus holboli	1	-	-	-	-	-	-	-	-	-
PELECYPODA										
Mya arenaria	-	-	-	-	-	-	-	-	1	1

APPENDIX II

Table 29

Station 5 - Infauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone longa	0.0002	-	-	-	-	-	-	-	-	0.0020
Phyllodoce mucosa	-	-	-	-	-	-	0.0008	0.0023	-	-
Eulalia viridis	-	-	-	0.0010	-	-	-	0.0003	-	-
Nereis virens	0.0057	0.0041	0.0092	0.0058	0.0078	0.2072	0.1861	0.0029	0.0036	0.0161
Polycirrus phosphoreus (?)	0.0027	-	-	-	-	-	0.0022	-	-	-
OLIGOCHAETA										
Oligochaeta	-	0.0007	-	-	-	-	-	-	-	-
CRUSTACEA										
Diastylis rugosa	-	-	-	-	-	-	-	0.0003	0.0002	-
Phoxocephalus holboli	0.0002	-	-	-	-	-	-	-	-	-
PELECYPODA										
Mya arenaria	-	-	-	-	-	-	-	-	0.0013	0.0054

APPENDIX II

Table 30

Station 5 - Infauna

Percentage composition of biomass of each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone longa	1.10	-	-	-	-	-	-	-	-	7.19
Phyllodoce mucosa	-	-	-	-	-	-	0.01	21.10	-	-
Eulalia viridis	-	-	-	0.02	-	-	-	2.75	-	-
Nereis virens	31.32	0.17	75.41	0.11	66.10	90.32	2.13	26.61	0.15	57.81
Polycirrus phosphoreus (?)	14.84	-	-	-	-	-	0.02	-	-	-
OLIGOCHAETA										
Oligochaeta	-	0.03	-	-	-	-	-	-	-	-
CRUSTACEA										
Diastylis rugosa	-	-	-	-	-	-	-	2.75	0.01	-
Phoxocephalus holboli	1.10	-	-	-	-	-	-	-	-	-
PELECYPODA										
Mya arenaria	-	-	-	-	-	-	-	-	0.05	19.42

APPENDIX II

Table 31

Station 6 - Infauna

Numbers of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone longa	-	1	-	-	-	-	-	-	-	-
Nereis virens	-	-	1	2	2	2	-	-	-	-
Polycirrus phosphoreus (?)	1	1	-	1	4	1	4	5	-	3
ECHURIDIA										
Echuridia	-	-	-	-	1	-	-	-	-	-

APPENDIX II

Table 32

Station 6 - Infauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone longa	-	0.0011	-	-	-	-	-	-	-	-
Nereis virens	-	-	0.0131	0.0072	0.0083	0.0077	-	-	-	-
Polycirrus phosphoreus (?)	0.0029	0.0094	-	0.0128	0.0379	0.0005	0.0153	0.0452	-	0.0286
ECHURIDIA										
Echuridia	-	-	-	-	0.0090	-	-	-	-	-

APPENDIX II

Table 33

Station 6 - Infauna

Percentage composition of biomass of each sample

	SAMPLE									
SPECIES	1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Eteone longa	-	0.03	-	-	-	-	-	-	-	-
Nereis virens	-	-	0.14	0.25	0.03	0.07	-	-	-	-
Polycirrus phosphoreus (?)	0.05	0.23	-	0.44	0.14	<0.01	0.18	0.12	-	0.20
ECHURIDIA										
Echuridia	-	-	-	-	0.03	-	-	-	-	-

APPENDIX II

Table 34

Station 6 - Epifauna

Numbers of individuals in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Lepidonotus squamatus	-	-	1	-	-	1	-	-	-	-
Harmothoë sp.	-	-	-	1	2	-	1	-	-	-
Harmothoë extenuata	-	-	-	1	-	1	-	1	-	-
Harmothoë imbricata	9	4	2	4	12	2	4	7	3	3
Pholoë minuta	-	1	-	-	-	-	1	1	-	-
Nereis pelagica	-	-	1	-	1	1	-	3	-	-
CRUSTACEA										
Balanus balanoides	-	-	2	-	-	-	1	-	-	-
Corophium bonelli	27	15	8	2	29	25	46	43	3	33
GASTROPODA										
Acmaea testudinalis	12	14	11	12	16	9	22	14	9	13
Littorina littorea	2	2	3	2	2	3	3	4	3	5
PELECYPODA										
Mytilus edulis	7	9	3	-	13	10	6	10	3	8
Anomia simplex	2	1	1	2	-	4	5	6	-	1
Anomia aculeata	-	-	1	-	-	-	1	1	-	-
Hiatella (Saxicava) arctica	3	5	6	2	29	8	9	17	2	4
ECHINODERMATA										
Strongylocentrotus droehbachiensis	-	-	-	-	1	-	-	-	1	-
ASCIDIACEA										
Ascidiacea	-	-	1	-	-	-	-	-	-	-

APPENDIX II

Table 35

Station 6 - Epifauna

Dry weight of species in each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Lepidonotus squamatus	-	-	0.0009	-	-	0.0009	-	-	-	-
Harmothoë sp.	-	-	-	0.0054	0.0142	-	0.0079	-	-	-
Harmothoë extenuata	-	-	-	0.0056	-	0.0100	-	0.0075	-	-
Harmothoë imbricata	0.0136	0.0054	0.0041	0.0882	0.0535	0.0283	0.0041	0.1109	0.0323	0.0206
Pholoë minuta	-	0.0005	-	-	-	-	0.0005	0.0058	-	-
Nereis pelagica	-	-	0.1276	-	0.0021	0.1568	-	0.1845	-	-
CRUSTACEA										
Balanus balanoides	-	-	0.0213	-	-	-	0.0901	-	-	-
Corophium bonelli	0.0030	0.0021	0.0016	0.0007	0.0034	0.0025	0.0063	0.0069	0.0002	0.0030
GASTROPODA										
Acmaea testudinalis	0.0470	0.1448	0.1171	0.1539	0.1376	0.0713	0.2854	0.1032	0.0806	0.0988
Littorina littorea	4.9154	2.9023	8.5484	2.1666	5.0323	8.6919	7.3182	9.1828	5.8021	12.0803
PELECYPODA										
Mytilus edulis	0.1821	0.8992	0.4281	-	4.5705	0.7951	0.6549	25.8087	48.1234	2.1481
Anomia simplex	0.0247	0.0273	0.0795	0.1437	-	0.1894	0.1084	0.1843	-	0.0422
Anomia aculeata	-	-	0.0609	-	-	-	0.0172	0.0323	-	-
Hiatella (Saxicava) arctica	0.1228	0.1034	0.0676	0.3079	0.7297	0.3489	0.1239	0.4962	0.0012	0.0050
ECHINODERMATA										
Strongylocentrotus droehbachiensis	-	-	-	-	16.7006	-	-	-	5.4050	-
ASCIDIACEA										
Ascidiacea	-	-	0.0312	-	-	-	-	-	-	-

APPENDIX II

Table 36

Station 6 - Epifauna

Percentage composition of the biomass of each sample

SPECIES	SAMPLE 1	2	3	4	5	6	7	8	9	10
POLYCHAETA										
Lepidonotus squamatus	-	-	0.01	-	-	0.01	-	-	-	-
Harmothoë sp.	-	-	-	0.19	0.05	-	0.09	-	-	-
Harmothoë extenuata	-	-	-	0.19	-	0.10	-	0.02	-	-
Harmothoë imbricata	0.26	0.13	0.04	3.05	0.20	0.27	0.05	0.31	0.05	0.14
Pholoë minuta	-	0.01	-	-	-	-	0.01	0.02	-	-
Nereis pelagica	-	-	1.34	-	0.01	1.52	-	0.51	-	-
CRUSTACEA										
Balanus balanoides	-	-	0.22	-	-	-	1.04	-	-	-
Corophium bonelli	0.06	0.05	0.02	0.02	0.01	0.02	0.07	0.02	<0.01	0.02
GASTROPODA										
Acmaea testudinalis	0.88	3.54	1.23	5.32	0.50	0.69	3.31	0.29	0.14	0.68
Littorina littorea	92.54	70.87	89.97	74.92	18.43	84.36	84.78	25.39	9.76	83.74
PELECYPODA										
Mytilus edulis	3.43	21.96	4.51	-	16.74	7.72	7.59	71.36	80.95	14.89
Anomia simplex	0.47	0.67	0.84	4.97	-	1.84	1.26	0.51	-	0.29
Anomia aculeata	-	-	0.64	-	-	-	0.20	0.09	-	-
Hiatella (Saxicava) arctica	2.31	2.52	0.71	5.32	2.67	3.39	1.44	1.37	<0.01	0.03
ECHINODERMATA										
Strongylocentrotus droehbachiensis	-	-	-	-	61.18	-	-	-	9.09	-

APPENDIX III

The mean number of individuals of the group II species that were collected at each station and the confidence level at which the means of any two stations are significantly different.

TABLE 1

Cephalothrix linearis

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	4.9	1	95	74	91	0	0
3	0.6	2		95	95	95	95
4	0.3	3			0	74	74
5	0	4				91	91
6	0	5					0

TABLE 2

Harmothoë imbricata

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	0.1	1	0	90	0	95	95
3	0.8	2		84	0	95	95
4	0.1	3			84	75	95
5	1.8	4				95	95
6	5.0	5					95

APPENDIX III

TABLE 3

Pholoë minuta

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	0.5	1	95	90	95	95	95
3	0.4	2		0	95	0	0
4	2.9	3			95	0	0
5	0.3	4				95	95
6	0.3	5					0

TABLE 4

Eteone heteropoda

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	2.1						
2	0.1	1	95	95	95	95	95
3	0.4	2		70	0	0	0
4	0.1	3			70	0	0
5	0	4				0	0
6	0	5					0

APPENDIX III

TABLE 5

Eteone longa

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	1.1	1	95	95	95	65	0
3	0.9	2		0	0	80	95
4	1.0	3			0	72	93
5	0.4	4				80	95
6	0.1	5					61

TABLE 6

Nereis virens

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	5.8						
2	0.3	1	95	95	95	95	95
3	0.7	2		95	0	95	95
4	0.3	3			95	95	0
5	1.8	4				95	95
6	0.7	5					95

APPENDIX III

TABLE 7

Scoloplos sp.

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	0.2	1	85	95	95	0	0
3	1.3	2		95	95	85	85
4	1.4	3			0	95	95
5	0	4				95	95
6	0	5					0

TABLE 8

Pygospio elegans

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	0.7	1	95	77	95	0	0
3	0.4	2		61	0	95	95
4	0.9	3			61	77	77
5	0	4				95	95
6	0	5					0

APPENDIX III

TABLE 9

__Polycirrus phosphoreus__ (?)

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	8.4	1	95	95	95	84	95
3	3.9	2		95	61	95	95
4	7.9	3			95	95	95
5	0.2	4				95	95
6	2.0	5					95

TABLE 10

Oligochaeta

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	26.7						
2	5.3	1	95	95	95	95	95
3	3.6	2		67	95	95	95
4	0.8	3			95	95	95
5	0.1	4				95	95
6	0	5					0

APPENDIX III

TABLE 11

Diastylis rugosa

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	0.1	1	0	95	95	83	0
3	1.8	2		95	95	0	0
4	1.3	3			0	95	95
5	0.3	4				95	95
6	0	5					83

TABLE 12

Corophium bonelli

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	0						
2	0.3	1	81	95	95	95	95
3	19.7	2		95	95	95	95
4	11.1	3			91	93	0
5	30.0	4				95	95
6	23.1	5					65

APPENDIX III

TABLE 13

<u>*Mya arenaria*</u>

STATION	MEAN	STATION	CONFIDENCE LEVEL (%) STATION 2	3	4	5	6
1	6.7						
2	0.8	1	95	95	95	95	95
3	1.7	2		77	95	86	94
4	2.8	3			78	95	95
5	0.2	4				95	95
6	0	5					85

APPENDIX IV

Yields of benthic samples taken at approximately monthly intervals at station 4 in Long Pond from October, 1964 to November, 1965.

TABLE 1

26 October 64

	SAMPLE					
SPECIES	1	2	3	4	5	MEAN
NEMERTEA						
Cephalothrix linearis	-	1	-	-	-	0.2
POLYCHAETA						
Nephthys caeca	-	2	-	-	-	0.4
Scoloplos sp.	1	-	-	-	-	0.2
Polycirrus phosphoreus (?)	2	1	-	-	1	0.8
Euchone elegans	-	-	1	1	-	0.4
OLIGOCHAETA						
Oligochaeta	1	-	-	-	5	1.2
CRUSTACEA						
Diastylis rugosa	-	1	4	-	-	1.0
PELECYPODA						
Mya arenaria	1	-	-	-	1	0.4

APPENDIX IV

TABLE 2

24 November 64

SPECIES	SAMPLE 1	2	3	4	5	MEAN
POLYCHAETA						
Eteone longa	-	1	1	-	-	0.4
Phyllodoce mucosa	2	1	1	1	-	1.0
Nereis virens	1	-	-	-	-	0.2
Nephthys caeca	-	1	-	1	-	0.4
Scoloplos sp.	1	1	-	2	2	1.2
Pygospio elegans	-	1	1	-	4	1.2
Polycirrus phosphoreus (?)	6	-	8	4	7	5.0
CRUSTACEA						
Diastylis rugosa	-	1	1	-	-	0.4
PELECYPODA						
Mytilus edulis	1	-	-	-	-	0.2
Mya arenaria	-	-	1	3	2	1.2

APPENDIX IV

TABLE 3

9 December 64

SPECIES	SAMPLE 1	2	3	4	5	MEAN
POLYCHAETA						
Pholoë minuta	-	1	-	2	-	0.6
Eteone longa	1	1	-	-	-	0.4
Phyllodoce mucosa	3	-	-	-	-	0.6
Nereis virens	1	-	-	-	-	0.2
Nephthys caeca	-	-	-	1	-	0.2
Scoloplos sp.	4	2	3	1	-	2.0
Pygospio elegans	-	-	-	-	1	0.2
Pectinaria sp.	-	-	-	1	-	0.2
Polycirrus phosphoreus (?)	3	2	3	-	5	2.6
OLIGOCHAETA						
Oligochaeta	-	1	-	-	-	0.2
CRUSTACEA						
Diastylis rugosa	1	-	1	2	1	1.0
Phoxocephalus holboli	-	-	-	1	-	0.2
Monoculodes borealis	-	-	-	-	1	0.2
PELECYPODA						
Crenella faba	-	-	-	1	-	0.2
Mya arenaria	6	3	2	7	2	4.0
ECHINODERMATA						
Echinarachnius parma	-	-	-	1	-	0.2

APPENDIX IV

TABLE 4

18 January 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
NEMERTEA						
Cephalothrix linearis	-	-	-	1	-	0.2
POLYCHAETA						
Pholoë minuta	-	1	-	-	-	0.2
Eteone longa	-	1	1	1	-	0.6
Nereis virens	-	-	-	1	-	0.2
Nephthys caeca	2	-	-	-	-	0.4
Scoloplos sp.	1	1	1	3	1	1.4
Pygospio elegans	2	-	-	-	-	0.4
Polycirrus phosphoreus (?)	4	7	4	3	4	4.4
OLIGOCHAETA						
Oligochaeta	-	1	-	-	1	0.4
CRUSTACEA						
Diastylis rugosa	-	2	4	2	-	1.6
Corophium bonelli	-	-	-	-	1	0.2
PELECYPODA						
Crenella faba	1	-	-	-	-	0.2
Mya arenaria	-	1	-	-	3	0.8

APPENDIX IV

TABLE 5

20 March 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
NEMERTEA						
Cephalothrix linearis	-	-	-	1	-	0.2
POLYCHAETA						
Pholoë minuta	1	1	-	1	-	0.6
Eteone longa	2	-	1	1	2	1.2
Nereis virens	-	-	-	-	2	0.4
Nephthys caeca	-	-	-	1	-	0.2
Scoloplos sp.	-	1	2	1	1	1.0
Pygospio elegans	2	-	-	-	-	0.4
Polycirrus phosphoreus (?)	10	10	5	4	8	7.4
Euchone elegans	-	1	1	1	-	0.6
CRUSTACEA						
Diastylis rugosa	1	1	1	-	-	0.6
Monoculodes borealis	-	-	1	1	-	0.4
PELECYPODA						
Mya arenaria	2	2	2	3	2	2.2

APPENDIX IV

TABLE 6

14 April 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
NEMERTEA						
Cephalothrix linearis	1	-	-	-	1	0.4
POLYCHAETA						
Pholoë minuta	1	3	-	2	-	1.2
Eteone longa	3	-	-	1	1	1.0
Phyllodoce mucosa	-	-	1	-	-	0.2
Nereis virens	-	-	-	-	2	0.4
Nephthys caeca	-	-	-	-	1	0.2
Scoloplos sp.	2	2	3	1	1	1.8
Pygospio elegans	1	1	1	-	1	0.8
Pectinaria sp.	-	-	1	-	-	0.2
Polycirrus phosphoreus (?)	5	12	12	5	10	8.8
Euchone elegans	-	1	-	1	1	0.6
OLIGOCHAETA						
Oligochaeta	-	-	-	-	1	0.2
CRUSTACEA						
Lamprops fuscata	-	-	-	-	1	0.2
Diastylis rugosa	1	1	-	2	8	2.4
Phoxocephalus holboli	-	1	-	-	-	0.2
Photis reinhardi	1	-	-	-	-	0.2
Ischyrocerus anguipes	-	1	1	-	-	0.4
Corophium bonelli	5	4	2	2	4	3.4
PELECYPODA						
Mya arenaria	1	1	2	-	2	1.2

APPENDIX IV

TABLE 7

28 May 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
POLYCHAETA						
Pholoë minuta	1	-	2	-	-	0.6
Eteone longa	-	-	3	-	-	0.6
Nereis virens	1	1	-	2	-	0.8
Scoloplos sp.	2	-	1	1	1	1.0
Pectinaria sp.	1	-	-	1	-	0.4
Polycirrus phosphoreus (?)	3	1	2	5	2	2.6
Euchone elegans	1	-	2	1	1	1.0
CRUSTACEA						
Diastylis rugosa	-	-	-	-	1	0.2
Corophium bonelli	32	11	13	14	13	16.6
PELECYPODA						
Mya arenaria	-	2	1	3	-	1.2

APPENDIX IV

TABLE 8

2 July 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
POLYCHAETA						
Harmothoë imbricata	-	4	-	2	1	1.4
Pholoë minuta	-	-	-	-	1	0.2
Eteone longa	2	2	1	-	-	1.0
Phyllodoce mucosa	-	-	-	2	-	0.4
Scoloplos sp.	-	1	2	2	1	1.2
Pygospio elegans	2	-	1	-	1	0.8
Polycirrus phosphoreus (?)	3	5	7	2	2	3.8
Euchone elegans	-	2	1	-	-	0.6
CRUSTACEA						
Diastylis rugosa	-	2	-	1	1	0.8
Dexamine spinosa	2	2	-	-	1	1.0
Monoculodes tuberculatus	-	1	-	-	-	0.2
Corophium bonelli	6	2	16	13	11	9.6
PELECYPODA						
Crenella faba	-	-	-	1	-	0.2
Mya arenaria	3	2	5	-	8	3.6

APPENDIX IV

TABLE 9

30 July 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
NEMERTEA						
Cephalothrix linearis	-	1	-	1	-	0.4
POLYCHAETA						
Harmothoë imbricata	-	4	-	2	-	1.2
Pholoë minuta	1	-	-	-	-	0.2
Eteone longa	1	-	-	1	1	0.6
Phyllodoce mucosa	-	1	-	-	-	0.2
Scoloplos sp.	-	3	-	-	1	0.8
Polycirrus phosphoreus (?)	-	5	5	1	-	2.2
Euchone elegans	-	2	-	2	-	0.8
CRUSTACEA						
Diastylis rugosa	1	2	2	-	2	1.4
Dexamine spinosa	-	1	-	-	-	0.2
Corophium bonelli	16	41	27	7	4	19.0
Caprella septentrionalis	-	-	1	-	-	0.2
PELECYPODA						
Mya arenaria	-	2	3	-	1	1.2

APPENDIX IV

TABLE 10

2 September 65

SPECIES	1	2	3	SAMPLE 4	5	MEAN
NEMERTEA						
Cephalothrix linearis	-	-	-	-	1	0.2
POLYCHAETA						
Harmothoë imbricata	1	-	5	2	-	1.6
Pholoë minuta	2	-	-	-	-	0.4
Eteone longa	1	4	-	4	1	2.0
Phyllodoce mucosa	-	1	-	1	3	1.0
Nereis virens	1	-	-	1	3	1.0
Scoloplos sp.	-	1	1	1	1	0.8
Polycirrus phosphoreus (?)	4	2	3	3	3	3.0
CRUSTACEA						
Diastylis rugosa	-	6	1	2	2	2.2
Dexamine spinosa	3	-	1	1	2	1.4
Corophium bonelli	32	11	4	17	3	13.4
GASTROPODA						
Acmaea testudinalis	-	-	1	-	-	0.2
PELECYPODA						
Crenella faba	-	-	-	1	-	0.2
Mytilus edulis	-	-	1	-	-	0.2
Mya arenaria	1	1	-	-	-	0.4

APPENDIX IV

TABLE 11

29 September 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
NEMERTEA						
Cephalothrix linearis	-	-	-	1	1	0.4
POLYCHAETA						
Harmothoë imbricata	-	1	-	-	-	0.2
Pholoë minuta	2	4	-	-	-	0.6
Eteone heteropoda	-	-	-	1	-	0.2
Eteone longa	-	1	2	1	3	1.4
Phyllodoce mucosa	-	3	2	2	1	1.6
Nereis virens	4	1	2	3	2	2.4
Scoloplos sp.	-	1	1	-	-	0.4
Pygospio elegans	4	7	1	3	3	3.6
Polycirrus phosphoreus (?)	9	1	3	4	3	4.0
CRUSTACEA						
Diastylis rugosa	2	-	2	-	3	1.4
Corophium bonelli	2	-	3	1	-	1.2
PELECYPODA						
Crenella faba	-	-	-	-	1	0.2
Mya arenaria	2	3	1	2	2	2.0

APPENDIX IV

TABLE 12

1 November 65

SPECIES	SAMPLE 1	2	3	4	5	MEAN
NEMERTEA						
Cephalothrix linearis	1	-	-	-	-	0.2
POLYCHAETA						
Harmothoë imbricata	-	1	-	3	-	0.8
Pholoë minuta	4	6	-	1	-	2.2
Eteone longa	3	2	-	3	-	1.6
Phyllodoce mucosa	4	-	-	-	-	0.8
Nereis virens	2	-	-	-	1	0.6
Nephthys caeca	-	2	1	-	-	0.6
Scoloplos sp.	1	3	-	-	-	0.8
Polycirrus phosphoreus (?)	3	1	1	-	3	1.6
CRUSTACEA						
Balanus balanoides	-	-	-	2	-	0.4
Phoxocephalus holboli	1	-	-	-	-	0.2
Corophium bonelli	-	-	-	1	-	0.2
Crago septemspinosus	-	-	1	-	-	0.2
GASTROPODA						
Acmaea testudinalis	-	-	-	5	-	1.0
PELECYPODA						
Mya arenaria	1	1	1	-	1	0.8

APPENDIX V

Classification of the organisms collected at Long Pond

PHYLUM NEMERTEA

Order Paleonemertea

Family Cephalothricidae

Cephalothrix linearis (Rathke)

PHYLUM ANNELIDA

Class Polychaeta

Subclass Errantia

Family Polynoidae

Lepidonotus squamatus (Linne)

Harmothoë sp.

Harmothoë extenuata (Grube)

Harmothoë imbricata (Linne)

Family Sigalionidae

Pholoë minuta (Fabricius)

Family Phyllodocidae

Eteone heteropoda Hartman

Eteone longa (Fabricius)

Phyllodoce mucosa Oersted

Eulalia viridis (Linne)

Family Nereidae

Nereis virens Sars

Nereis pelagica Linne

Family Nephtyidae

Nephthys caeca (Fabricius)

APPENDIX V

Family Orbinidae

Scoloplos sp.

Subclass Sedentaria

Family Spionidae

Pygospio elegans Claparede

Family Capitellidae

Family Amphictenidae

Pectinaria sp.

Family Terbellidae

Polycirrus phosphoreus (?) Verrill

Family Sabellidae

Euchone elegans Verrill

Class Oligochaeta

PHYLUM ARTHROPODA

Class Crustacea

Order Thoracica

Family Balanidae

Balanus balanoides (Linne)

Order Cumacea

Family Lampropidae

Lamprops fuscata Sars

Family Diastylidae

Diastylis rugosa Sars

Order Amphipoda

Family Phoxocephalidae

Phoxocephalus holboli (Kroyer)

APPENDIX V

Family Gammaridae

Gammarus lawrencianus Bousf.

Family Photidae

Photis reinhardi Kroyer

Family Jassidae

Ischyrocerus anguipes Kroyer

Family Dexaminidae

Dexamine spinosa (Montagu)

Family Oedicerotidae

Monoculodes borealis Boeck

Monoculodes tuberculatus Boeck

Family Corophidae

Corophium bonelli Sars

Family Caprellidae

Caprella septentrianalis Kroyer

Order Decapoda

Family Cragonidae

Crago septemspinosus (Say)

PHYLUM ECHURIDIA

PHYLUM MOLLUSCA

Class Gastropoda

Order Archaeogastropoda

Family Acmaeidae

Acmaea testudinalis Muller

APPENDIX V

Order Mesogastropoda

Family Littorinidae

Littorina littorea Linne

Class Pelecypoda

Order Fillibranchia

Family Mytilidae

Crenella faba Muller

Mytilus edulis Linne

Family Anomiidae

Anomia simplex Orbigny

Anomia aculeata Muller

Order Eulamellibranchia

Family Tellinidae

Macoma balthica (Linne)

Family Hiatellidae

Hiatella (Saxicava) arctica Linne

Family Myacidae

Mya arenaria Linne

PHYLUM ECHINODERMATA

Class Asteroidea

Order Forcipulata

Family Asteriidae

Asterias forbesi (Desor)

Class Echinoidea

Order Diadematoidea

Family Strongylocentrotidae

Strongylocentrotus droehbachiensis (Muller)

APPENDIX V

Order Clypeastroidea

Family Scutellidae

Echinarachnius parma (Lamarck)

PHYLUM CHORDATA

Class Ascidiacea