Short Title:

Mysidacea of the Gulf of St. Lawrence.

Occurrence and Distribution of the Mysidacea of the Gulf of St. Lawrence

by

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Abstract

A survey of the mysid fauna of the Gulf of St.Lawrence indicates the presence of seven species which are new to the existing list for the area; *Amblyops abbreviata*, *Amblyops kempii*, *Erythrops abyssorum*, *Erythrops microps*, *Mysidetes farrani*, *Parerythrops obesa* and *Pseudomma affine*, and greatly extends the records of occurrence of the other species with the exception of the littoral forms. Their distributional patterns are largely defined by the various water masses of the Gulf. Two genera, Erythrops and Pseudomma, are each represented by three species which are characteristic of three sublittoral regimes. There is evidence of a discrete community which is characteristic of the slope of the Laurentian Channel and influenced by the physical nature of the 'boundary' layer in addition to a cold layer community and a deep, warmer layer community.

The telson of *Pseudomma affine* consistently possesses three pairs of apical spines, one more pair than does *P.roseum*. *Amblyops abbreviata* and *A.kempii* differ somewhat from their type specimens of the western Atlantic. The antero-lateral margins of the carapace of *Boreomysis arctica* become more produced with age such that the adult possesses distince 'shoulders'. *B.arctica* and *B.tridens*, which are very similar morphologically and exhibit similar zoogeographics, appear to be separated from one another vertically in the water column.

There is evidence that *Boreomysis nobilis* exhibits prolonged breeding and a two year life cycle that *Pseudomma roseum* breeds in the spring and autumn and has a one year to 18 month life

cycle, that _B.arctica_ breeds in the autumn or winter and exhibits a two year life cycle, and that _Mysis mixta_ populations in the Magdalen Shallows are segregated by age group, perhaps in response to a schooling behaviour rather than to physical stimuli.

Une étude de la faune mysidacée du Golfe Saint-Laurent indique la présence de sept espèces nouvelles qui viennent s'ajouter à la liste existante; *Amblyops abbreviata*, *Amblyops kempii*, *Erythrops abyssorum*, *Mysidetes farrani*, *Parerythrops obesa* and *Pseudomma affine*, et élargit de beaucoup les dossiers d'occurrence des espèces sous-littorales. Leur répartition est définie par les nappes d'eau du Golfe. Deux genres, Erythrops et Pseudomma, sont chacun représentés par trois espèces qui sont caractéristiques de trois régions sous-littorales. Tout laisse croire qu'une communauté se trouve en pente du canal Laurentien et qu'elle est soumise à l'influence de la nature physique de la nappe 'frontière' en plus d'une communauté de la nappe froide, intermédiaire, et d'une communauté de la nappe profonde et plus chaude.

Le telson du *Pseudomma affine* possède trois paires d'épines apicales, soit une paire de plus que *P.roseum*. *Amblyops abbreviata* et *A.kempii* diffèrent un peu des spécimens typiques de l'Atlantique ouest. Les bords antéro-latéraux de la carapace de *Boreomysis arctica* deviennent plus aigus avec la croissance et les adultes possèdent des "épaules". *B.arctica* et *B.tridens*, qui sont très semblables morphologiquement et qui montrent des zoogéographies semblables, semblent être séparés verticalement dans la colonne d'eau.

Il y a évidence que *Boreomysis nobilis* se reproduit en toutes saisons et a un cycle de vie de deux ans, que *Pseudomma roseum* se reproduit au printemps et en automne et possède un cycle de vie de 12 à 18 mois, que *B. arctica* se reproduit en automne ou en hiver et possède un cycle de vie de deux ans, et que, les populations du _Mysis mixta_ se divisent par groupes d'âge, répondant peut-être ainsi à un instinct de s'attrouper plutôt qu'à des stimuli physiques.

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Introduction

The first illustration of a mysid, *Mesopodopsis slabberi*, a shrimp with trumpet-like eyes, was published by M. Slabber in 1778 and the first published description was given by O.F.Muller who described *Cancer flexousus* (*Praunus flexuosus*) in 1796 (Tattersall and Tattersall, 1951).

Since that time a large volume of material concerning mysids has been published, most notably by M. Sars, G.O. Sars, A. Norman (1860, 1892, 1906) S.I. Smith, Illig (1930), William Tattersall (1906, 1907, 1908, 1909, 1911, 1912, 1915, 1919, 1922, 1925, 1926, 1927 etc), H. Nouvel (1939, 1940, 1942, 1943, 1945, 1950(a), 1950(b)) and a host of others. Particularly W.M. Tattersall, it can be seen from the literature, has devoted enormous energies to their study.

The Mysidacea are very diverse: from fresh water, (e.g. *Mysis relicta*) which probably left the sea quite recently, to marine; from eyeless cave dwellers, (Macquart-Moulin, 1966 - Abstract only), to deep-sea dwellers of the Kurile-Kamchatka trench (Vinogradov - Abstract, 1955), to *Mysis gaspensis* foraging along the shoreline (personal observation). Meglitsch (1967, p.792) states that the Mysidacea consist of about 450 species but this is probably a conservative estimate. It is for this reason that a complete literature review would be out of the question and therefore the contents of the paper must be restricted primarily to those workers who contributed to the knowledge of the Mysidacea of the Gulf of St. Lawrence. This narrows the scope of the review considerably for little work has actually been done in the area;

"The list of species is somewhat meagre" (Tattersall, 1939).

Whiteaves (1874), it seems, was the first worker to record any of the Mysidacea of the Gulf of St. Lawrence. The Ministry of Marine and Fisheries sponsored a dredging expedition during which Whiteaves found *Pseudomma roseum* (G.O. Sars, 1870), *Pseudomma* (*nov.sp.*), and a "species of Mysidae near to *Erythrops* and *Parerythrops* of G.O. Sars". *Pseudomma roseum* was captured in the Laurentian Channel near Gaspé and, what were later named by Smith (1879) upon examination as *Pseudomma truncatum* and *Meterythrops robusta* respectively, near Baie des Chaleurs.

Few collections reporting mysids were made in the Gulf of St. Lawrence from the time of Whiteaves until the Canadian Fisheries expeditions.

Rodger (1895) made some collections in the Strait of Belle Isle and reported the presence of *Stilomysis grandis* (Goes, 1863). Calman (1901) listed *Erythrops microps* (G.O. Sars, 1864) from the coast of Labrador in his catalogue but Tattersall (1939) discounted it as being a specimen of *Erythrops erythropthalma*. Whiteaves (1901) published a catalogue of the Marine Invertebrata of Eastern Canada which included only the three mysid species which he personally had encountered in the Gulf of St.Lawrence.

Schmitt (1904) recorded *Mysis stenolepis* (S.I. Smith, 1873) and *Neomysis americana* (S.I. Smith, 1873) from the Anticosti Island region. Kindle and Whittaker (1918) published a "Bathymetric Checklist" which made no additional contributions beyond the records of Whiteaves.

Small collections of Mysids were made by the Canadian Fisheries Expeditions in the Gulf; the "Princess" and "33" expeditions of 1915, the expeditions of the "Prince" in 1917, and the Belle Isle expedition of the "Arleux" in 1923. The material was examined by Tattersall (1939) and five new species:

Boreomysis nobilis (G.O. Sars, 1879)
Boreomysis tridens (G.O. Sars, 1870)
Erythrops erythropthalma (Goes, 1864)
Mysis mixta (Lilljeborg, 1852)
Mysis oculata (Fabricius, 1780)

were added to the Gulf of St. Lawrence list, particularly from the Bay of Islands, West Newfoundland area. He also recorded Neomysis americana, Mysis stenolepis, Pseudomma truncatum and Meterythrops robusta from these collections. Prefontaine (1931) reported Neomysis americana and Mysis stenolepis from the St. Lawrence estuary (Trois Pistoles) and in 1933 reported Boreomysis arctica from the same area (320m).

O. Tattersall (1954) described a new and apparently endemic species, Mysis gaspensis, from existing collections taken in the St. Lawrence estuary and the Baie des Chaleurs.

Black (1956) studied in detail Erythrops erythropthalma, Mysis mixta, Mysis stenolepis, Neomysis americana, and Mysis oculata of the Bras d'Or Lakes.

Occasional catches of mysids were made by the Grande Riviere-Station de Biologie and reported by Brunel (1962), adding to the list Boreomysis arctica (Kroyer, 1861) and Boreomysis tridens var. lobata (Nouvel, 1942) from the Saguenay fjord. In 1962 Lacroix and Bergeron found Erythrops erythropthalma and Mysis mixta in collections from Banc de Bradelle. Brunel (1968) collected mysids as part of a study of food resources for cod of the Gaspé and

and Baie des Chaleurs area.

Poirier (1971) has done a detailed study of the vertical distribution, seasonal abundance and life histories of the Mysid species Erythrops erythropthalma, Mysis mixta, Pseudomma truncatum, and Meterythrops robusta of the Baie des Chaleurs area.

Tattersall (1939) stated that the list was small for the shore and shallow water species but he could easily have included the deep water forms as well.

Brunel (1970) was the author of a Catalogue of Benthic Invertebrates among which were eleven species of Mysids classified according to bathymetric distribution. These Mysid collections were primarily from Baie des Chaleurs, Saguenay fjord, and the waters surrounding the Magdalen Islands and he states that the deep water fauna was not well sampled.

No attempt has been made to survey the Mysidacea of the Gulf of St. Lawrence. The present study attempts to add to the knowledge of the Mysid fauna of the Gulf by
(1) adding to the list of species for the area
(2) more closely defining the species distributions
relative to (a) the presence of the particular water mass in contact with the bottom (as noted previously by Whiteaves (1874) who stated that Pseudomma truncatum and Meterythrops robusta appeared to have arctic affinities as well as by Brunel (1970) who was able to relate the occurrences of benthic species to prevailing physical characteristics of the various water masses. He ascribed a fauna similar to that of the southern U.S. Atlantic coast to the waters of the southern Gulf shoreline, an Arctic or

or Arctic-borealfauna to the cold water areas, and a subarctic-stenoboreal faunal to the warmer waters (0-5°C) of the Laurentian Channel, and (b) by considering these species in relation to physical parameters over a larger area than previously done.

(3) Certain taxonomic problems and life history problems, where feasible, are considered.

Material & Methods

(a) The Sampling Area

(i) The Range

The Gulf of St. Lawrence; bounded by the Quebec North Shore, Newfoundland, the Strait of Belle Isle, the Maritime provinces to Cape Breton (Cabot Strait) and east of Point des Monts in the estuary; is a small inland sea of approximately 214 x 10^3 KM^2. (Forrester & Vandall, 1968 as cited by El-Sabh etal, 1969).

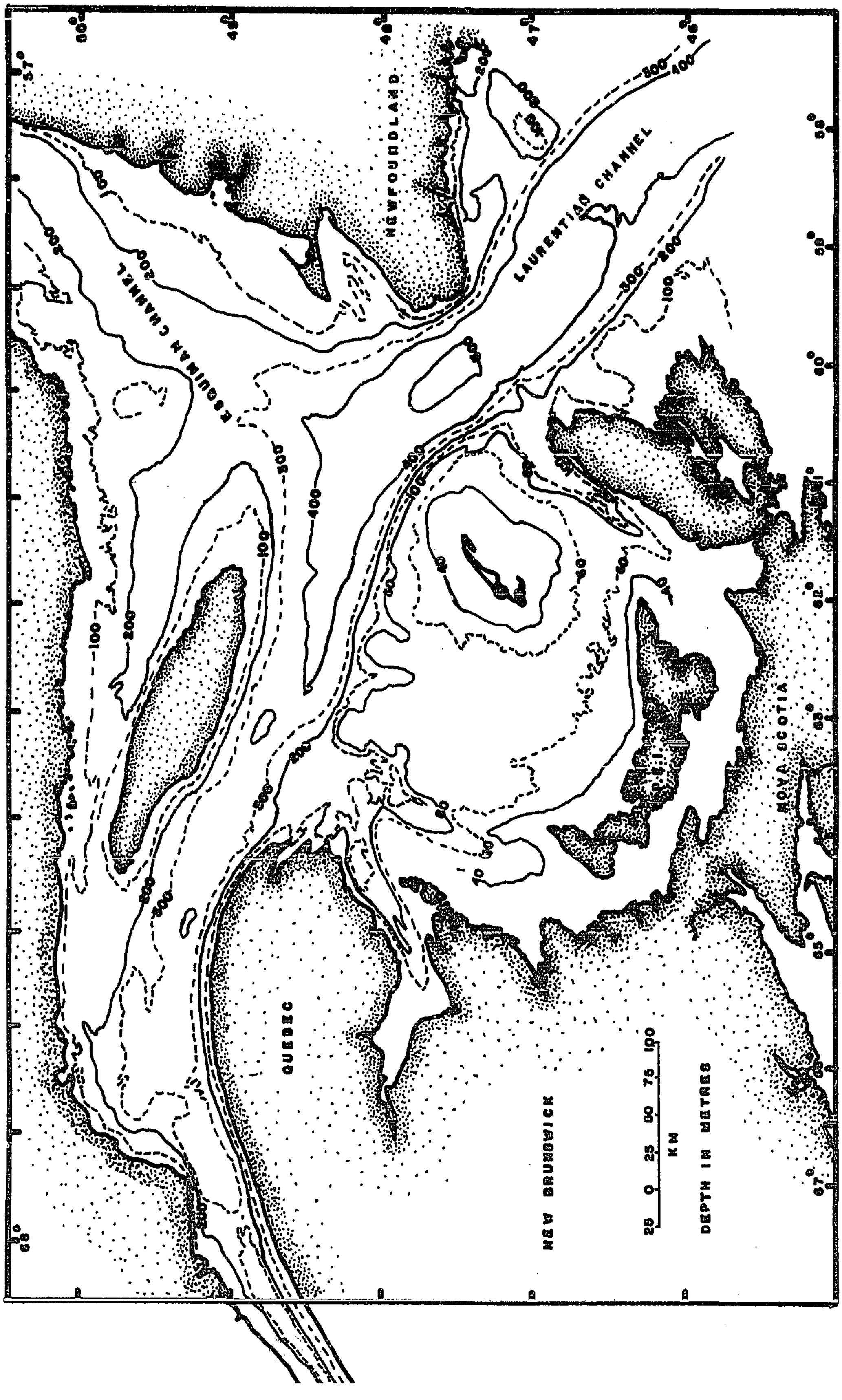
This area represents the primary region to be discussed in this report although sampling was done further into the estuary to the Saguenay, in Bonne Bay East Arm, West Newfoundland, and just outside Cabot Strait near the south coast of Newfoundland.

(ii) Topography and Bathymetry

The most obvious topographical feature of the Gulf is the Laurentian Channel which extends from the edge of the continental shelf, through Cabot Strait, and as far as the Saguenay River in the St. Lawrence estuary. The Esquiman Channel is its north-eastward branch which extends almost to the Strait of Belle Isle. The Mingan Channel is a branch of the Esquiman and it is carved out Northeast of the Parallel to the long axis of Anticosti Island. The channel is generally delineated by the 100 fathom or 183 meter contour although most of it is somewhat deeper than this, the 200 meter line being its upper boundary. The greatest depths of the Laurentian Channel are found outward of Cabot Strait. Stations in Cabot Strait were approximately 450 meters and Lauzier and Trites (1958) state that from the continental shelf to Cabot Strait depths range from 600 to 400 meters(Fig.1). In

FIGURE 1

Bathymetry of the Gulf of St. Lawrence (meters). After Canadian Hydrographic Service chart


NEWFOUNDLAND
LAURENTIAN CHANNEL
ESQUIMAN CHANNEL
QUEBEC
NEW BRUNSWICK
P.E.I.
NOVA SCOTIA
25 0 25 50 75 100
KM
DEPTH IN METRES
10
40
60
100
200
300
400
50°
49°
48°
47°
46°
57°
58°
59°
60°
61°
62°
63°
64°
65°
66°
67°
68°

the Gulf proper, Channel depths range from 200 to 400 meters, with small regions of 500 meters being encountered near Cabot Strait.

One quarter of the Gulf area is shallower than 46 meters (25 fathoms) while less than one fifth is deeper than 275 meters (150 fathoms) (Hachey, 1961). The Magdalen Shallows, the southern portion of the Gulf enclosed by the Maritime provinces and bounded to the North by the Laurentian Channel, constitute a major portion of the total shallow zone.

(iii) Hydrography

A very important and interesting feature of the Gulf is its three layered system.

The surface layer, its lower limit being the thermocline, developes in the summer and is almost homogeneous as to temperature and salinity. Over the summer period there is a thinning of the layer accompanied by decreasing salinity. The temperature, of course, varies greatly seasonally (Hachey, 1961). Conditions similar to those of the surface layer prevail in the inshore areas.

A cold intermediate layer, below the thermocline in the summer shows temperatures of less than $0^{\circ}C$ (Hachey, 1961). The IBP temperature data, utilized in this study, shows that the minimum may be below $0^{\circ}C$ but in some cases was as high as $1.5^{\circ}C$. El-Sabh (1971) has defined the cold intermediate layer in Cabot Strait as being the 1° isotherm. The associated salinities vary from $32^{\circ}/oo$ to $34^{\circ}/oo$ in the open Gulf (Hachey, 1961) but IBP data shows it to be from $30\text{-}32^{\circ}/oo$. The thickness of the layer varies from 28 meters to more than 92 meters. An obvious decrease in its thickness occurs between spring and autumn. (Hachey, 1961) it was originally believed that this layer was formed outside the Gulf but Forrester (1964) showed that it was formed inside the Gulf as a result of winter cooling and mixing. (El-Sabh etal,1969)

The presence of this layer is an important factor, along with the sloping sea floor, in providing a locally variable and somewhat unstable environment in parts of the Magdalen Shallows. It is here that the cold intermediate layer may reach the bottom in a wide band and provide a suitable environment for an arctic or subarctic-like benthic and hyperbenthic fauna. Bottom temperatures may change drastically over short or long periods of time depending upon the thickness of this layer. This was pointed out by Lauzier (1952) in his consideration of the effects of storms on water conditions in the Magdalen Shallows.

A warmer deep layer is present chiefly in the Laurentian Channel. Lauzier and Bailey (1957) showed, by means of T./S. data that the deep waters of the Channel retain their characteristics seasonally. The salinity of this water mass is greater than 34°/oo and the temperature ranges between 4°C and 6°C. The temperatures of the deep layer have been found to depend on the temperature of the Labrador water since the mixing of the Slope and Labrador water seems to take place in the same proportions from year to year. Between the cold intermediate layer and the deep warm layer is a boundary layer with temperatures from 1°C to 4°C and salinities generally from 33°/oo to 34°/oo (Lauzier and Trites, 1958). Hachey does not mention this layer in his account but must have included it with the cold intermediate layer which he defines as having a salinity of 32°/oo to 34°/oo.

This boundary layer is relatively small, but on the Channel Slope where the depth may be only 200-250 meters, this layer probably has a greater influence on the bottom regime.

The deep warm layer is not highly variable but its temperature has increased from 4°C to roughly 6°C from the 1920's to the 1950's (Lauzier and Trites, 1958). Therefore it can probably be assumed that the layer provides a fairly stable environment. IBP collections rarely record temperatures greater than 5°C.

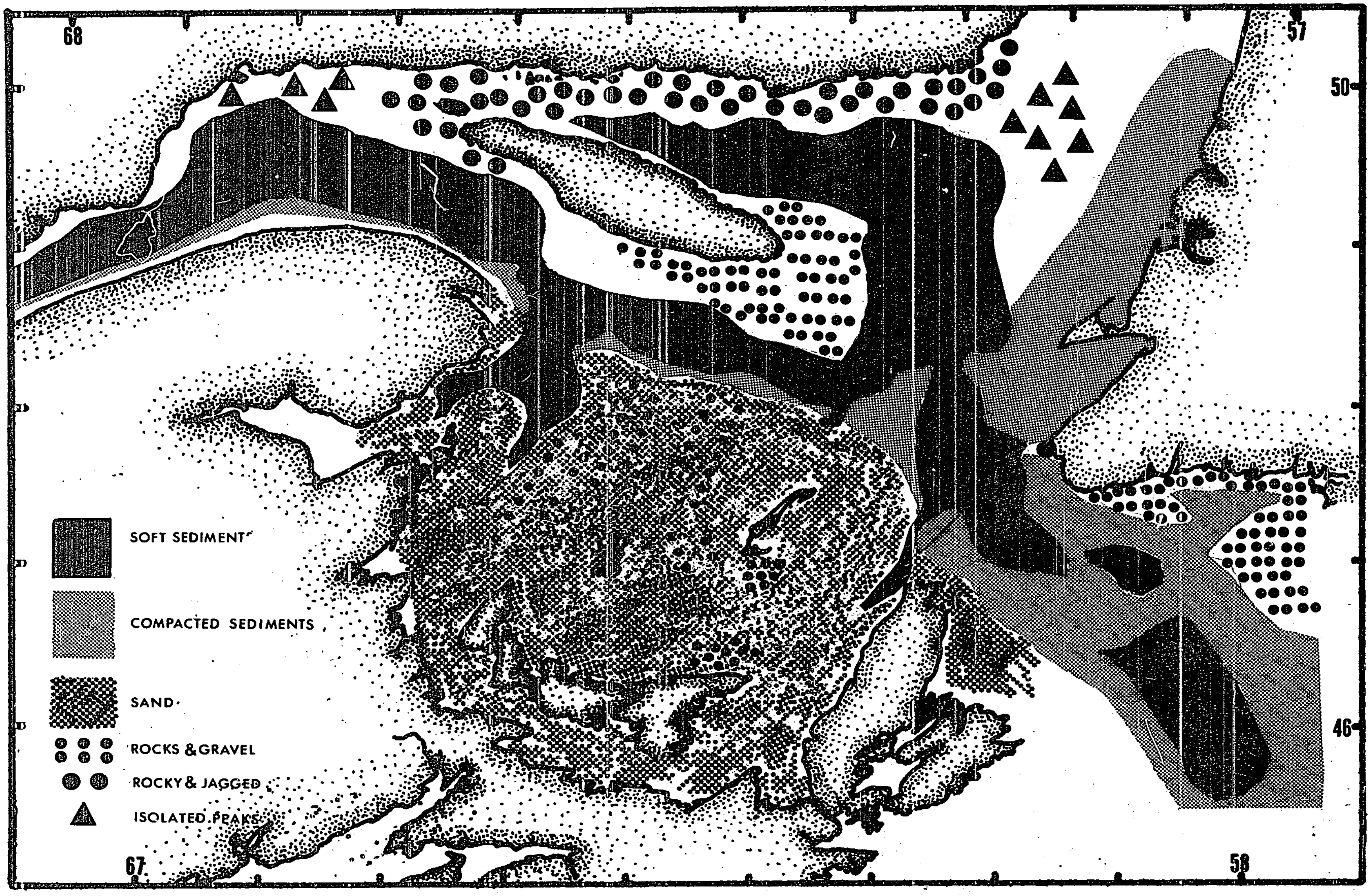
(iv) Bottom Type

Besides the three layer system upon which the general temperature and salinity regimes within the Gulf can be based, the sedimentation and the bottom type of the Gulf floor may be of importance in this study. Williams (1958) found sediment type to be an important factor in shrimp distribution and Poirier (1971) has found it to be an important factor in the distribution of certain mysid species, to name a few.

Loring (1962) published a general account of the distribution of soft sediments and acoustically hard sediments in the Gulf of St. Lawrence. The soft sediments were classified according to the thickness of the layer while the hard sediments were classified according to their physical nature. The main areas of soft sediment correspond to the deeper channel areas including the Mingan Channel. Exceptions are found in the Esquiman Channel and the areas adjacent to Cabot Strait. In the Esquiman are found isolated peaks, possibly in conjunction with soft or compacted sediments while in the latter area compacted sediments are present. It should also be noted that the North

Figure 2

General pattern of sediments of the Gulf of St.Lawrence. After Loring (1962) and IBP data.


68
57
50
46
67
58
SOFT SEDIMENT
COMPACTED SEDIMENTS
SAND
ROCKS & GRAVEL
ROCKY & JAGGED
ISOLATED PEAKS

Shore area is one of rocks and jagged peaks.

Further works by Loring and Lahey (1964) in the Magdalen Shallows revealed a high degree of variability in sediment types. The bottom consists of sands, gravels, muds and their combinations in varying proportions, as well as areas of sandstone and bedrock.

A third area which seems to be important in this study is the zone which can be defined as the slope of the Laurentian Channel. This zone extends from approximately the 150 meter line to the bottom of the Channel, with a gradient of approximately 2 to 6% along the margin of the Magdalen Shallows and the west coast of Newfoundland. The slope bottom in these two areas, according to Loring (1962), is composed of compacted soft sediments.

(v) Oxygen

Available data concerning oxygen levels in the Gulf of St. Lawrence indicate that concentrations generally do not fall below 2.0 ml/litre. This was pointed out by d'Anglejan and Dunbar (1968) for the locations which they sampled throughout the area. IBP measurements agree with this and in most instances values were above 3.0 ml/litre in the summer months.

In general concentrations decrease with depth, the lowest values being found near the bottom. The highest deep water values are found in the Cabot Strait (4ml/litre) and the lowest values are found in the deep waters of the Channel extremities, particularly the Esquiman Channel. The deepest strata of the shallow zones, eg. the Magdalen Shallows, possess oxygen concentrations which are similar to those at the same depth at deeper stations.

Richards (1957) concluded from a literature survey by Bishop

(1950) that most aquatic organisms consume oxygen at a rate which is independent of oxygen tension down to a certain limit. This lower limit is certainly likely to be below 2.0 ml/litre for most animal groups. Many animals, eg. euphausids, have been captured at levels where oxygen concentrations have been less than 0.5 ml/litre. The large mysid Gnathophausia ingens in the eastern Pacific has been found to spend part of its life cycle in association with the oxygen minimum layer. The data of Childress (1968) indicate that intermediate sized animals are maintained and grow in waters of less than 0.5 ml/litre of oxygen. They were found to live at oxygen concentrations down to 0.2 ml/litre.

In most areas of the open ocean near bottom waters contain less oxygen than the waters directly above but have rarely been found to be anoxic.

There is no reason to suspect, therefore, that oxygen levels should be a limiting factor to mysid distribution over the major part of the Gulf of St. Lawrence. Bonne Bay east arm is apparently richly supplied with oxygen (deep waters 5.5 ml/litre) despite the fact that it is cut off from the Gulf by a substantial sill.

(b) The Sampling

(i) Zooplankton

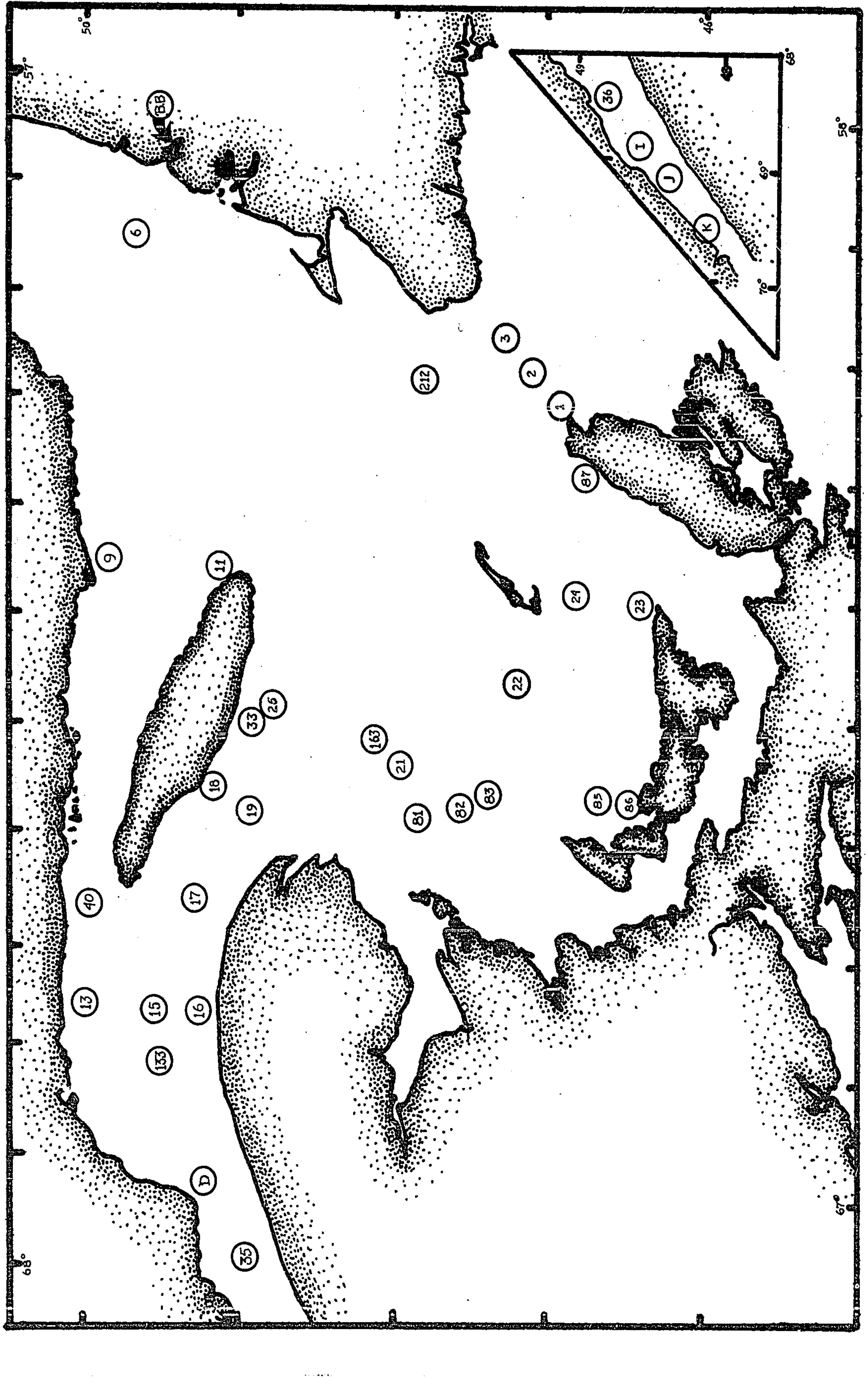
The International Biological Programme under the direction of Dr. D.M. Steven carried out a study of primary and secondary production in the Gulf of St. Lawrence during the summers (April through September) of 1969, 1970, and 1971. Zooplankton sampling was included in the programme and collections were made at a series of stations giving good coverage to the sublittoral Gulf. In 1969, 31 stations were included in the study while in 1970 the number of stations in the Gulf was increased to 216 and the range extended to include sampling in the St. Lawrence estuary. In the 1971 collecting season, (April through September) stations in the Strait of Belle Isle were added. Also occasional sampling at a station in Bonne Bay, east arm was done (Figure 3).

During the summer of 1969 the zooplankton sampling made use of 0.5 meter No. 0 and No. 6 nets. In 1970 and 1971 only No. 6 nets were used. The collections were made with oblique hauls which generally included 90% of the water column although at shallow water stations the proportion was often greater. There was a high degree of variability in the proportion of the water column sampled and in many instances the net actually hit the bottom, while in others the net only sampled, perhaps, one half of the total water column. These variations had to be taken into consideration when analysing the data. During the 1969 season, deep and shallow horizontal tows, of some significance to this study, were done.

Appendix 1 lists all zooplankton stations.

Figure 3

IBP zooplankton stations at which mysids were captured.


57°
50°
BB
6
9
11
212
3
2
1
87
24
23
22
26
33
163
21
18
19
81
82
83
85
86
40
17
13
15
16
133
D
35
68°
67°
48°
49°
36
I
J
K
58°
69°
70°
48°
68°

(ii) Hyperbenthos

A method used extensively in the 19th Century for the capture of mysids and other bottom organisms, was the dredge. The collection of three mysid species in the Gulf of St.Lawrence by Whiteaves occurred on a dredging expedition. It was found though, that for the capture of mysids and other such bottom plankton, that digging into the bottom was unnecessary and that an apparatus running along the bottom but with the mouth elevated was efficient in their capture.

Holt and Tattersall (1905) used tow nets attached behind a beam trawl to obtain mysid specimens. Russell (1928) developed a net for catching plankton near the bottom. With this apparatus he caught 50% of the known mysid species from Plymouth waters in one haul. This was a very good yield since not all of the species present would be expected in the small tract sampled (Tattersall and Tattersall, 1951).

Bossanyi (1951) developed a sampler for use just above the sea bottom and Wickstead (1953) developed one of a different design.

Black (1956), studying the mysids of the Bras D'Or Lakes, used an apparatus patterned after one which he had seen in operation at the Atlantic Biological Station, which consisted of a plankton net attached to a steel ski of considerable weight. This was attached to the cod end of an otter trawl and the two were towed simultaneously.

More recently Macer (1967) developed a bottom sampler which he claimed was more rugged and lighter than those constructed previously. Poirier, Grainger, Weinstein and Brunel (1969) modified the design of Macer and used it for their work in the Gulf of St. Lawrence.

Late in the summer of 1970, a hyperbenthic sampler designed and constructed by Dr. D. Faber, Mr. M. Brennan and Mr. L. Marhue, was put into operation in the Gulf of St. Lawrence by IBP. This model was considerably lighter and likely somewhat less costly than many of the previous samplers designed by others (Figure 4).

Construction was of 2" by 2" angle iron. The runners were 4" flat steel and the sampler mouth was a 24" by 36" rectangle, fitted with an opening and closing mechanism during the 1971 season. Unfortunately the opening and closing mechanism was not quite adequate and time for its modification was lacking.

One towing eye was fitted to each of the runners and one to the upper beam of the frame in such a way that the center of gravity was kept low and the apparatus reached bottom with the runners properly oriented. The specially fitting square mouth net was made of B. & S.H. Thomson Nitex No. 860 nylon monofilament netting (mesh size = .86 mm). Enlarged PVC buckets (and bucket liners) for the cod end were constructed for 1971 operations since the standard zooplankton buckets were too small and the side filtering apparatus was quite inefficient, frequently allowing severe damage of specimens by crushing. The enlarged buckets had end drainage holes which seemed to improve the catch quality.

Also in 1971, the length of the net itself was increased in order to increase the overall sampling efficiency by reducing the amount of backwash through the mouth of the apparatus. This, of course, gives the animals less chance to avoid the oncoming net.

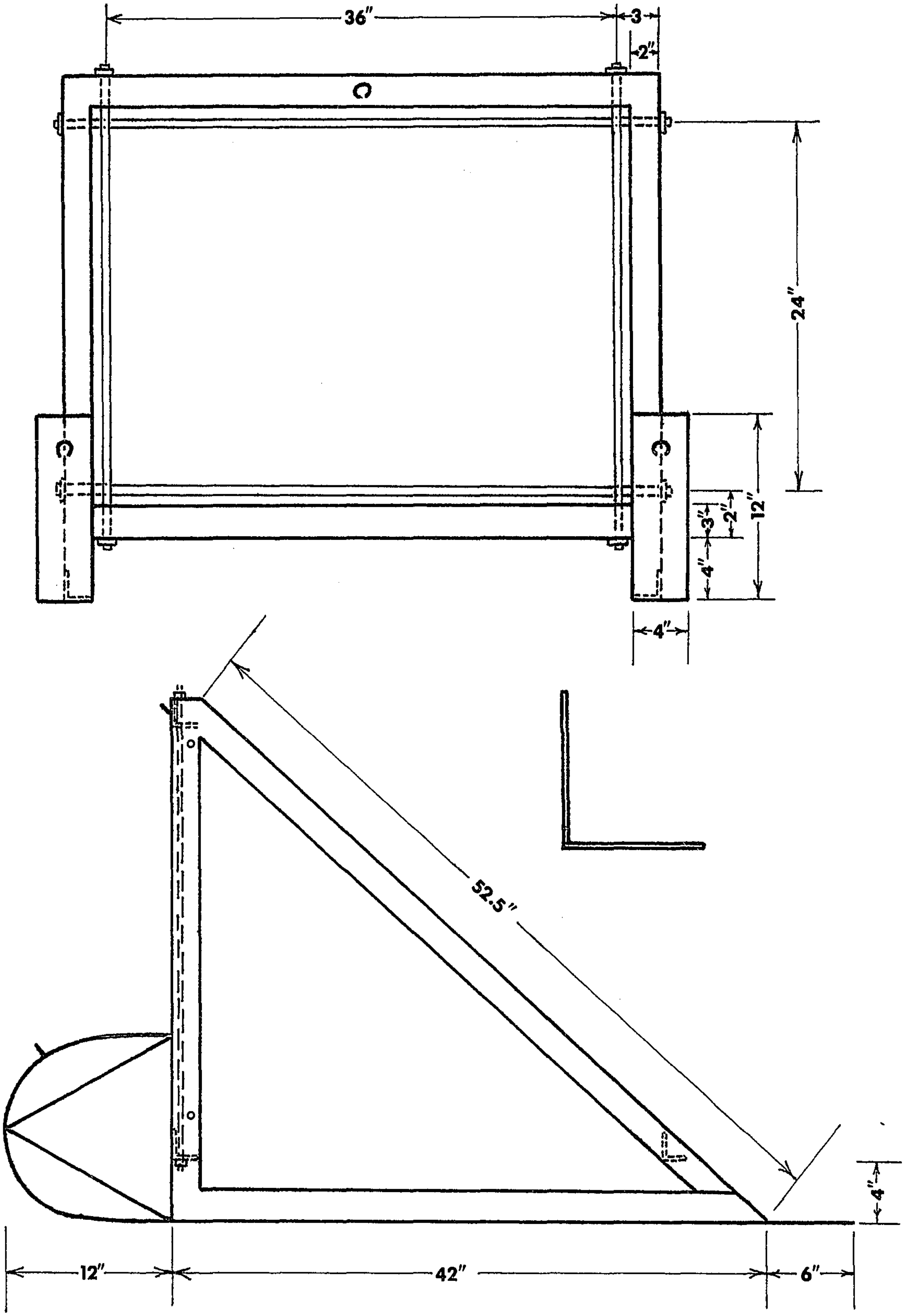
The hyperbenthic sampling programme was continued in March

Figure 4

IBP hyperbenthic sampler.

Frame is constructed of 2" x 2" angle iron.

Runners of 4 inch x 3/16" flat steel.


36"
3
2"
24"
12"
3"
2"
4"
4"
52.5"
4"
12"
42"
6"

of 1971 aboard CNAV Sackville. The cruise concentrated on the south coast of Newfoundland and the area outside Cabot Strait in the Laurentian Channel.

The Sackville had stern trawling facilities but the cable on the winch was of 1" diameter while the sampler was constructed for use with 5/32" cable. The cable quite likely reached the bottom with the sampler causing (a) stirring in front of the sampler and (b) the digging into the substrate of the sampler. There were also problems on this cruise keeping the sampler from contacting the bottom in an inverted position, probably due again to the great weight of the cable. This was somewhat remedied with a series of floats attached to the upper bars of the apparatus.

With the exception of two collections, both made over soft bottom, the numbers of animals per sample were low in proportion to those of the other cruises. This may also be related to the dragging of the heavy towing cable along the bottom in front of the net as well as the weighting of the mouth end of the sampler. The presence of rock fragments entering the net probably accounted for the tearing of two nets on this cruise. These occurrences probably caused considerable net avoidance by the animals. The problem did not appear to be as serious over the soft bottom of the Laurentian Channel.

Since there were no facilities for stern trawling aboard the M.V. Ambrose Foote, side trawling was carried out using the hyperbenthic apparatus. Cable again was a problem but this time because there was insufficient length to enable the sampler to collect from the Laurentian Channel bottom.

Since there was no information feedback from the apparatus itself it was not known for sure, especially over smooth bottom, and with only a limited amount of cable, at what depth the gear was sampling.

In 1970, fifteen late summer samples were made, seven of which contained no mysids at all. Three of the seven samples it was judged had not actually sampled the bottom layer of water but had behaved more in the manner of a midwater trawl. This ratio improved somewhat with the samples from Sackville 1971 when only two of the hauls did not sample along the sea floor. One of these two contained mysid specimens anyway. An additional collection, yielding only one mysid specimen, appeared to have come near the bottom for only a short time as evaluated by the amount of bottom plankton of other taxa present.

Of the 29 collections made in the 1971 summer season aboard the M.V. Ambrose Foote, only two samples did not reach the bottom.

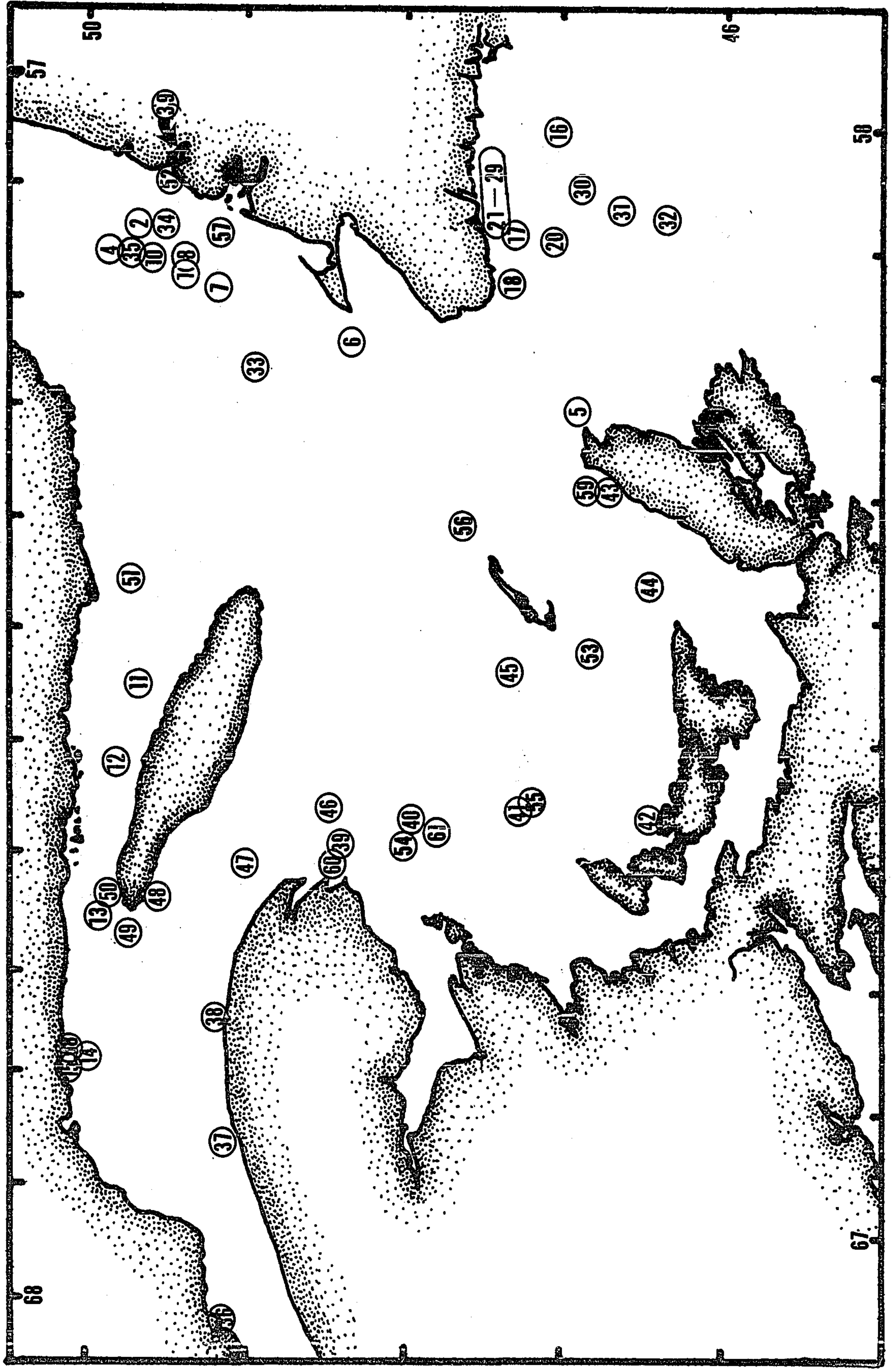
The other factor causing failure was the loss of samplers, or the tearing of nets. Of the 61 samples, 4 were lost because the nets were torn on hard bottom. Two samplers were lost due to the ruggedness of the bottom on the North Shore of the Gulf.

The collections made in March 1971 were very valuable since they proved to be the only ones taken from the deep water of the Laurentian Channel well below the 300 meter line. Only four such samples were made.

The collections from 1970 were concentrated off the west coast of Newfoundland and off the Gulf's North Shore, North of Anticosti, while those of 1971 were concentrated in the Magdalen Shallows and the shores, particularly the south shore, of the lower estuary. No samples were taken from the lower north shore

Figure 5

IBP hyperbenthic stations.


50
46
57
58
67
68
3,9
52
2
34
4
35
10
1,8
7
57
6
33
16
21—29
30
31
32
17
20
18
5
59
43
56
51
44
11
45
53
12
46
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42
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48
49
38
15
14
37
36

although two were attempted. The area proved to be too jagged and on both occasions, one in 1970 and one in 1971, the samplers were lost (Figure 5).

Attempts were made on two occasions by the Ambrose Foote to make collections in the Laurentian and Esquiman Channels inside the Gulf. Both failed due to the limited amount of cable on board.

(iii) Temperature and Salinity Data

Temperature data was obtained at the standard IBP stations in the Gulf using both bathythermograph, reversing thermometers and, in 1970 and 1971, an onboard STD apparatus.

Salinity values were obtained by using the conductivity method in the laboratory at McGill on samples collected at each station and/or by in situ measurement using the STD apparatus.

When hyperbenthic collections were made, special temperature and salinity data were not obtained but values from adjacent bottle stations were used, in most cases close enough in distance and time to be adequately applied to analysis of the collections.

Pertinent physical data concerning the locations of mysid occurrence are given in general Appendices II and III and values quoted throughout the presentation may be found by consulting these.

(c) The Collections

The zooplankton sampling nets were fitted with TSK flowmeters and therefore all the oblique collections made were quantitative.

On the other hand, the hyperbenthic collections were non-quantitative due to the fact that the opening and closing mechanism of the apparatus was not in operation and therefore flowmeters were not attached. An attempt was made to quantify some of the data, where deemed possible, on a specimens per minute basis.

The zooplankton collections sorted were, for the most part, half samples, while entire hyperbenthic samples were sorted with the exception of those with very large volumes of material and/or very large numbers of mysids. In these latter instances, representatives aliquots of approximately 24 oz. were sorted.

In the case of the Sackville 1971 collections, some onboard sorting was done due to the presence of large amounts of bottom material in some of the collections, particularly in those made over soft bottoms.

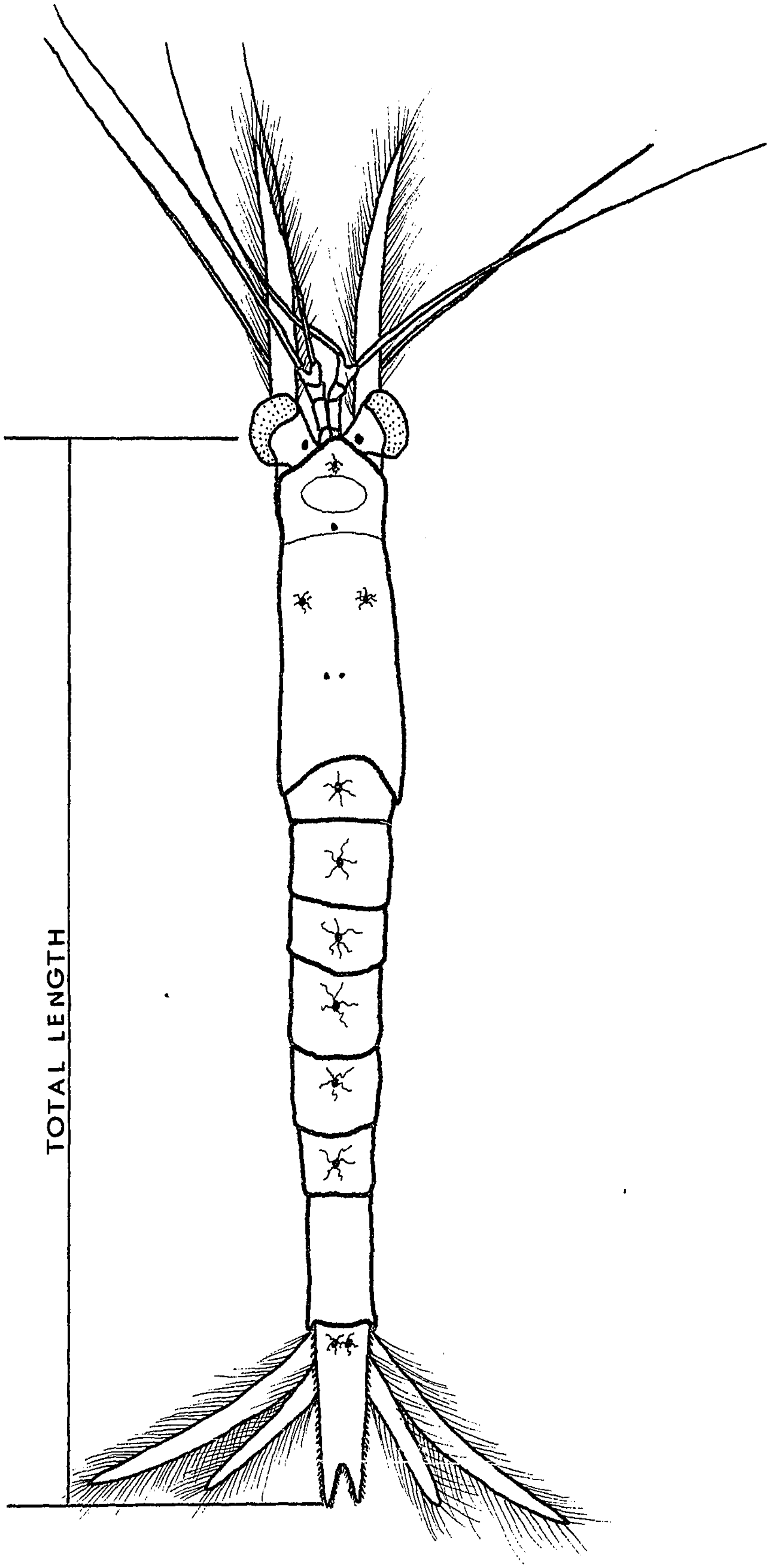
All representatives of the Mysidacea were counted, measured for length, sexed and maturity stage estimated.

(i) Measurement

Length of the animal was considered to be the distance from the tip of the telson, excepting setae or spines, to the anterior margin of the carapace as per Tattersall and Tattersall (1951) (Figure 6). It was felt that since the monograph of Tattersall and Tattersall is so widely used that their procedure would

Figure 6

Mysis mixta showing area considered to be total length.


TOTAL LENGTH

probably be the standard. Some workers have used other characters for body length measurement such as anterior extremity of the eye to the distal end of the telson or the tip of the antennal scale to the tip of the exopod of the uropod. Dunbar (1940) for example, did not include the telson in measurement. Perhaps the optimal accuracy would be achieved by comparing the distance from the anterior edge of the carapace to the posterior edge of the last abdominal segment. This would eliminate errors due to broken telsons, antennals scales, rostra, uropods, eyestalks or any other appendages which are frequently damaged. Some animals in this study could not be measured because they were so badly damaged.

(ii) Sex and Maturity

Determination of the sex of an animal was related to the nature and shape of the sexual appendages. In the male, the penes are short, conical protuberances (in most species) at the bases of the eighth thoracic limbs while the females possess lamellar projections which may vary in number from two to seven pairs depending upon species, arising again at the bases of the thoracic limbs and always beginning at the hindmost pair. In mature female specimens, it may be seen that the oviducts open near the bases of the sixth thoracic limbs. Females carrying eggs and embryos were noted and the eggs or embryos were counted for some species.

Immature specimens were distinguished from juveniles by the presence or absence of rudiments of the sexual apparatus just medial to the bases of the last pair of thoracic appendages and by the presence or absence of developing secondary sexual characters such as the appendix masculina, antennular brushes or the development of pleopods in the male (when a specific characteristic).

Maturity of specimens was judged subjectively, depending upon the degree of development of the marsupium of the female and the penes, pleopods, antennular brushes or appendix masculinae of the males.

Measuring, sexing and staging was all done using a Wild binocular dissecting scope.

Most of the figures were made using a camera lucida attachment adapted to the Wild dissection microscope.

Gross measurements were made using a **Turtox** millimetre grid while fine measurements were made using an eyepiece micrometer.

Certain calculations and statistics used for taxonomic purposes were done on IBM 370 system at McGill University using Fortran IV G.

(iii) Identification

References for identification purposes were Tattersall and Tattersall (1951) The British Mysidacea, Tattersall (1951), A Review of the Mysidacea of the U.S. National Museum, and Brunel (1960), An Artificial Key to the Mysidacea of the Canadian Atlantic Continental Shelf.

Results

(1) The species composition of the Gulf of St. Lawrence.

(a) Past records.

The mysid species previously recorded from the Gulf of St. Lawrence have already been covered in the introduction.

In summary, those species which have been previously recorded and were present in these collections are;

Boreomysis nobilis
Boreomysis tridens
Boreomysis arctica
Erythrops erythropthalma
Meterythrops robusta
Mysis gaspensis
Mysis mixta
Mysis stenolepis
Pseudomma roseum
Pseudomma truncatum
Stilomysis grandis

The capture of Mysis gaspensis, an intertidal form, was purely accidental and not a planned aspect of the sampling programme. The species was present along a portion of the shoreline of Moisie Bay, North Shore, and were easily captured with a dip net at low tide.

Mysis stenolepis, also a common intertidal form, was represented in a 146 m. hyperbenthos collection by one specimen. No explanation for its occurrence at this abnormal depth can be given.

(b) Present Collections

Collections made by IBP aboard the Ambrose Foote added new species to the existing list for the Gulf of St. Lawrence and many new locations to the known ranges of those species hitherto recorded from the area.

Previous workers identified and recorded thirteen species of mysids in the Gulf of St. Lawrence. In the present study the following species of Mysidacea, hitherto unrecorded from the Gulf, were identified.

Erythrops microps (G.O. Sars, 1864)
Erythrops abyssorum (G.O. Sars, 1869)
Pseudomma affine (G.O. Sars, 1870)
Pareythrops obesa (G.O. Sars, 1864)
Amblyops abbreviata (M. Sars, 1869)?
Amblyops kempii (Holt and Tattersall, 1905)?
Mysidetes farrani (Holt and Tattersall, 1905)?

The question marks beside the last three species are for two reasons. First, *Amblyops abbreviata* and *Amblyops kempii*? produced a taxonomic problem which will be explored in some detail later on and secondly *Amblyops kempii*? and *Mysidetes farrani* were found only at the entrance to Cabot Strait. The question of whether or not they belong to the Gulf fauna, since their degree of penetration into the Gulf is in some doubt, will be discussed. *Mysidetes farrani*, *Parerythrops obesa* and *Amblyops kempii* have not before been recorded on this side of the Atlantic.

Species found by other workers but not represented in these collections are:

Boreomysis tridens var. *lobata*
Mysis oculata
Neomysis americana

Mysis oculata is a shallow water, arctic form (Stephensen, 1912), and *Neomysis americana* is a very shallow water form sometimes found associated with Zostera beds (Prefontaine, 1931).

Boreomysis arctica was present on the estuary (Prefontaine, 1933) and was found to inhabit the same geographical area as *B.tridens*. *B. tridens* var. *lobata* was recorded by Brunel (1971) from the Saguenay region and he considered it to be well sampled by plankton gear. *B.tridens* and *B.arctica* have been found to inhabit the same geographical area in other locations (Tattersall & Tattersall, 1951) and Hansen (1908) notes the apparent planktonic occurrences of *B.arctica*.

The question therefore arises as to whether the form present in the Gulf is *B.arctica* or *B.tridens* var. *lobata*, as *B.arctica*, a common form, has been poorly described. Subsequent examination of U.S. National Museum specimens led to the conclusion that it is actually *B.arctica*. The question of the validity of *B.tridens* var.*lobata* arises due simply to the fact that Nouvel makes no further mention of this variety in the literature e.g. Nouvel (1950, Fiche 19).

PART I

(2) Taxonomy

(a) Introduction

In any study which considers species previously unknown to an area, taxonomy becomes of critical importance, as a great deal of what is observed concerning the distribution and ecology of a species in one area may be clarified by the knowledge of these parameters in another area.

Likewise, the process of properly identifying a species previously unrecorded from an area is a process which requires a great deal of care.

In the present study, careful consideration gave rise to questions concerning species identity which were transformed to problems worthy of analysis and discussion.

The following section will attempt to deal with those problems which appear to be the most noteworthy.

Mysis mixta, *Mysis stenolepis*, and *Mysis gaspensis* were considered by Black (1956) and his studies require no further elaboration. *Meterythrops robusta*, *Stilomysis grandis* (although a mature adult has not been described, Tattersall, 1951), *Pseudomma truncatum*, *Pseudomma roseum* and *Boreomysis tridens* were immediately recognizable, fairly well described in the literature and showed no morphological anomalies.

Although *Parerythrops obesa* and *Mysidetes farrani* are new to the faunal records, they were quite distinct and easily dealt with.

On the other hand *Genus Erythrops* exhibited certain characteristics which defied the literature. Pseudomma affine was for some time rather elusive and was quite easily confused with P.roseum and P.truncatum. It is felt that it might be worthwhile to point out some of the salient features of P.affine which differ from the corresponding features of the other two species of this genus. Tattersall and Tattersall (1951) describes the difference between the Pseudomma affine and Pseudomma roseum but it appears that the former is somewhat variable in structure over its global range and certain of the differences described by Tattersall are not as obvious in the Gulf populations as one would be led to believe.

Genus Amblyops, appearing in two forms in the Cabot Strait area, presented a systematic problem worthy of consideration.

The Genus Boreomysis is described by O. Tattersall (1955) as being a difficult group with remarkable interspecific similarities yet considerable phenotypic variation. Some question arises as to the status of Boreomysis tridens var. lobata (and B.arctica) as observed from Gulf collections.

(b) Results & Discussions

(i) Genus Erythrops

Erythrops abyssorum was identified primarily by virtue of the number of serrulations on the outer margin of the antennal scale and the nature of the terminal spine of the antennal scale. The antennal scale of Erythrops abyssorum has fewer serrations in the adult than does that of Erythrops serrata (matures were found to have 7 serrulations) and the terminal spine does not project beyond the apex of the antennal scale.

One point of confusion arose however. Erythrops serrata is supposedly quite distinct from Erythrops abyssorum by virtue of the presence of 'club-shaped' protuberances or sternal processes on the males and immatures. (Tattersall and Tattersall, 1951). On close examination, the Gulf form, considered to be Erythrops abyssorum, was also found to possess these processes on the ventral portion of the thoracic somites.

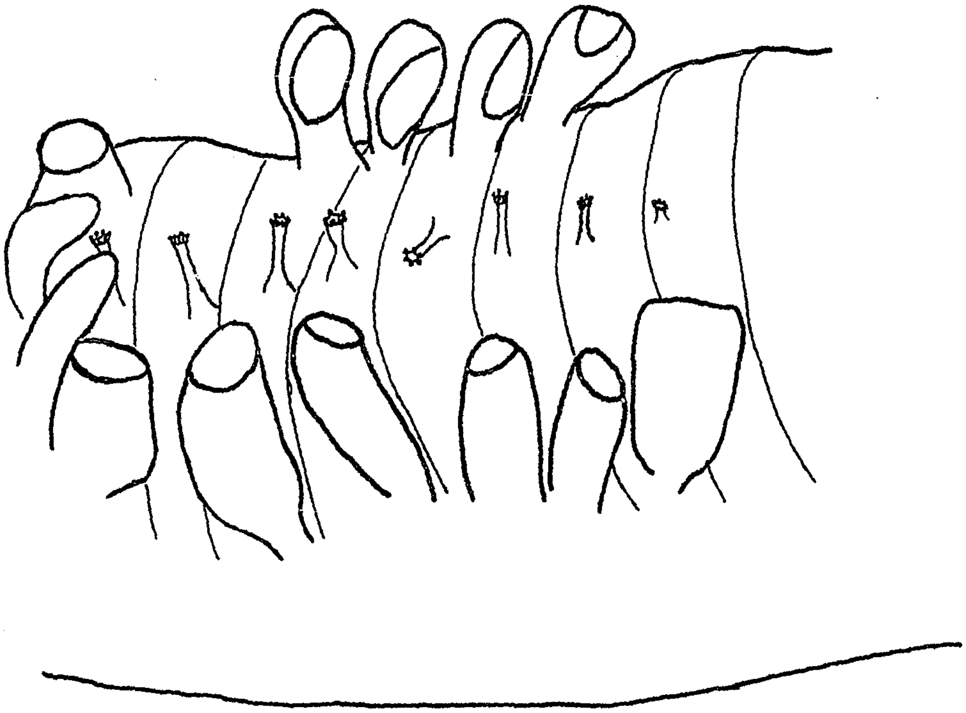
Subsequent examination of the other two Gulf forms, Erythrops microps and Erythrops erythropthalma revealed that they too possessed sternal processes in the males and immatures (Figure 7).

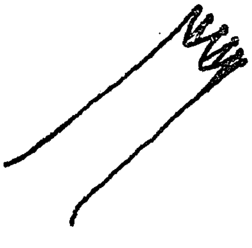
In all three species, (1) the processes became larger from anterior to posterior and (2) they became progressively smaller, proportional to the length of the animal, with an increase in total length of the animal.

It is noteworthy, then, that these were found in all Erythrops species of the Gulf when, from the literature, it is mentioned as being characteristic of only two species. It appears

Figure 7

Erythrops erythropthalma; ventro-lateral view showing sternal processes.   X 50





that perhaps these peculiar processes have been overlooked in the Erythrops species in the past, with the exception of Erythrops serrata and Erythrops africana. The latter a species relatively recently described by O. Tattersall (1955).

(ii) Genus Pseudomma

The most obvious difference between the Pseudomma species lies in the shape and apical spination of the telson. Pseudomma truncatum is distinct from the other two in possessing an apically truncated telson while the telsons of Pseudomma affine and Pseudomma roseum are rounded apically. The difference between the latter two is that Pseudomma affine possesses one more pair of apical spines than does Pseudomma roseum (Figure 8). P.roseum possesses two pairs of apical spines while P.affine possesses 3 pairs. Wigley & Burns (1971) note that P.affine consistently has 6 spines (3 pairs). Both the spines of the telson and those of the ocular plate of P.roseum are larger, more widely spaced, fewer, and more irregular than those of P.affine.

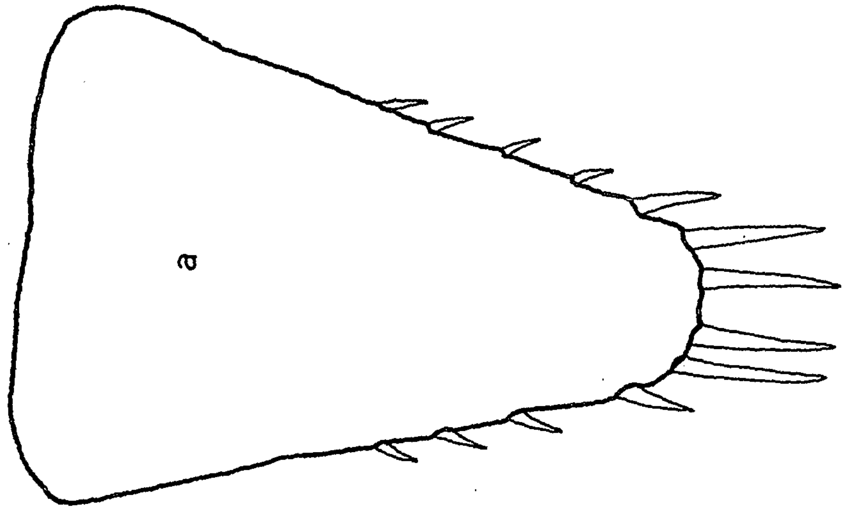
Tattersall and Tattersall (1951) are aware of the confusion which may arise between Pseudomma affine and Pseudomma roseum and adequately describe the difference in eyeplate denticulation (Figure 9) and the difference in the proportion of the apex of the antennal scale to its total length. The latter character was found, for the Gulf specimens, to be an unreliable visual aid and even upon measurement was difficult to use with any degree of confidence.

A Pseudomma roseum population in the Cabot Strait area was sampled in March 1971 and a size-frequency histogram was constructed (Figure 10). The value of this histogram lies not in

Figure 8

(a) telson of _Pseudomma_ _roseum_. x 50

(b) telson of _Pseudomma_ _affine_. x 50


a

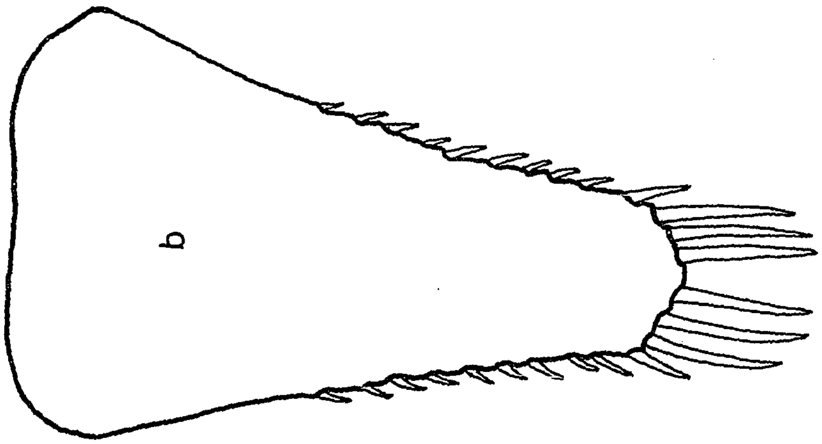
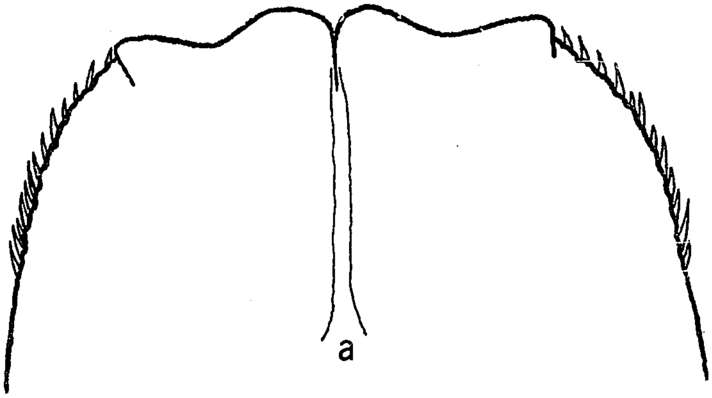

b

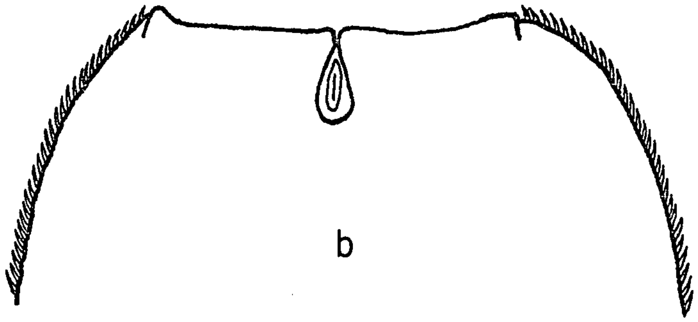
Figure 9

(a) ocular plate of P.roseum x 50

(b) ocular plate of P.affine x 50



a



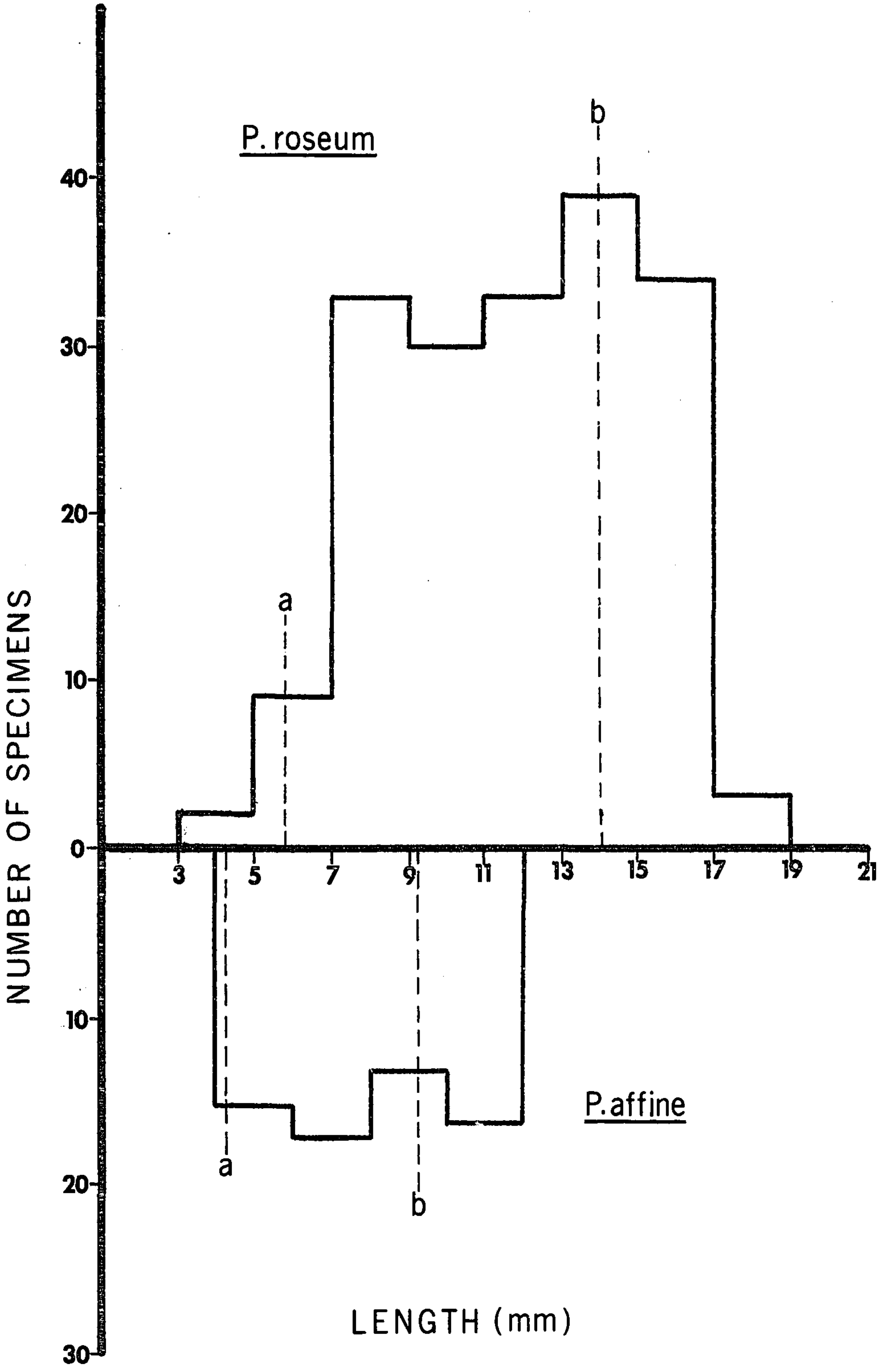
b

Figure 10

Size-maturity histograms of P. roseum and P. affine

(a) size at which sexes become distinguishable.

(b) size at which maturity is attained.


P. roseum
P. affine
a
b
a
b
NUMBER OF SPECIMENS
LENGTH (mm)
40
30
20
10
0
10
20
30
3
5
7
9
11
13
15
17
19
21

the population size distribution but in the size-maturity characteristics of the population. Pseudomma affine specimens from all areas of the Gulf were pooled and used to construct a similar histogram. It became evident in doing so that the specimens of Pseudomma affine were either (1) from two separate populations; one from the Cabot Strait area and one from the North Shore of the Gulf and/or (2) size-maturity characteristics were slightly variable seasonally since the samples from the two areas were made at different times of the year. The average values of size at maturity were used in the histogram.

In either instance, it is obvious that size-maturity as well as maximum size of specimens of each species differ to a significant extent. The largest specimen of Pseudomma affine, albeit that the numbers of animals captured were small, fell into the 11 to 12 mm. interval. This was a male endowed with a fully developed antennular brush. The largest Pseudomma roseum was found to belong to the 17 to 18 mm. interval.

Average size at maturity for the pooled Pseudomma affine specimens was found at approximately 9.2 mm. while for Pseudomma roseum it was found to be at 13.9 mm. One specimen; female, 13.9 mm., of the latter species was carrying embryos in March. Similar, yet not so acute differences, were found for the size at which the secondary sexual characteristics begin to appear. In Pseudomma roseum they began at approximately 5.8 mm. while for Pseudomma affine at 4.3 mm.

(iii) Genus Amblyops

The separation of Amblyops abbreviata and Amblyops kempii presented a great deal of difficulty since both forms deviated considerably from the descriptions of each presented by Tattersall and Tattersall (1951). The eastern Canadian forms were found to have many characters in common which Tattersall and Tattersall stated as differing for the two species from the eastern Atlantic.

Amblyops abbreviata and Amblyops kempii were separated on the basis of four characters which were found to be the same as those of type specimens. (1) The telsons differed considerably in both form and armature. The telson of Amblyops abbreviata is linguiform with the lateral margins tapering to a bluntly rounded apex while that of Amblyops kempii narrows near the base and the lateral margins are almost parallel.

Only two-thirds of the lateral margin of the telson of Amblyops abbreviata is armed with spines while three-quarters of that of Amblyops kempii is armed. The lateral spines of both forms grade evenly into a series of apical spines which are proportionately shorter in Amblyops abbreviata than in Amblyops kempii (Figure 11a). (2) Typical of Amblyops kempii is a sharp prominent spine at the outer corner of the distal segment of the antennal sympod. Amblyops abbreviata possesses a more laterally flattened and apically blunt projection at this spot (Figure 11b). (3) The antennal peduncle of each form is composed of four segments although the division of the first and second segments of the peduncle of Amblyops kempii was found to be incomplete, as described by Tattersall and Tattersall (1951). The first and

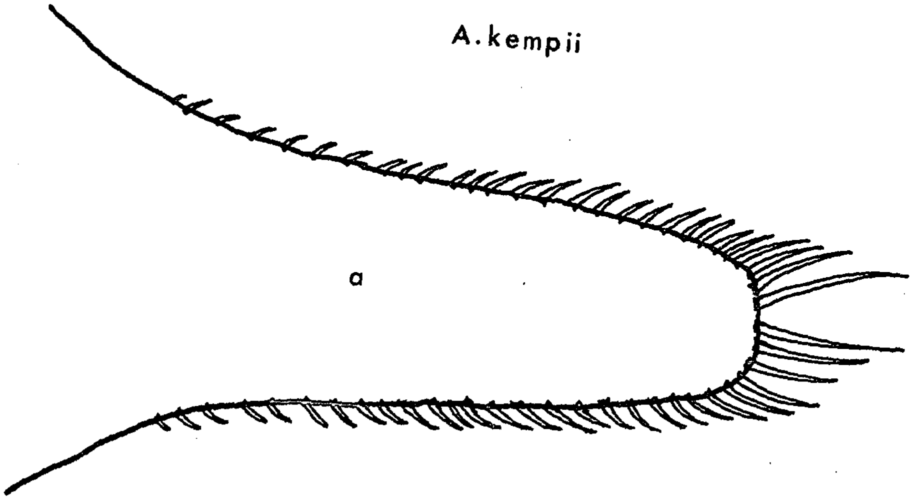
Figure 11 (2 pages)

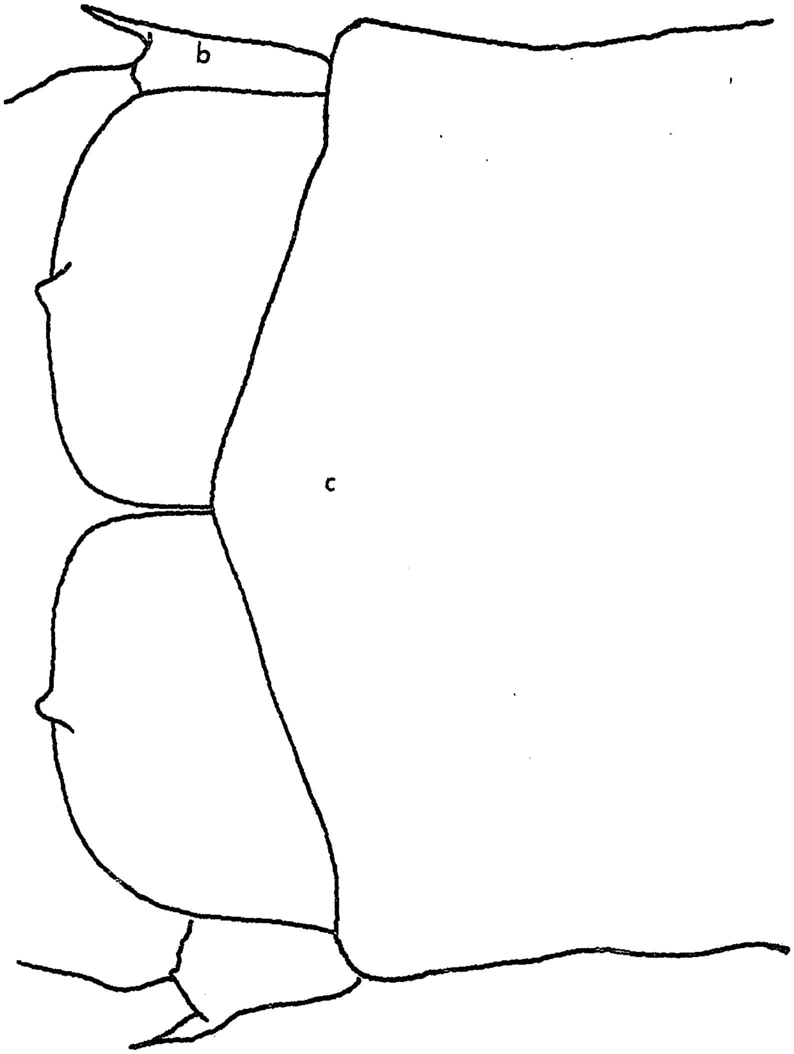
(a) Telsons of *Amblyops abbreviata* and *A.kempii*. X 50.

(b) Antennal sympods of *A.abbreviata* and *A.kempii*. X 50.

(c) Anterior ends of *A.abbreviata* and *A.kempii*. x 50.

A.kempii





A.abbreviata

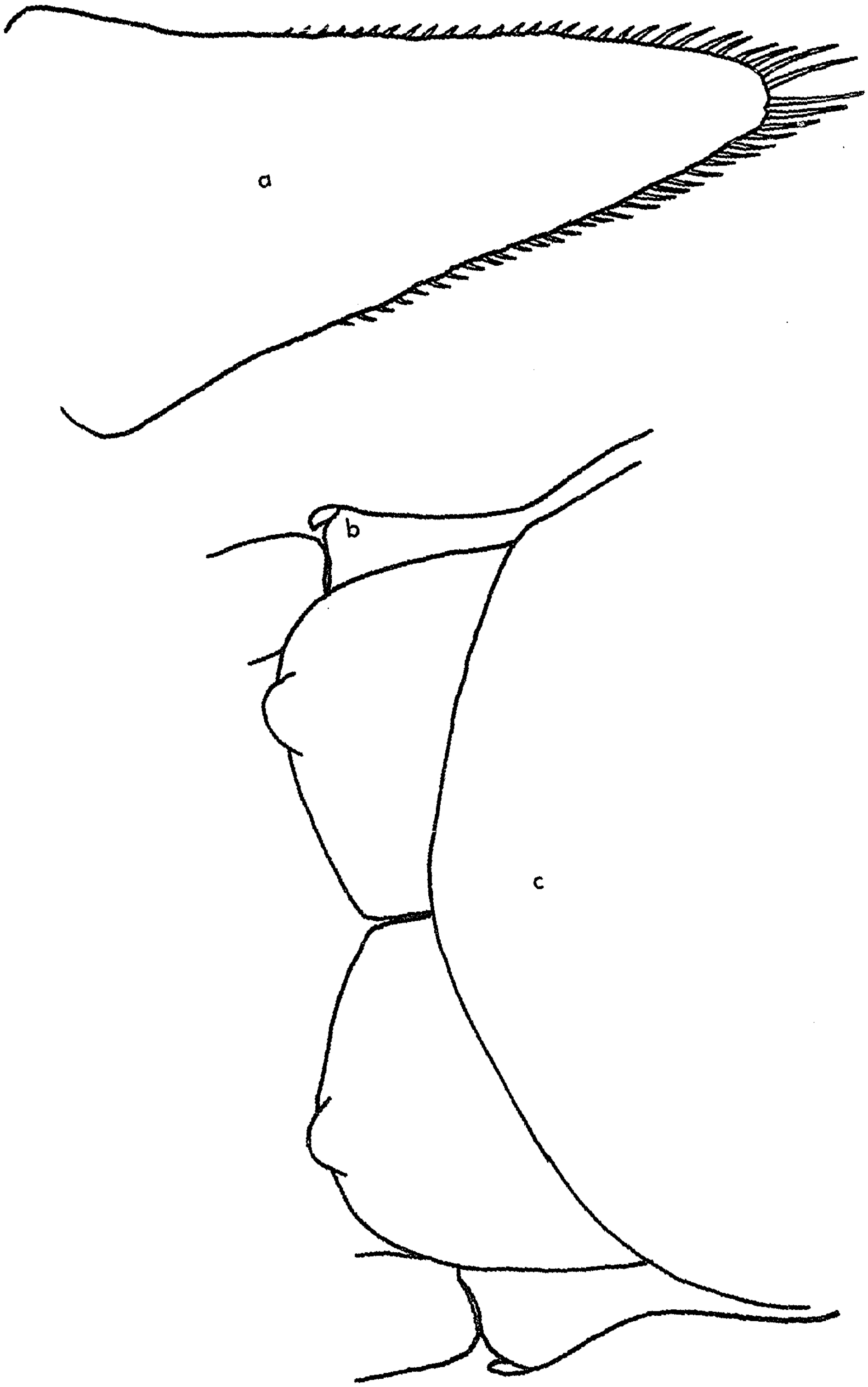
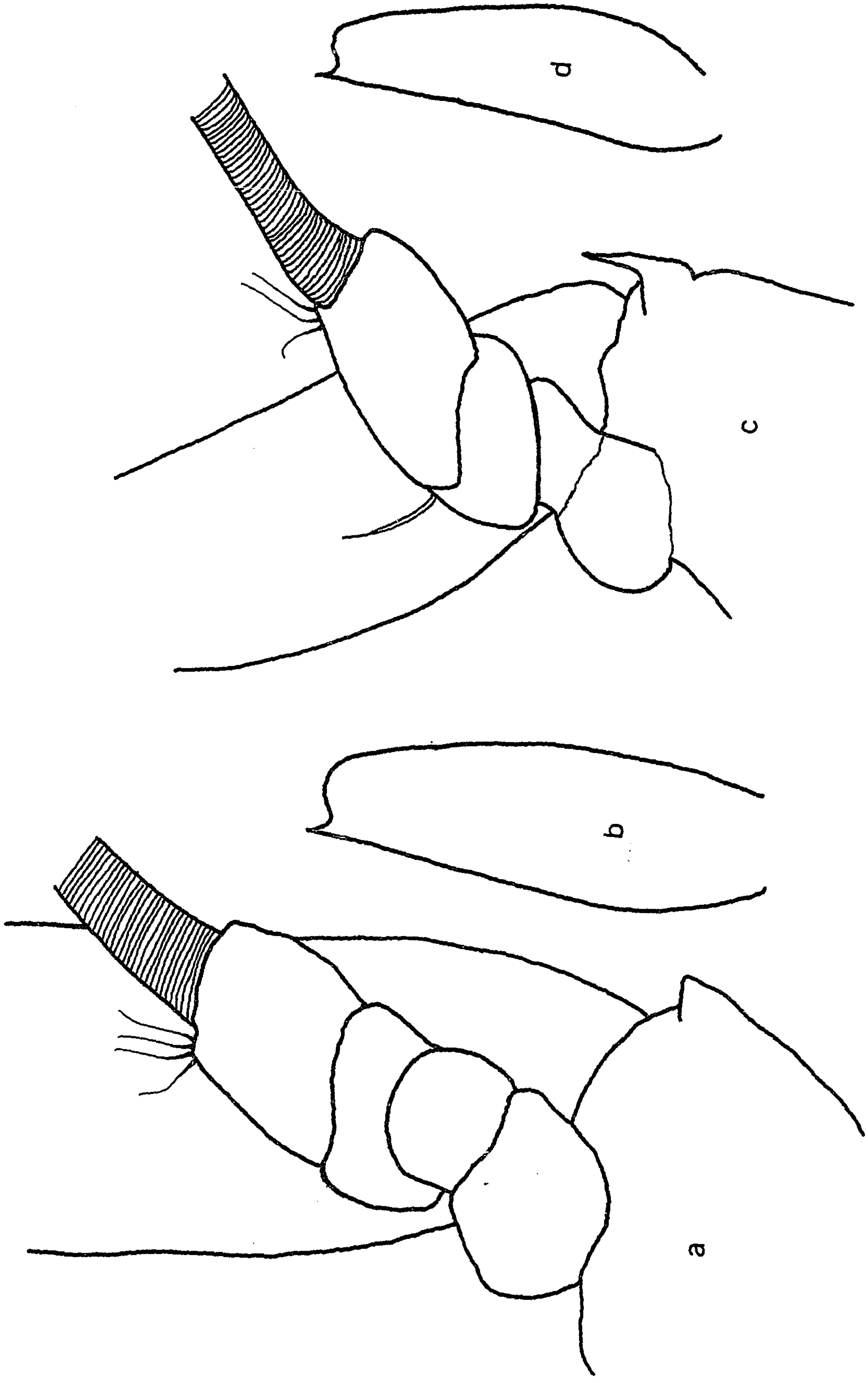


Figure 12

(a)	Antennal sympod and peduncle of _A.abbreviata_.	X 100
(b)	Antennal scale of _A.abbreviata_.	X 50
(c)	Antennal sympod and peduncle of _A.kempii_.	X 100
(d)	Antennal scale of _A.kempii_.	X 50


d
c
b
a

second segments of the peduncle of Amblyops abbreviata are completely separate and articulated. In each case, the third segment (or second in Amblyops kempii, if the first and second segments are considered as one) overhangs the second (or first) dorsally (Figure 12a). (4) The antennal scale of Amblyops abbreviata is found to be more robust than that of Amblyops kempii and does not taper to as great an extent distally (Figure 12b).

The present forms differed from those described from eastern Atlantic waters in the following ways.

(1) The anterior margin of the carapace of Amblyops abbreviata was found to be less rounded than that of the specimen figured in Tattersall and Tattersall (1951) and quite similar to that of Amblyops kempii.

(2) The proportions of the various abdominal segments to one another correspond to those of neither of the species described previously and are quite variable from animal to animal.

(3) The ratios of uropodal exopod length to telson length for the two forms do not correspond to those described by Tattersall and Tattersall for these two species. The exopod/telson ratio is greater for Amblyops kempii than for Amblyops abbreviata, opposite to that previously described.

(4) Both forms possess two long slender spines near the ventral surface of the statocyst. In the original descriptions Amblyops abbreviata was described as possessing one short blunt spine in this position.

(5) Tattersall and Tattersall describe Amblyops abbreviata as having many setae on the inner margin of the antennular peduncle

TABLE I LENGTH TO WIDTH RATIOS OF THE EXOPOD OF THE UROPOD.

Amblyops abbreviata (both sexes)

Body Length (mm.)	Ratio of Length to Width
14.0	4.7
13.0	4.7
13.7	5.0
13.5	4.7
12.6	5.1
16.0	5.0
8.7	4.8
13.0	5.0
14.0	4.8
	$\bar{X}$ = 4.9

Amblyops kempii (both sexes)

Body Length (mm.)	Ratio of Length to Width
13.6	6.0
13.5	5.7
13.7	5.9
13.8	5.4
13.0	5.9
12.0	5.8
12.0	6.0
14.0	5.75
12.5	5.8
11.8	5.5
	$\bar{X}$ = 5.8

and Amblyops kempii as having few. The specimens in the Gulf region did not exhibit this pattern but rather it was found for both species that males had few setae in this position while females had many.

(6) The spinules of the eye plates, a supposedly salient feature, were quite difficult to observe and served poorly as a criterion for the separation of the two forms.

(7) One additional feature, not mentioned by Tattersall and Tattersall (1951), was found in the length to width ratio of the exopods of the uropods. Based on 10 specimens of A.kempii the mean of the ratio was found to be 5.8 while for A.abbreviata (9 specimens) the ratio was found to be 4.9 (Table 1) significantly different at better than P = .001 (Appendix IV).

(iv) Genus Boreomysis

In the Gulf of St. Lawrence, three forms of Boreomysis are considered; two are common to the deep waters of the Laurentian Channel, the third is spatially separated from the other two and restricted to the Arctic-like waters of the coastal fjords.

The original description of Boreomysis arctica poorly figures the anterior margin of the carapace. Nouvel (1943) mentions that the antero-lateral margins appear to be more produced than originally figured and Holt & Tattersall (1905) note the same. It is also evident from present collections that the 'shoulders' become much more prominent with age (Figure 13).

In the adult, the shoulders very closely resemble those figured for B.tridens var. lobata (Nouvel, 1942). As will be shown, B.arctica is very similar to B.tridens and therefore to B.tridens var. lobata.

(A) Gross Morphology

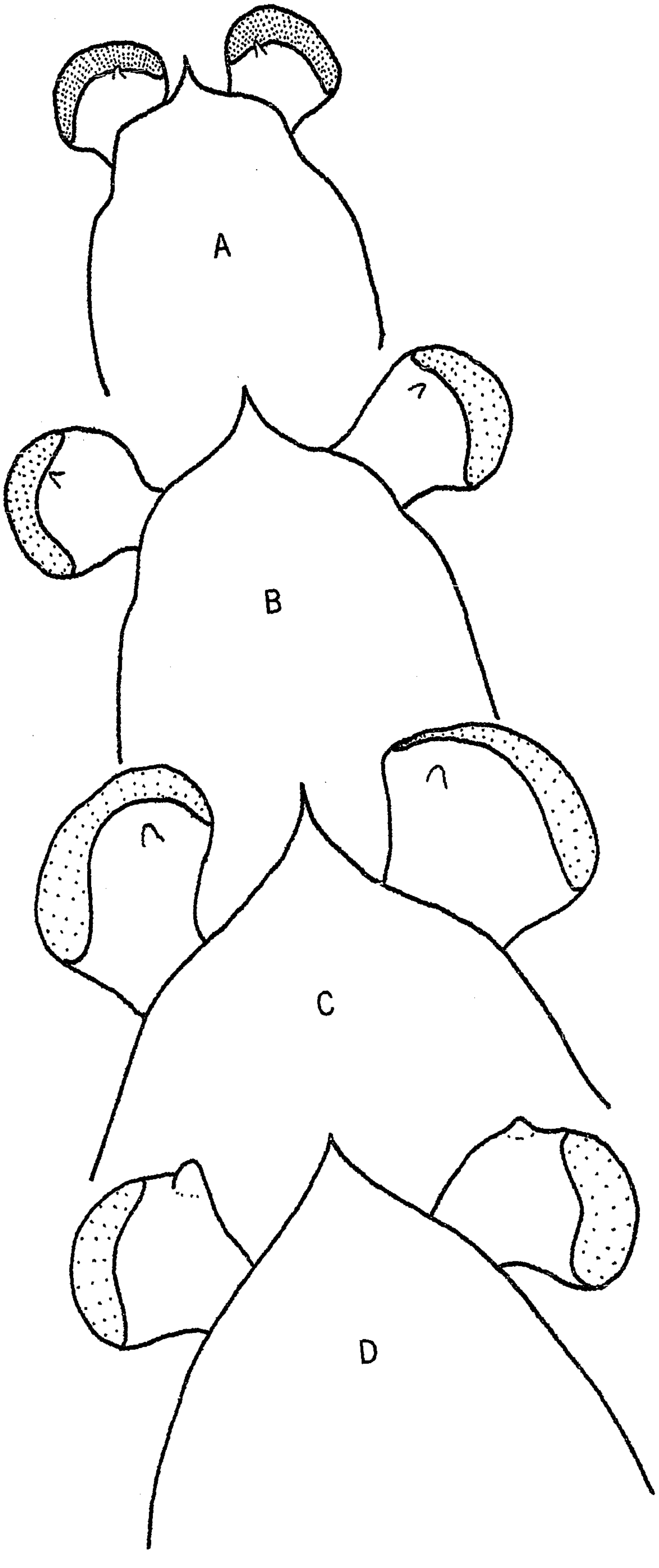
Each species is immediately distinguishable at a glance under low power microscopy by two prime characteristics; (1) the shape and extent of the rostrum (and anterior margin of the carapace) (2) and the nature of the telson and its armature.

It is seen from the figures, drawn to scale from specimens of approximately equal length, that there are marked similarities but each has its own distinctiveness.

Boreomysis nobilis has a very long rostrum, the longest of all the species, extending to the second segment of the antennular peduncle. Boreomysis tridens possesses a distinctive three spined

Figure 13

(a) *Boreomysis arctica* - 25.2 mm x 6
(b) " " - 16.3 mm x 12
(c) " " - 13 mm x 25
(d) " " - 10 mm x 25


A
B
C
D

or tridentate rostrum while Boreomysis arctica and Boreomysis nobilis possess rounded and distinct shoulders on the anterior lateral margins of the carapace. The rostrum of Boreomysis arctica is shorter than that of Boreomysis nobilis and in profile is more upturned than that of the latter species (Figure 14).

It may be worthy to point out here what seems to be the cause of some confusion concerning the rostral spine of Boreomysis nobilis. In the figures of Sars (1879), Zimmer (1909) and that of Tattersall (1951) which was drawn after Sars, the rostrum is figured as having a line down the centre of it which Brunel (1960) describes as a rostrum composed of two closely appressed spines. There is, however, no evidence of this in these specimens. Also, O. Tattersall (1955) describes B.nobilis as having no ocular papilla although Bonne Bay specimens possess a small papilla somewhat medial to the midline of the eyestalk.

The telson of Boreomysis nobilis possesses very straight lateral margins and is not as tapered distally as are the telons of Boreomysis tridens and Boreomysis arctica. That of Boreomysis arctica is concave in the margins, the narrowest portion being not at the apex but at approximately 2/3 of the distance from the proximal end (Figure 15).

The telson of Boreomysis tridens, is, in design, superficially intermediate between those of the other two. The margins are very slightly concave yet the narrowest part of the telson appears to be very near or at the apex.

The armature of the telsons follows a similar pattern to the relative straightness of the margins. The telson of Boreomysis

Figure 14

(A)	Anterior end of	*B.tridens*	X 6
(B)	" "	*B.nobilis*	X 6
(C)	" "	*B.arctica*	X 6

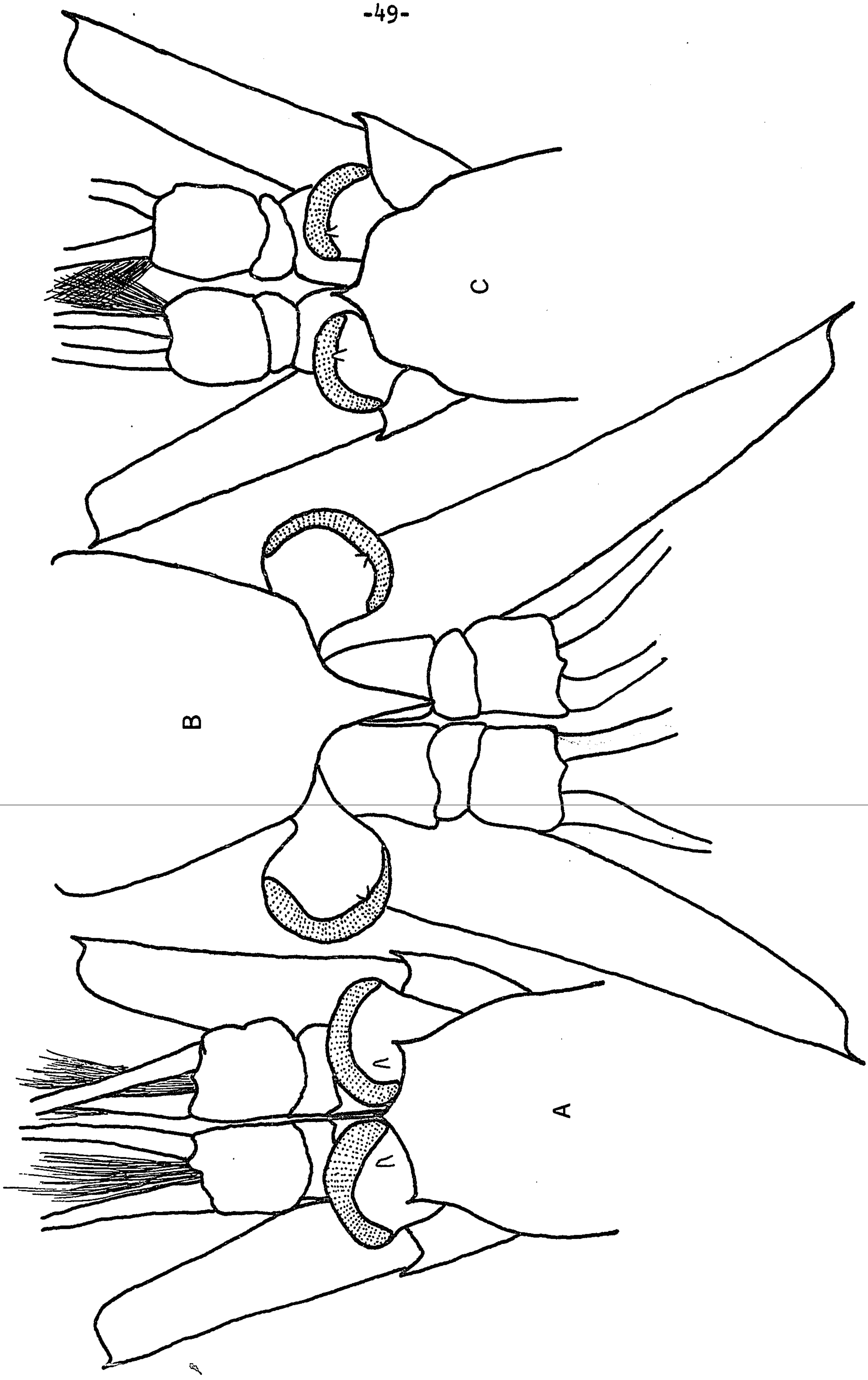
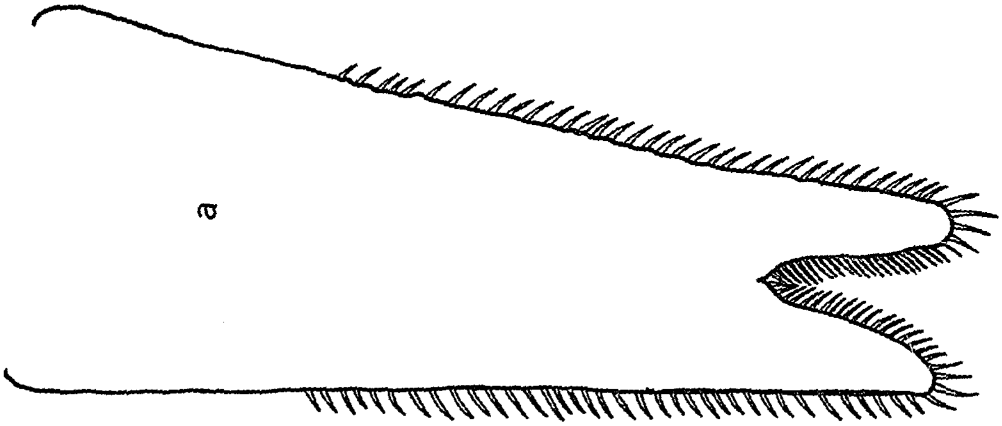

C
B
A

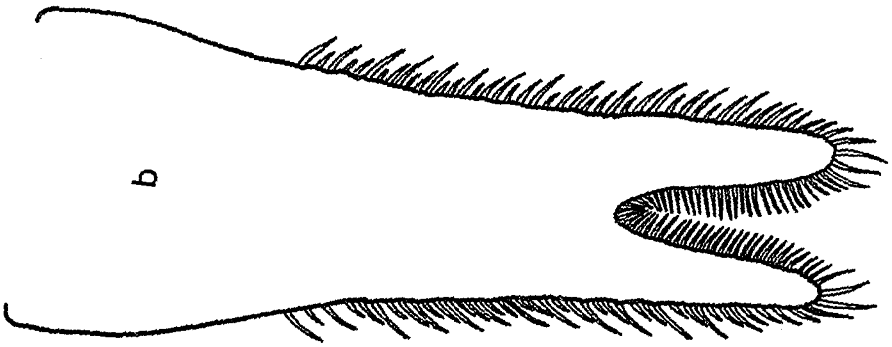
Figure 15

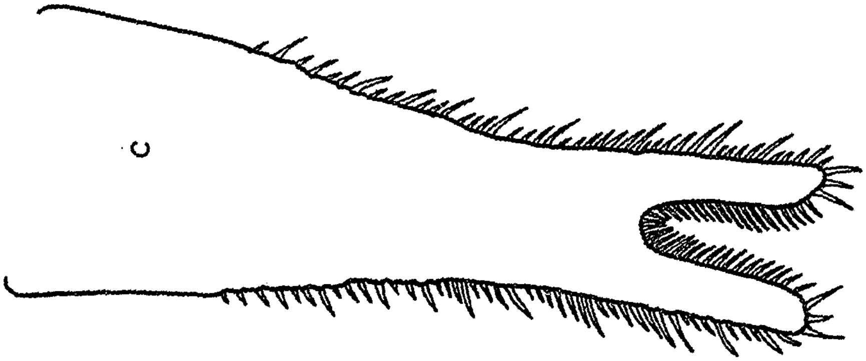
(a) telson of B.nobilis X 25

(b) telson of B.tridens X 25

(c) telson of B.arctica X 25


a


b


c

nobilis is armed with a series of 34-38 spines in the mature individual. These spines are of approximately equal length along the margins. On the other hand, in *Boreomysis arctica*, the spination is distinctly serial, with the number of graduated spines or denticles in a series increasing posteriorly. The margins of that of *Boreomysis tridens* have spines which tend to be stouter than those of the latter and arranged in a vaguely serial fashion (series of 3 spines) and not increasing appreciably in number from anterior to posterior.

Boreomysis nobilis shows an antennal scale unlike that of the other two, which are almost identical in this character. On close examination the antennal scale is seen to be slightly different than that originally figured by Sars in that it has a more distinct, narrower, proximal portion of the terminal spine and the scale apex is slightly more truncate than acute in shape.

(B) *Characters Not Immediately Obvious to the Eye*

Figures of the endopod of the uropod indicate that there is a difference between *Boreomysis tridens* and *Boreomysis arctica* with respect to the spines on the ventral surface of the statocyst. This is a character commonly mentioned by mysid taxonomists and it is seen here that *Boreomysis tridens*, like *Boreomysis nobilis*, has two distinct spines. *Boreomysis arctica* has only one, although it has previously been described as having two (Tattersall and Tattersall, 1951).

Boreomysis tridens and *Boreomysis arctica* are, in most ways, remarkably similar while *Boreomysis nobilis* is, in many ways, quite different from the other two. In other terms, the genus is very close but the former two are closer to one another in form than either is to *Boreomysis nobilis*.

The antennal scales of these two are similar in structure within the limits of individual variation while that of *Boreomysis nobilis*, as mentioned previously, is quite distinct. Figure 14 shows that the proportion of the length of the scale to that of the antennular peduncle, for male specimens in this case, are actually the same for *Boreomysis tridens* and *Boreomysis arctica*.

The mature male pleopods, again, are the same for *Boreomysis tridens* and *Boreomysis arctica*, the relative lengths of the exopods to the endopods being similar in the two forms. Those of *Boreomysis nobilis*, however, are similar only as far as is characteristic of the genus. Visual observation of the figure 16 reveals that these pleopods vary significantly from those of the two previous forms, particularly in the nature of the second and third limbs and their relative proportions.

Another taxonomic character of importance is the modification of the exopods of the pleopods. It is characteristic of the family to have the endopod of the first male pleopod reduced to a single segment but the spines of the last few segments of the subsequent exopods may show more specificity than this.

Boreomysis tridens as described by Sars (Tattersall and Tattersall, 1951) possesses non-setulose, stout spines only on the distal few segments of the exopod of the third pleopod. This modification is shared with other members of the genus such as *Boreomysis microps* (G.O. Sars, 1883) and *Boreomysis arctica*.

Boreomysis nobilis has this modification of spines on the 2nd and 3rd exopods but the resulting spines are shorter and stouter than those of *Boreomysis tridens*, *Boreomysis*

Figure 16

(a) Male pleopods of *B.tridens* X 12

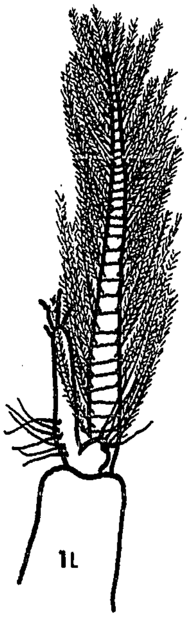
(b) " " " *B.arctica* X 12

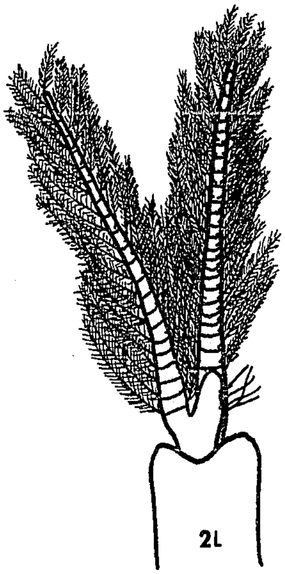
(c) " " " *B.nobilis* X 12

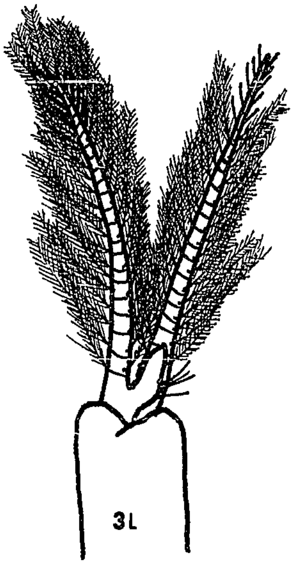
N.B. L = left R = right

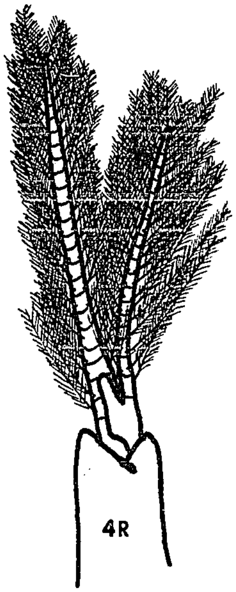
1 = 1st abdominal appendage etc.

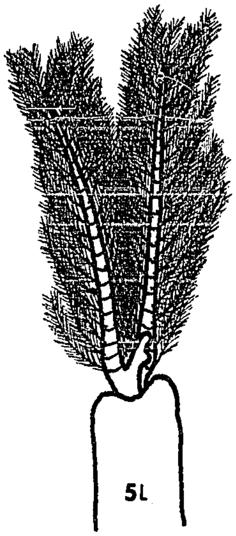
a


1L

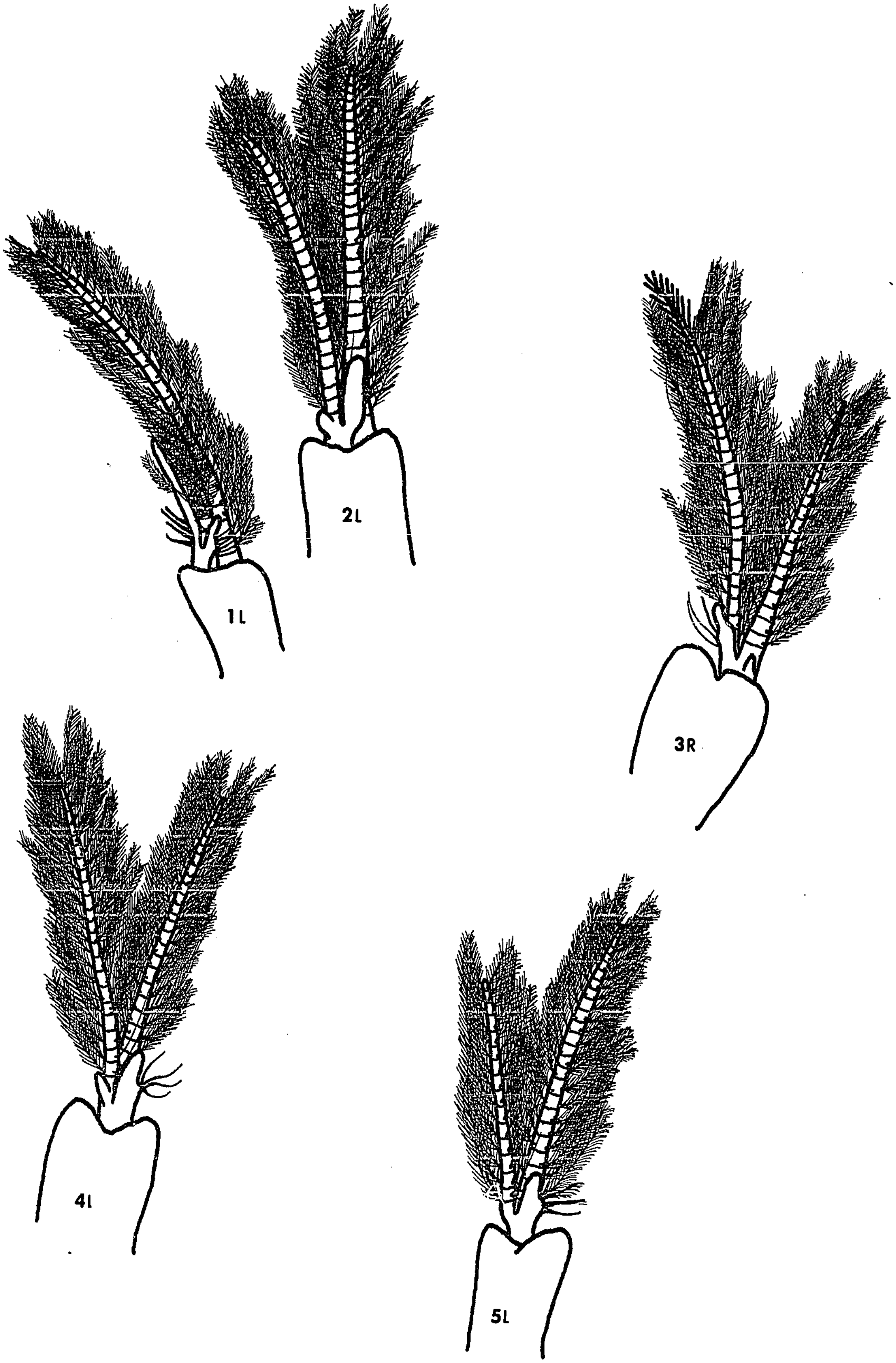

2L


3L


4R

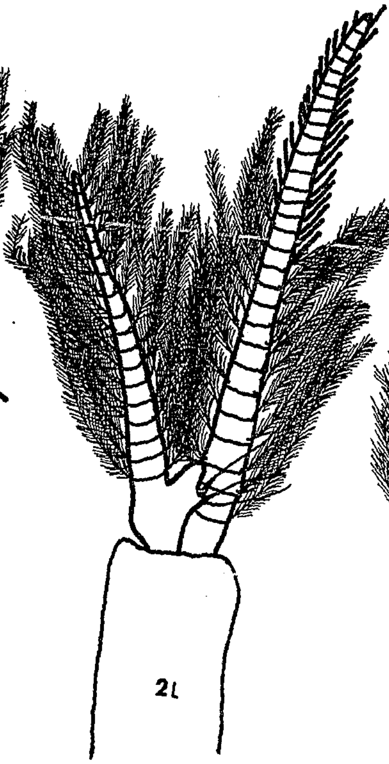

5L

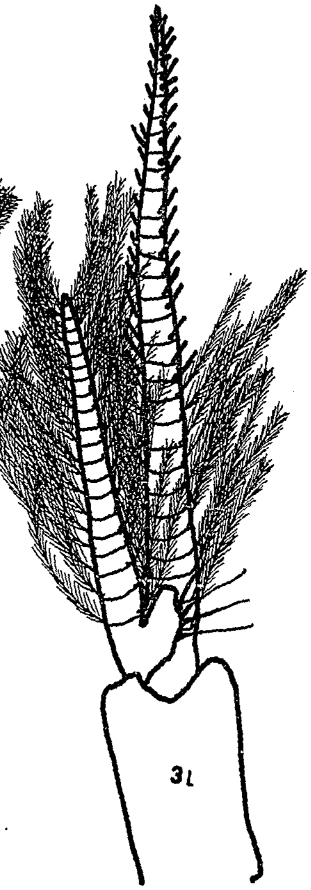
b

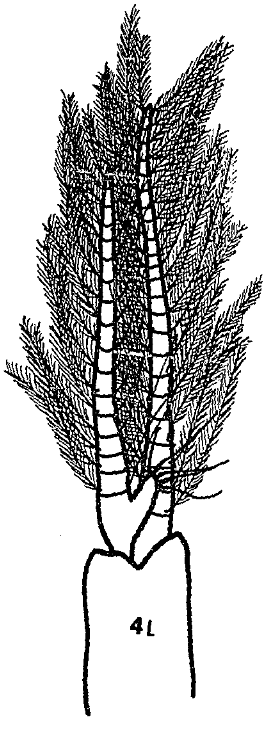


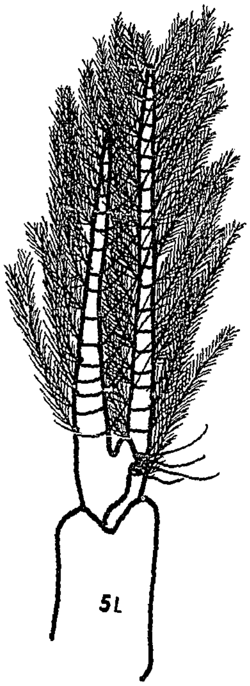
c


1L


2L


3L


4L


5L

arctica or *Boreomysis megalops* the latter as figured in Tattersall and Tattersall (1951). These non-setulose spines are found on a greater number of segments of *B.nobilis* exopods than in the other forms mentioned. As indicated in the figure, these modified spines of *Boreomysis nobilis* are shorter on the 3rd exopod than on the 2nd.

The mouth parts of the three species of Boreomysids are virtually identical, likely attesting to the similarity of their feeding habits or food preferences.

Cannon and Manton (1927) described the feeding and the functional significance of the mouth parts of *Hemimysis lamornae* in great detail. They felt that the mechanism for filtering, current formation and general feeding mechanisms would be similar for mysids and even proceeded as far as to compare mysid mechanisms with those of certain copepods.

Anraku and Omori (1963) were able to correlate the food preferences of several copepods species with the structures of their mouth parts. Therefore it is felt that a brief description of the mouth parts of the Boreomysids at this time might shed some light on the habits one might expect in nature.

Three major points may be made.

(1) Cannon and Manton (1927) claim that the basal endite of the maxilla constitutes the only true filtering plate in the mechanism. *Hemimysis* possesses such a filtering comb which with the aid of the proximal endites of the first thoracic limbs pushes food into the mouth. In the Boreomysid species, the endite of the second segment, as well as those of the third segment, bears heavy, strong setae doubtfully used to filter out fine material. The rest of the

current forming structures are present but any filtering would likely be restricted to small animal material. This would seem logical when considering the depths which they inhabit. On the other hand, if the filtering mechanism described by Cannon and Manton is in operation, then one would not expect them to be able to filter out fine bottom detrital material as does Hemimysis, if the filtering plate is sufficiently fine.

The proximal endites of the first thoracic appendages of B.tridens and B.arctica are seen to bear four very stout spines which would indicate that they push rather coarse material toward the mouth. These spines are not as strong in Boreomysis nobilis as in the other two forms.

(2) The mandibular plate structure is indicative of diet as well. In all three forms the incisor process is comprised of a series of few, very sharp, very strong teeth on both the left and right sides. The lacinia mobilis, on the left side, possesses processes as strong and sharp as those of the incisor process while, on the right side, it is composed of a greater number of slender piercing processes. The spine row of the left mandible consists of a series of very large spines while that of the right consists of slightly smaller spines. These too would appear to be suited to manipulating large pieces of food material.

(3) Stomach content analysis carried out on Boreomysis nobilis shows a definite preference for animal material as opposed to organic detritus (Table 2.). No attempt was made to quantify the total material present in the stomach as there was a high degree of variation due to differences in the sizes of the individuals, feeding activity and/or the degree of digestion of food items

Figure 17

Boreomysis arctica

(a)	1st thoracic appendage	X 25
(b)	maxilla	X 50
(c)	right mandible	X 100
(d)	left mandible	X 100

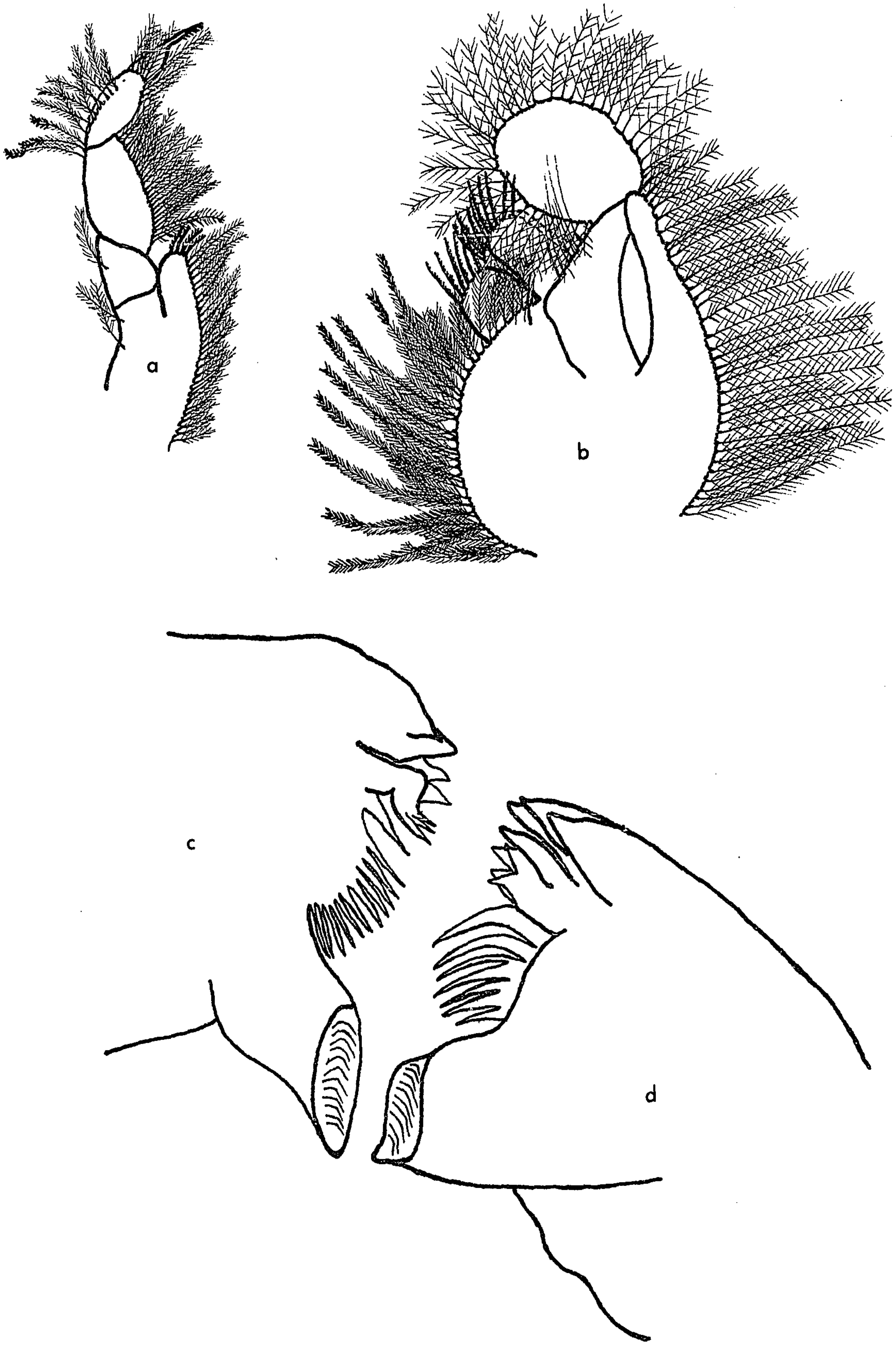

a
b
c
d

Figure 18

Boreomysis tridens

(a)	1st thoracic appendage	X 50
(b)	maxilla	X 100
(c)	right mandible	X 100
(d)	left mandible	X 100

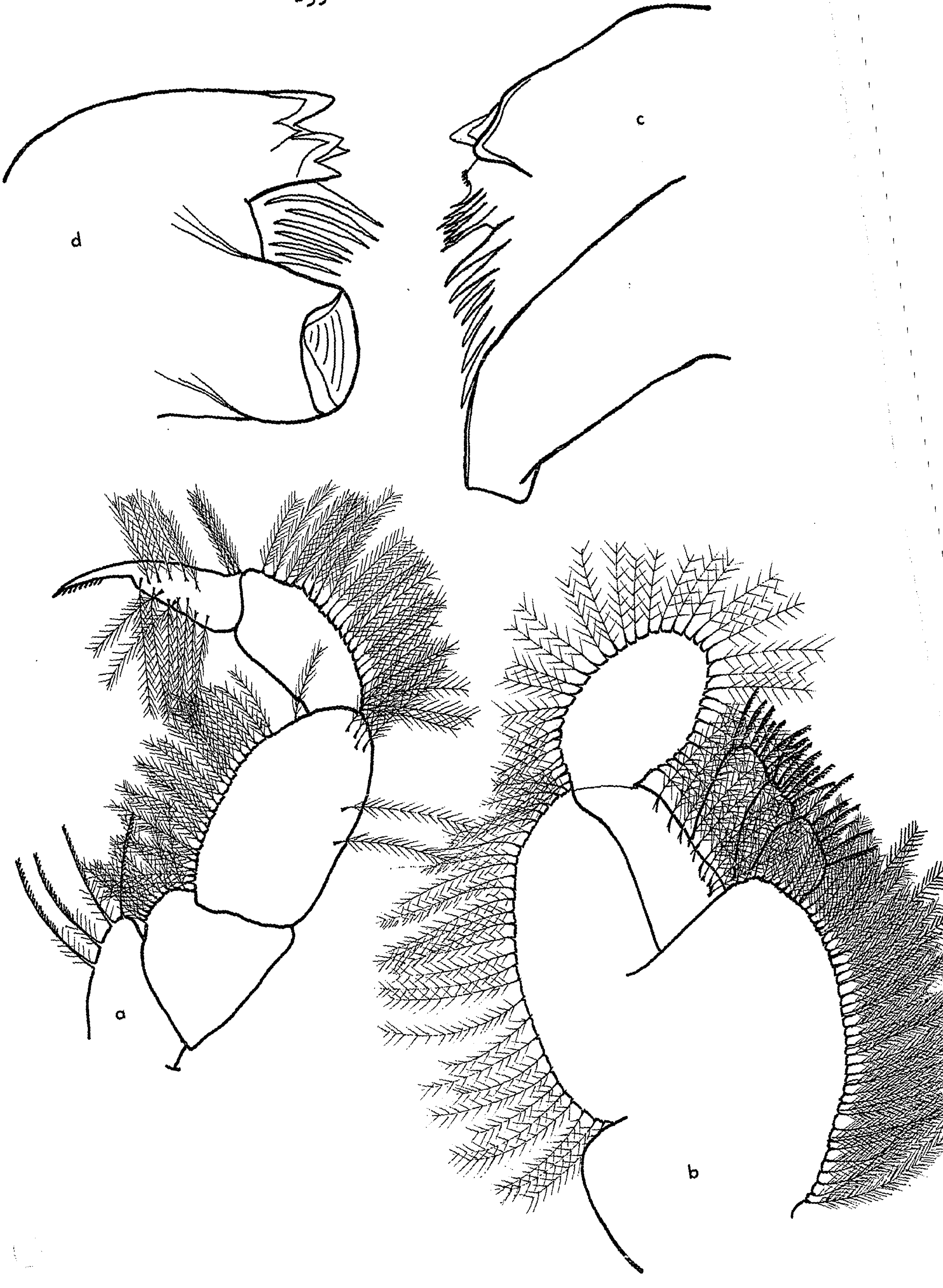

d
c
a
b

Figure 19

Boreomysis nobilis

(a)	1st thoracic appendage	X 25
(b)	maxilla (curled)	X 25
(c)	right mandible	X 50
(d)	left incisor process	X 50


b
d
c
a

prior to capture.

Boreomysis nobilis contained primarily non-calanoid crustacean parts in the form of very finely broken pieces of appendages. Identifications were therefore not within the time limits of this study. Unfortunately facets of eyes were not present among the ingested parts. In one instance however, a specimen contained a fragment of the ocular plate of Pseudomma truncatum, another mysid species of the region.

Small amounts of organic material of a light colour were present among the contents of many stomachs. These were considered to be undigested soft parts of prey animals.

Boreomysis tridens and Boreomysis arctica both showed large proportions of animal remains in stomach contents (Table 3).

Although they feed upon animal material, it is unknown whether they actively seek out prey, take advantage of dead organisms sinking through the water column or lying on the bottom, or filter out small animal material.

It would certainly be worthwhile to carry out laboratory studies on the feeding behaviour of these mysids.

(C) Numerical Description of Certain Body Proportions

Rather than relying upon subjective judgements concerning the relative proportions of the various phenetic characters of the three species, they were considered morphometrically.

Characters common to all three species, and representative of both the anterior and posterior regions of the animals were chosen, and measured for length and width. Included here are measurements of the total body length, the length and width of

TABLE 2.

Boreomysis Nobilis

July,1970	Length (mm)	Non-Calanoid Crustacean	Calanoid	Plant Material	U.O.D.	Other
1.	34.0	100%	/	/	/	/
2.	33.0	100%	/	/	/	/
3.	26.0	90%	/	/	10%	/
4.	20.0	90%	/	/	10%	/
5.	17.5	90%	/	/	10%	/
6.	15.5	90%	/	/	10%	/
7.	15.0	empty stomach	/	/	/	/
8.	12.5	100%	/	/	/	/
9.	10.0	90%	/	/	10%	/
10.	9	100%(very little)	/	/	/	/
Sept.1970						
11.	33.0	95%	/	/	5%	/
12.	27.0	90%	/	/	10%	/
13.	23.0	50%	/	/	40%	10%unid
14.	21.0	30%	/	/	70%	/
15.	18.0	100%	/	/	/	/
16.	15.0	80%	/	/	20%	/
17.	15.0	100%	/	/	/	/
18.	13.0	empty stomach	/	/	/	/
19.	13.0	empty stomach	/	/	/	/
20.	10.0	100%	/	/	/	/
21.	9.0	100%	/	/	/	/

TABLE 3

STOMACH CONTENT ANALYSIS

<u>B.arctica</u> (March - September)

	Length (mm.)	Non-Calanoid Crustacean	Colanoid	Plant Material	U.O.D.	Other
1.	24.0	100%	/	/	/	/
2.	23.0	90%	/	/	10%	/
3.	24.2	70%	/	5%	25%	/
4.	25.9	empty stomach	/	/	/	/
5.	26.0	85%	/	5%	10%	/
6.	19.4	80%	10%	/	10%	/
7.	16.3	80%	10%	/	10%	/
8.	17.8	95%	/	/	5%	/
9.	21.3	70%	/	5%	25%	/
10.	17.4	85%	10%	/	5%	/

<u>B.tridens</u> (March -

1.	27.0	90%	/	/	10%	/
2.	27.0	85%	/	/	10%	5%
3.	26.8	85%	/	/	15%	/
4.	22.1	80%	/	/	15%	5%
5.	20.8	65%	10%	/	25%	/
6.	19.0	95%	/	/	5%	/
7.	16.8	80%	/	/	20%	/
8.	13.9	85%	/	/	10%	5%
9.	14.0	empty stomach	/	/	/	/
10.	19.0	75%	/	/	10%	15%

the antennal scale, width of cornea, total body width immediately posterior to the cervical sulcus, the length and width of the telson, depth of the cleft, and lengths of the endopods and exopods of the uropods.

The values are given in Appendix V. Calculations of the ratios of length of the antennal scale, telson, exopod of the uropod and the width of the cornea and body width to body length (telson to rostrum) were made, as well as width to length of antennal scale, telson, the endopod to exopod of the uropod and depth of the cleft of the telson to the telson length. Cochran and Cox t-tests were carried out on the between species means for each ratio (Appendix Vl).

Graphic representation of these ratios is shown in figures 20 through 27, with the principal axes of the scatter diagrams drawn (Appendix Vll).

These scatter plots are meant only as visual aids in subjectively comparing the ratio means of each species for each character.

Nine ratio means of characters were calculated for each of the three forms. Of the nine, the means values of the ratios of four characters were considered to be insignificantly different between <u>Boreomysis tridens</u> and <u>Boreomysis arctica</u> while four were highly significant. The differences which were highly significant between these two forms were:

(a) Breadth of cornea to total body length
(b) Length of the antennal scale to the total body length
(c) Width to length of the telson
(d) Depth of the telson cleft to the total telson length

One character was only slightly significant between the two.

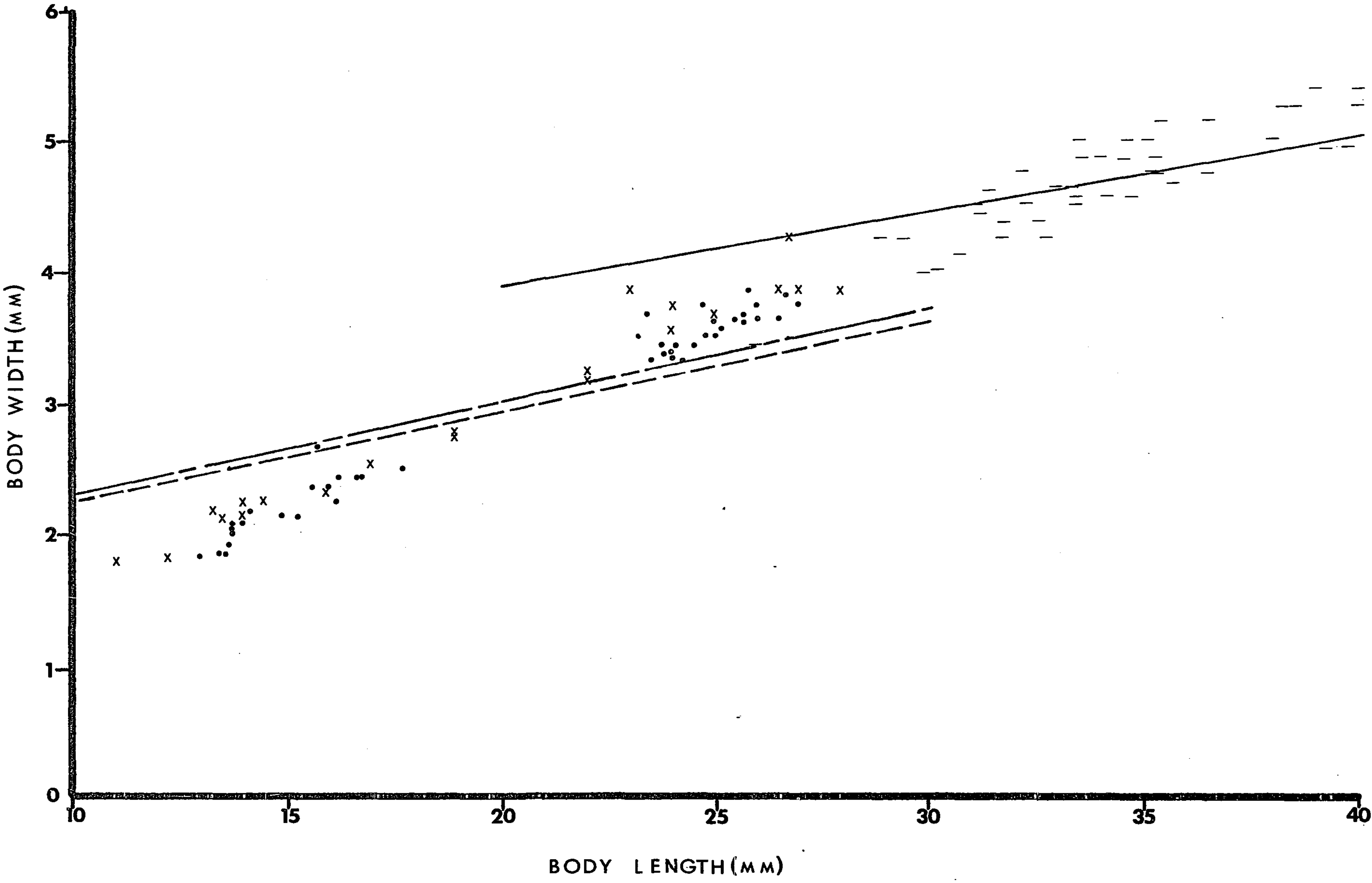
The difference between Boreomysis nobilis and each of the other two forms were more marked than for Boreomysis tridens to Boreomysis arctica. In all but two instances for Boreomysis nobilis to Boreomysis tridens and three instances for Boreomysis nobilis to Boreomysis arctica, differences in the various ratios were marked.

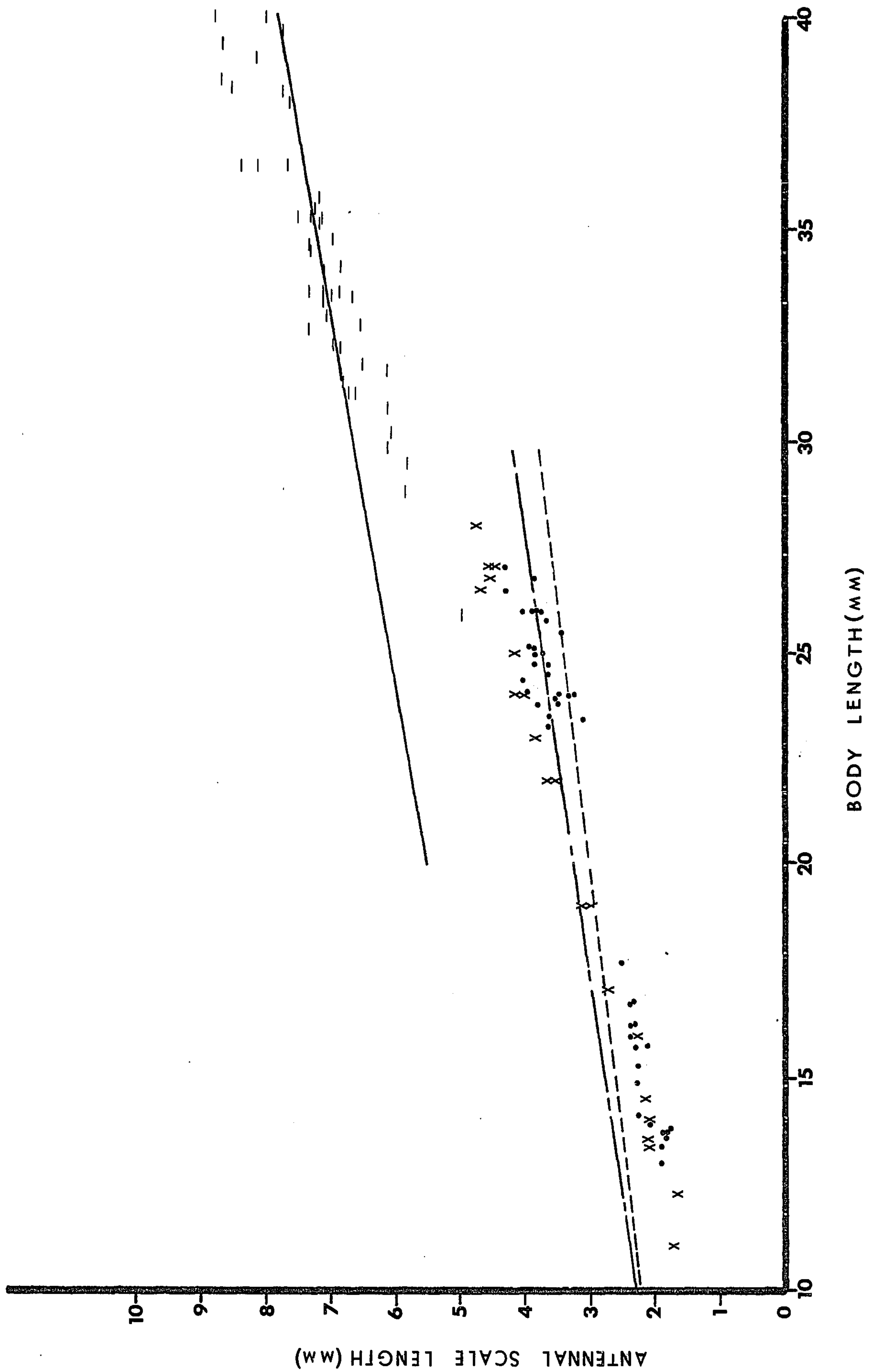
It is obvious that Boreomysis tridens and Boreomysis arctica are more similar to one another than is either to Boreomysis nobilis in quantitative terms.

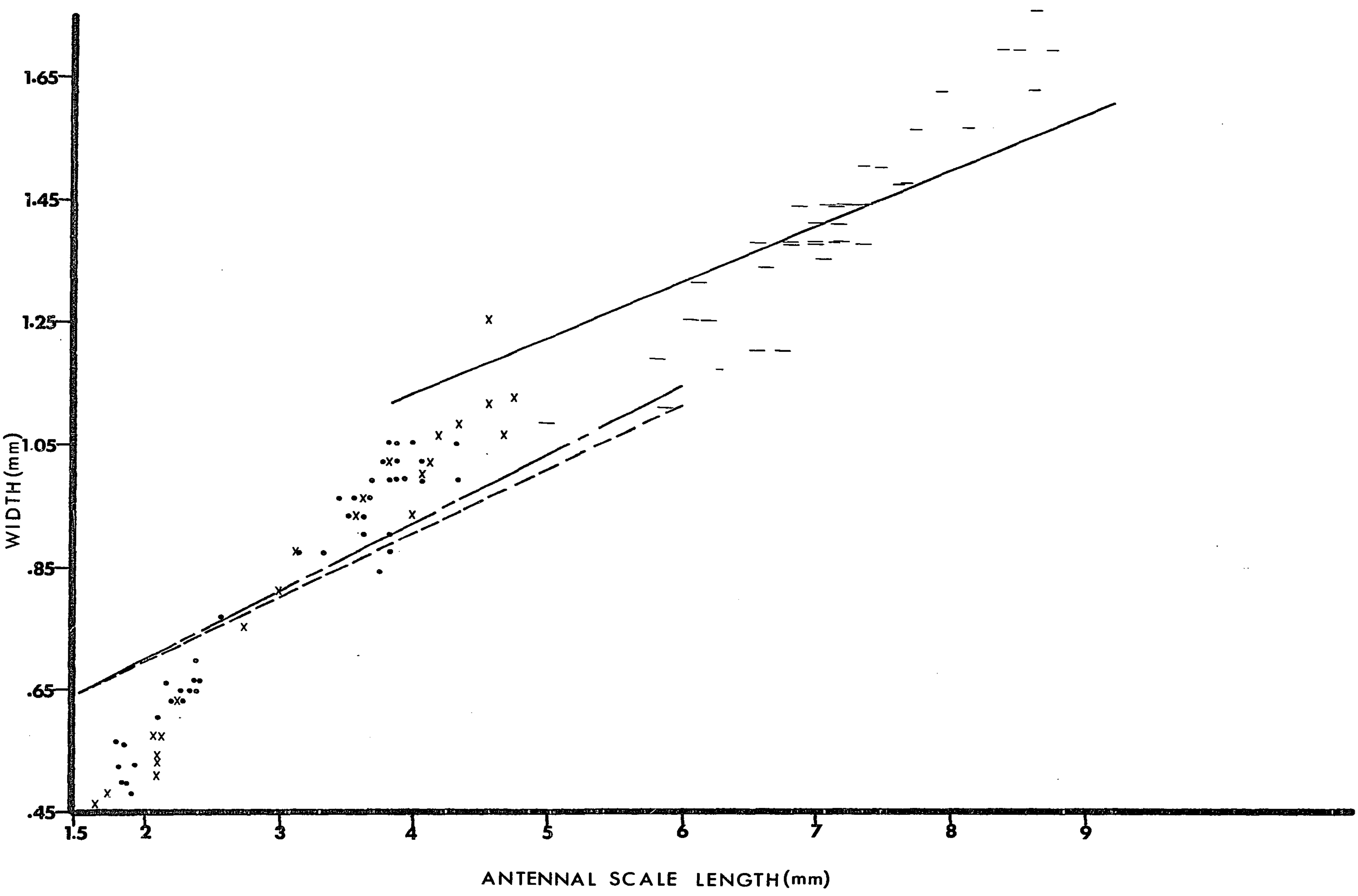
Figure 20-27

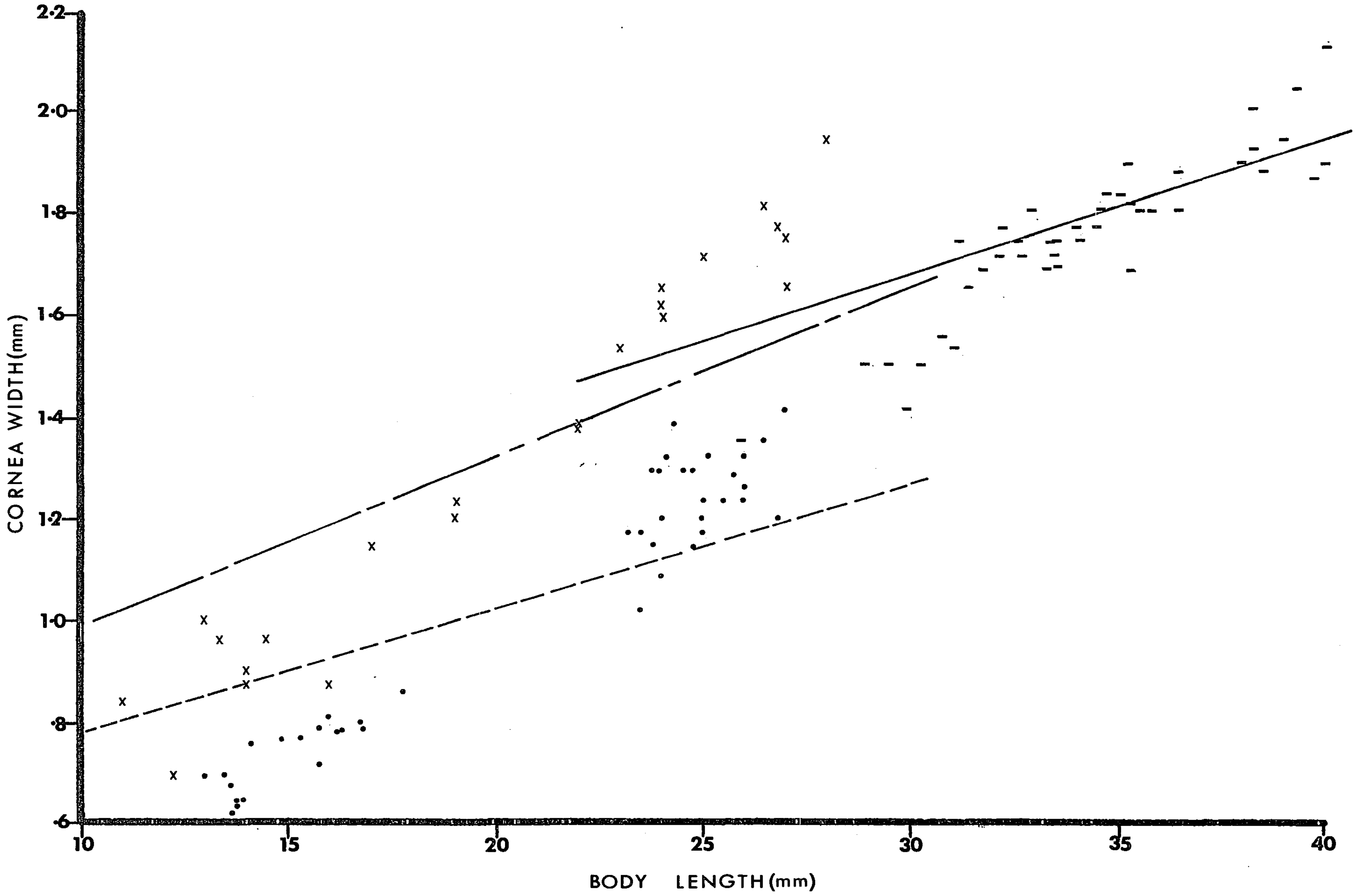
Principal axis diagrams

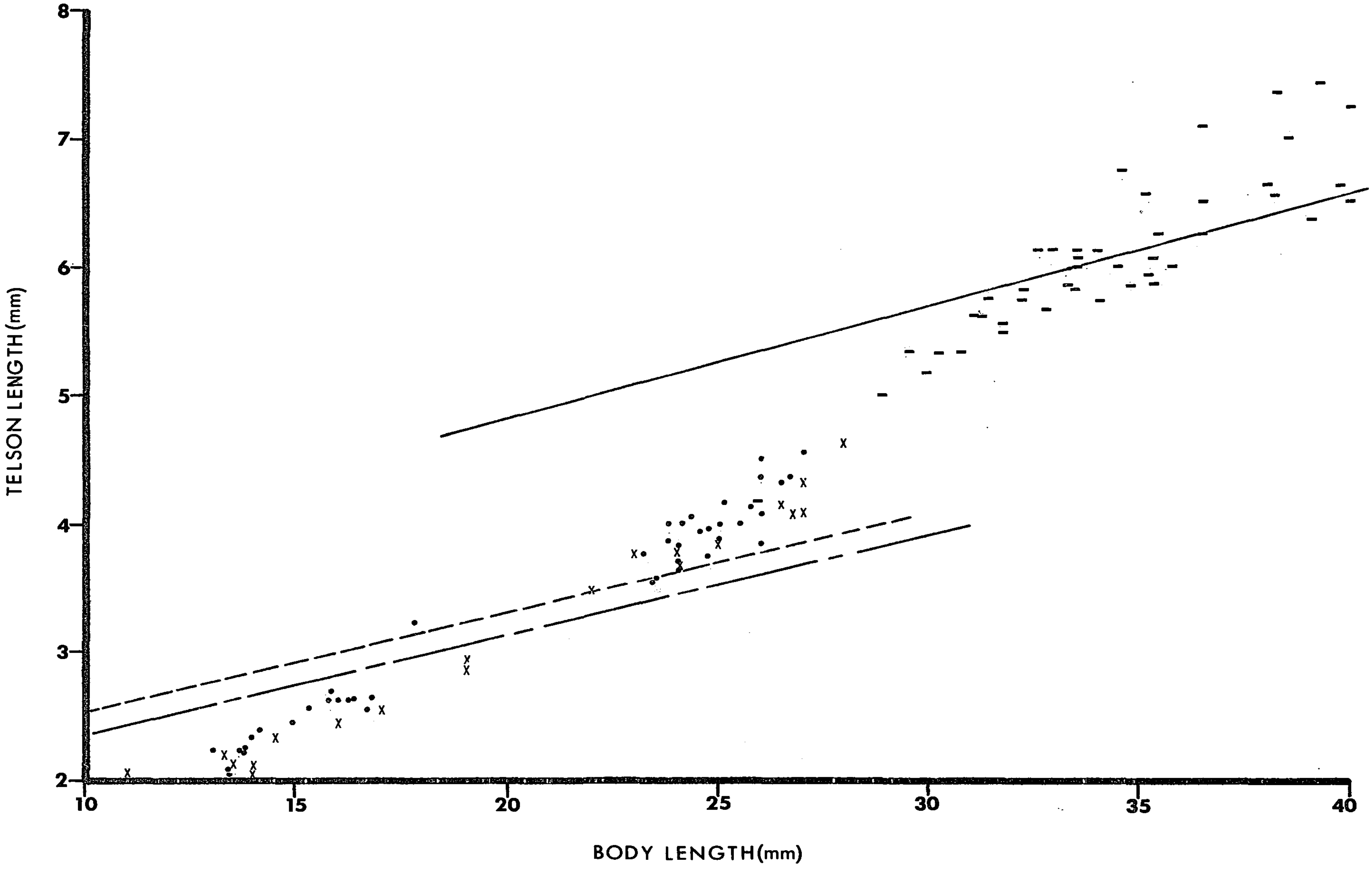
-	*B.nobilis*	————————————
x	*B.tridens*	—————— - ——————
•	*B.arctica*	- - - - - - - - - - -

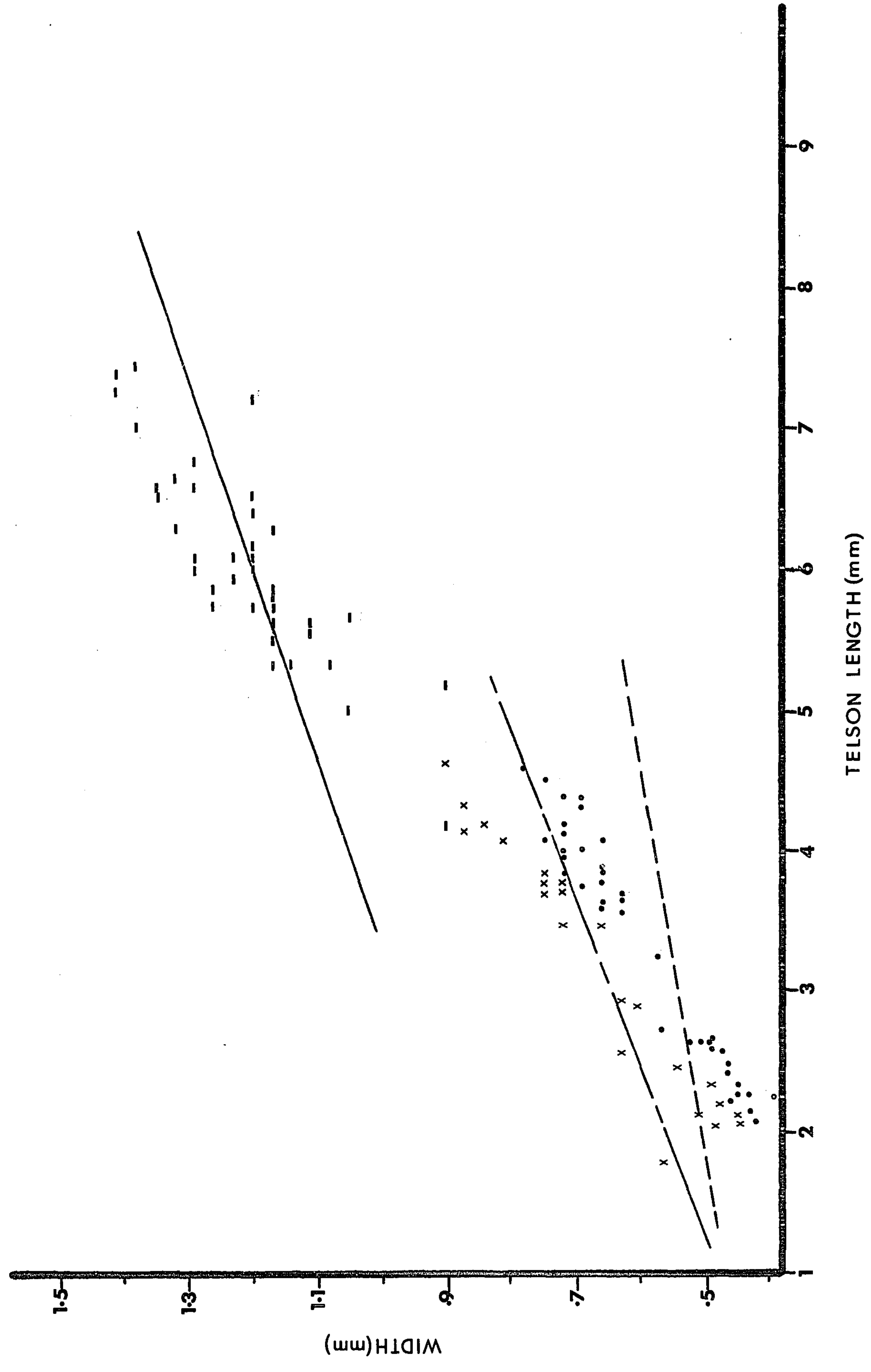

BODY WIDTH (MM)
0
1
2
3
4
5
6
BODY LENGTH (MM)
10
15
20
25
30
35
40

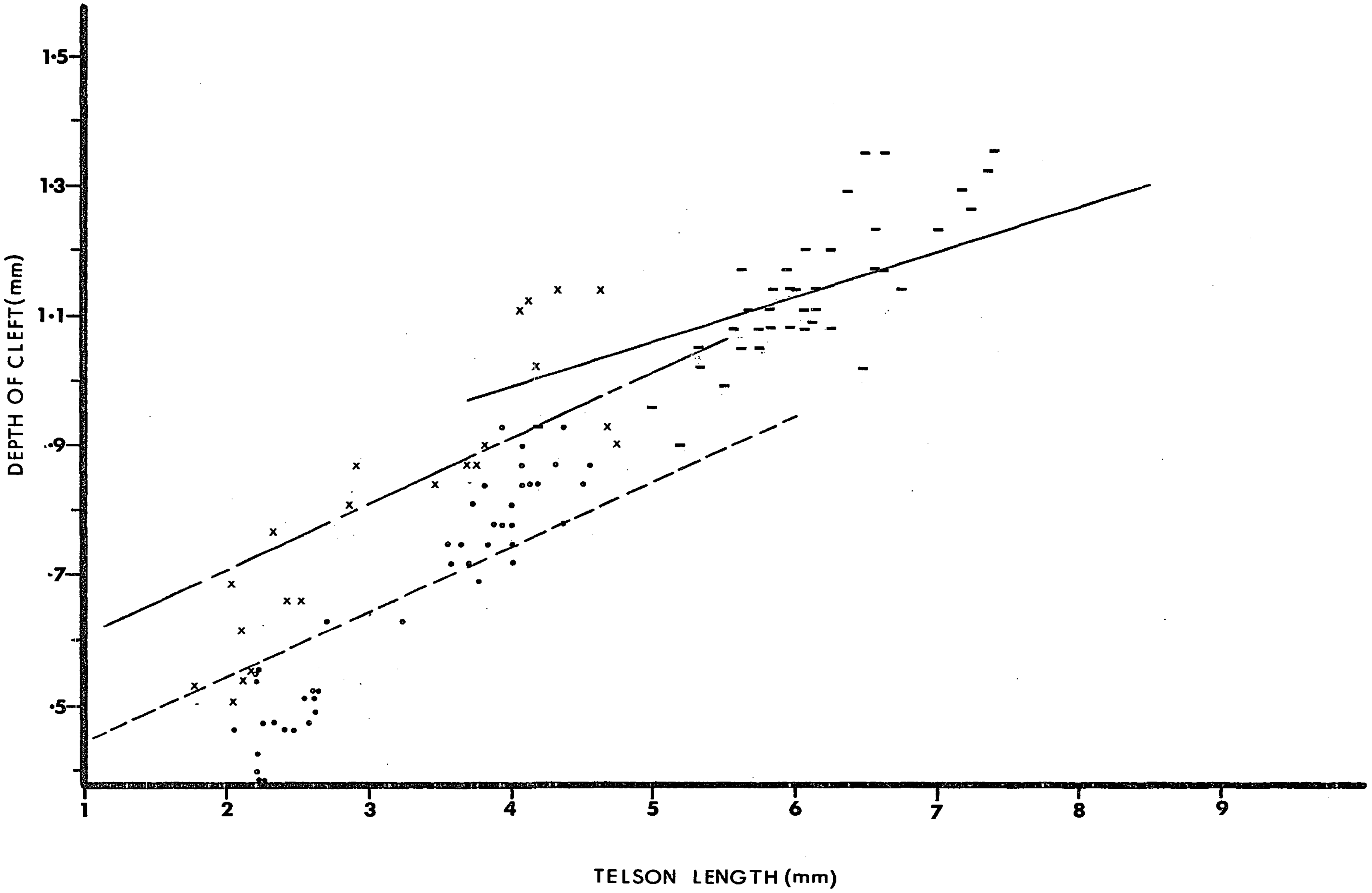

ANTENNAL SCALE LENGTH (MM)
BODY LENGTH (MM)
0
1
2
3
4
5
6
7
8
9
10
10
15
20
25
30
35
40

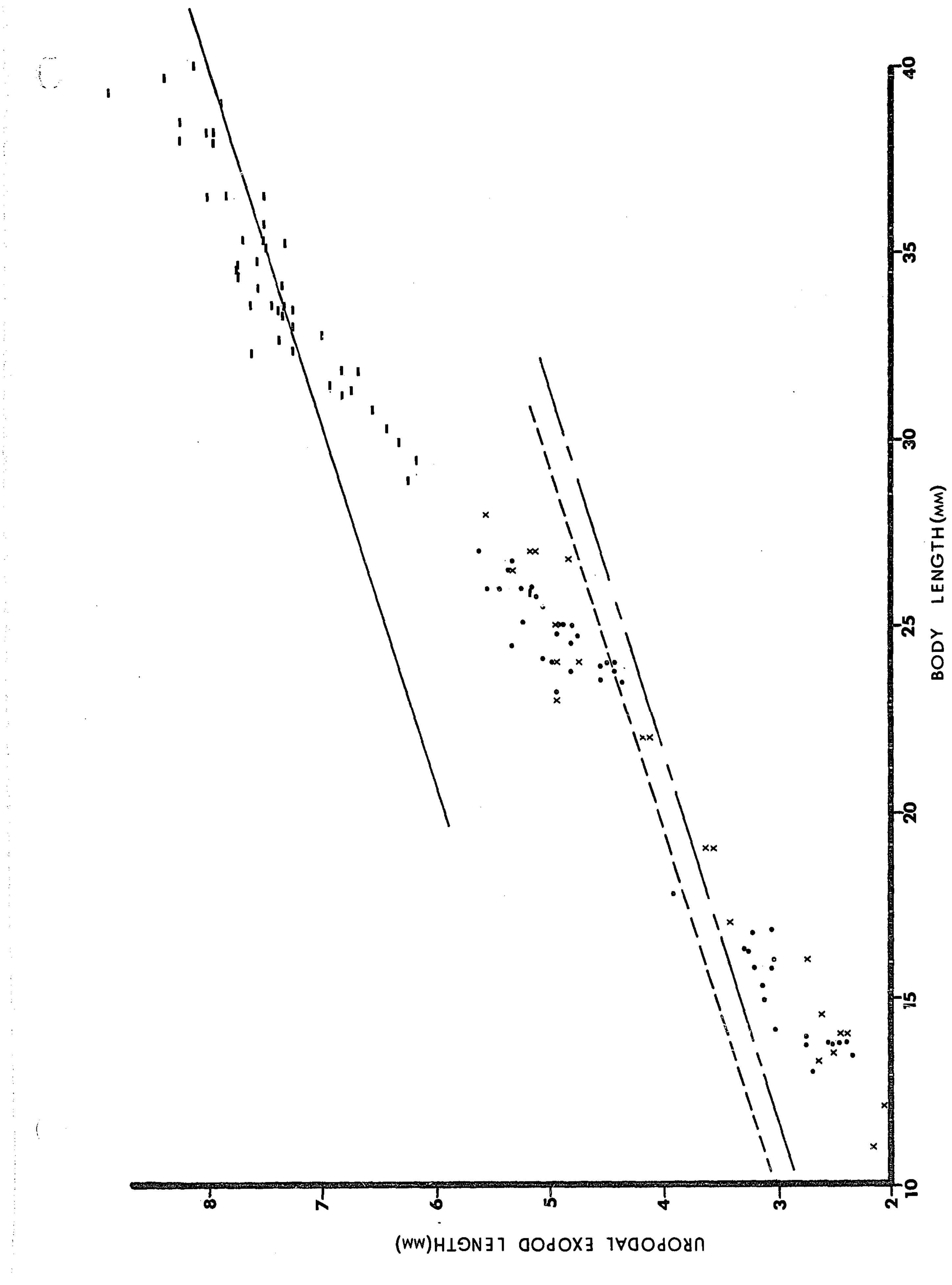

1.65
1.45
1.25
1.05
.85
.65
.45
WIDTH (mm)
1.5
2
3
4
5
6
7
8
9
ANTENNAL SCALE LENGTH (mm)


2·2
2·0
1·8
1·6
1·4
1·2
1·0
·8
·6
CORNEA WIDTH (mm)
10
15
20
25
30
35
40
BODY LENGTH (mm)


TELSON LENGTH (mm)
8
7
6
5
4
3
2
10
15
20
25
30
35
40
BODY LENGTH(mm)


WIDTH(mm)
1·5
1·3
1·1
·9
·7
·5
TELSON LENGTH (mm)
1
2
3
4
5
6
7
8
9


DEPTH OF CLEFT (mm)
1·5
1·3
1·1
·9
·7
·5
1
2
3
4
5
6
7
8
9
TELSON LENGTH (mm)


UROPODAL EXOPOD LENGTH(MM)
8
7
6
5
4
3
2
10
15
20
25
30
35
40
BODY LENGTH (MM)

(3) Life History Data

(a) Introduction

The sampling of populations of Mysis mixta, Pseudomma roseum, Boreomysis nobilis and Boreomysis arctica yield sufficient numbers of specimens to speculate on their life histories. Erythrops erythropthalma and Mysis mixta have been adequately studied in the Gulf of St. Lawrence area. Both Black (1956) and Poirier (1971) have treated these species with respect to life history. Poirier has also considered Meterythrops robusta and Pseudomma truncatum.

Poirier (1971), working with Erythrops erythropthalma of the Baie des Chaleurs, finds the presence of two year classes, the first consisting of juveniles and immatures and the second composed of some immatures and many mature adults. Reproduction began in May and continued through to Autumn with fewer females carrying eggs as the summer progressed. Females carrying eggs were also captured in the fall. Black (1956) came to the same conclusions and found that reproduction and recruitment did occur in the winter in the Bras d'Or Lakes.

Poirier (1971) found Mysis mixta had a life span of 12 to 18 months in the Baie des Chaleurs area. During the summer months, all animals were immature, with signs of maturity appearing in the month of September. The population was bimodal throughout the sampling season, the members of the first cohort beginning to breed in the fall, the second group later on in the season. Black (1956) found also that breeding took place in winter months in the Bras d'Or Lakes.

Poirier also studied Pseudomma truncatum and Meterythrops robusta. Pseudomma truncatum shows a six month breeding period commencing in May and probably terminating in the autumn while Meterythrops robusta begins to reproduce in the winter, the young appear in the spring and reproductive rate decreases through the summer. Present collections have shown carrying females in March, April, May and September.

An attempt will be made to draw some inferences concerning the life histories of Pseudomma roseum, Boreomysis nobilis, Boreomysis arctica and Mysis mixta from present data.

(b) Results & Discussion

(i) Pseudomma roseum

The histogram constructed from the pooled collections of Pseudomma roseum in March 1971, in the Laurentian Channel near Cabot Strait, is assumed to be valid because the collections were close both temporally and spatially and thus are considered to have been samples drawn from the same population at approximately the same moment in time (Figure 28).

The population is not normally distributed but shows a definite negative Kurtosis and thus is likely composed of two or more cohorts. The size range represented by the specimens is also thought to be too wide to represent that of a single cohort. Therefore it is felt that it perhaps represents two or more generations.

Plotting the data (anomalies corrected by a moving average advocated by Taylor (1965) to accentuate trends) on probability paper as per Hardy (1949) reveals the presence of two modes; one with a mean at 8.2 mm. and a second with a mean at 13.1 mm. (Appendix V111). The second cohort consisted primarily of immatures while the first cohort was composed of large immatures and matures. The truncation of the probability line for the first cohort is a product of the sharp reduction of the number of adults from 15 to 18 mm. length which could be caused by one of three factors.

(1) Net avoidance by the largest animals. This, however, seems unlikely because relative to other species captured it is not a large species. Also, one would expect a more gradual decrease in the number of large specimens if this were the case.

(2) Determinate growth may be responsible for this peculiarly abrupt decline in the number of large animals. If this were the case, the first mode would be suspected of containing more than a single generation. There is, however, no evidence of determinate growth found for other mysid species.

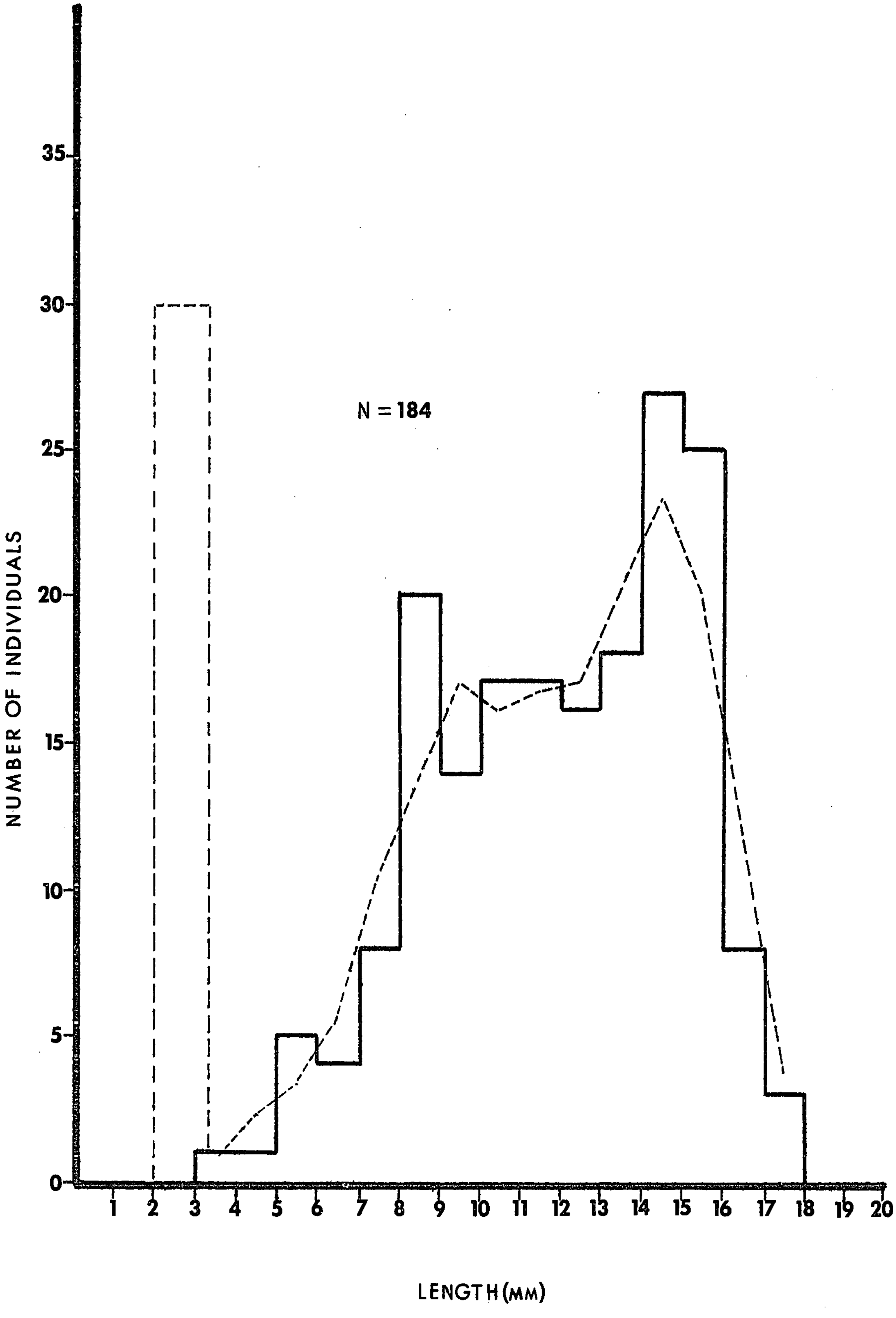
(3) The final and most likely explanation is an age-specific mortality. If growth rates are fairly constant in this environment, which is very stable over long periods of time, one would expect a particular size to be achieved at approximately the same time for all surviving animals. This life span would undoubtedly be keyed to some factor such as the termination of, for example, a discrete breeding period.

Forty-nine per cent of the mature females of the first cohort were carrying eggs or embryos, at various stages of development, at this time and it is felt that within a short time, perhaps a month, would give rise to a third mode consisting of numerous juveniles (Figure 29).

It is fairly obvious that extensive winter breeding and the release of young during the winter months, does not occur. Since

Figure 28

Size-frequency distribution of P.roseum population. Broken line at the left hand side of the histogram represents the mode likely to appear in a short time. March, 1971.


N = 184
NUMBER OF INDIVIDUALS
0
5
10
15
20
25
30
35
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
LENGTH (MM)

the percentage of expectant females is so high, it is more likely that the breeding period begins in late winter or early spring and that the young are released beginning in March or April, the maximum probably being in late spring and decreasing over the summer or early summer period.

Since the onset of maturity almost coincides with the mean of the first mode it may be that the entire cohort will reproduce within the next few months, the peak population density (mean of the mode) giving rise to the peak of the potential recruitment mode of that year or season. The first mode will continue to disappear from the population, likely after breeding and at a length of 16 to 18 mm.

The second mode probably represents the animals recruited over the previous season or the previous autumn. This cohort would likely have reproduced either in the following autumn or the following year.

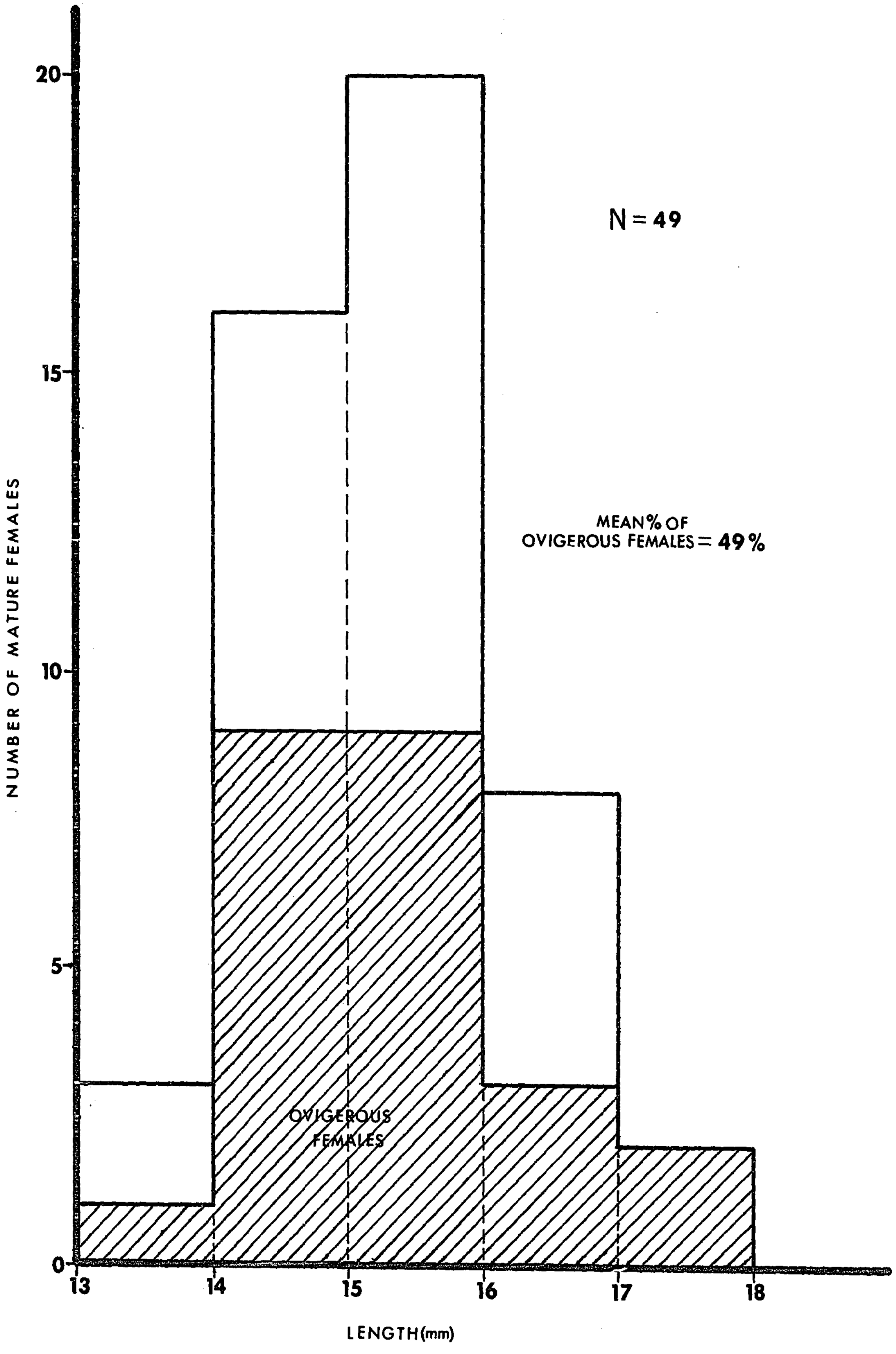
It is, unfortunately, impossible to determine the life span from available data and therefore to determine generation time.

It is likely however, that there are either one or probably two reproductive peaks per season. If there are two per year, a spring and an autumn maximum, then the life expectancy is one year and seldom 18 months (some autumn offspring may overwinter the following year) while if there is only one broodpeak per year, they live for two years. Only additional samples of this population at a different time of the year to allow the estimation of growth rates or autumn collections to show the population structure at that time could resolve this question.

It is likely, however, that as a relatively warm water species, there are two broods per year, a spring and autumn which overlap somewhat, with no winter reproduction occurring,accounting for the near absence of juveniles in March.

Figure 29

Distribution of ovigerous females to mature females of P.roseum.


NUMBER OF MATURE FEMALES
20
15
10
5
0
13
14
15
16
17
18
LENGTH(mm)
N = 49
MEAN% OF
OVIGEROUS FEMALES = 49%
OVIGEROUS
FEMALES

(ii) Genus Boreomysis

(A) Boreomysis nobilis

Dunbar(1940) has studied a population of Boreomysis nobilis from Ata Sound, Greenland and describes the size-frequency distribution of the animals in late July and early August. He found the population to be composed of a large number of small individuals and a fairly small number of large individuals.

The Bonne Bay collections from both July and September, 1970 contained specimens of the full size range of the species, with comparatively more small animals than large (Figures 30 and 31).

Unlike the size distributions of the Boreomysis nobilis population of Ata Sound, there is a definite case for the bimodality of the size-frequency distributions of the Bonne Bay animals.

The July curve, due to the relatively small number of specimens collected at that time, does not exhibit as reliable a bimodality as does the September data.

However, when the method of Harding (1949) employing probability paper is used, the modes can be separated out and the resultant interpretation shows two separate and slightly overlapping cohorts (Appendix IX). The September data, when plotted, also shows two separate cohorts (Appendix X). The cohorts involved do not represent two separate broods but represent two distinct year classes. The term year class here does not imply that all the young are released at approximately the same time , and die at approximately the same time but only acts as a point of reference as to animals produced sometime during 1969 and those produced sometime during 1970. In July, the mean of the first year cohort was 12.9 mm. with confidence intervals from 9.4 to 16.3 mm. By September, the mean value had shifted to 13.8 mm. with confidence intervals from 9.4 to 19.3 mm. It appears that there is recruitment of young animals throughout this time period and that a shift in the mean size for that mode may be erroneous. The presence of small (10mm) and large (15mm) juveniles in samples from May, June, July and September indicate breeding throughout the summer months and probably in the early spring as well. Mature and ovigerous females (containing eggs and all embryonic stages) in the September collections indicate that breeding and recruitment probably occur well into the fall as well.

Dunbar concludes from his data that breeding of Boreomysis nobilis in Ata Sound is of the prolonged summer variety but in Bonne Bay fjord, it is likely that it occurs throughout most of the year.

The region of the size-frequency histogram at 22 mm. in July and 25 mm. in September, represented by the point of inflection of the probability curve, where the class modes overlap probably represents the period of reduced winter breeding.

Since the shift of the cohort mean of the first year class is probably masked considerably by recruitment throughout the summer season, and the shift of the mean of the second year class masked at one end of the curve by mortality, and by the upwardly shifting minimum at the other end, particularly in September, the best measure of population dynamics is probably found in the shift of this zone of the minimum or inflection. This zone is seen to have shifted from the 22 mm. value in July to the 25 mm. interval by September.

The probability curve allowed the separation of only two clear modes in each case, and therefore there is no reason to believe that the life cycle of Boreomysis nobilis in Bonne Bay fjord is any longer than two years. Without having collections made periodically over an extended time span, it is difficult to say how long an individual may persist. If, however, the change of length 22 mm. to 25 mm. at inflection from July 4 to September 5, 1970 is extrapolated, an approximate mean value of 18 mm. per year can be calculated.

This value is not intended to represent a true growth factor since growth is undoubtedly more rapid below the 22 to 25 mm. level and slower above it, leading to a slow overlapping of the modes, however, it does give an estimate of longevity and it is seen that within slightly less than two years, an animal may theoretically attain maximum length.

On three points, the populations of Bonne Bay fjord and Ata Sound are in fairly close agreement (Figure 32).

(1) The maximum size attained by the specimens encountered is approximately the same, approximately 40 mm. in length. Dunbar, when measuring specimens, did not include the telson. This would account for the maximum length, as read from his histogram, at 38 mm. In the present study, telson length was considered in the measurement of total length.

(2) The size at which animals became 'unsexable' was 15 mm. for animals of Ata Sound. For those of Bonne Bay, it was seen to be 15 mm. in July and 14 mm. in September. There is probably little significance to the difference between the two months since (a) these are mean values and (b) they probably reflect a

Figure 30

Size-frequency distribution of *Boreomysis nobilis* population in July, 1970. (Bonne Bay, east arm). Broken line represents a moving average.

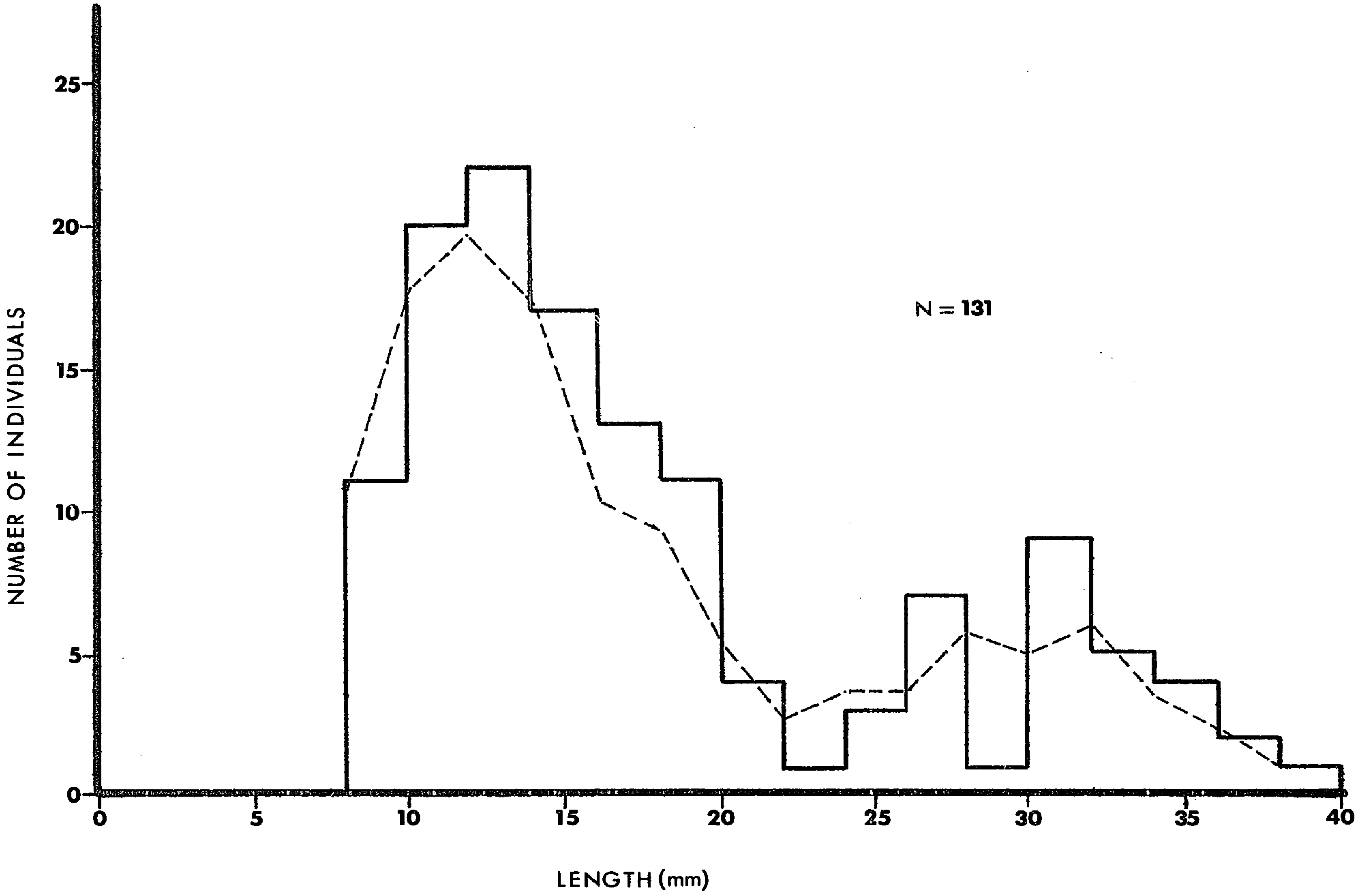

N = 131
NUMBER OF INDIVIDUALS
0
5
10
15
20
25
LENGTH (mm)
0
5
10
15
20
25
30
35
40

Figure 31

Size-frequency distribution of B.nobilis population in September, 1970. (Bonne Bay, east arm).

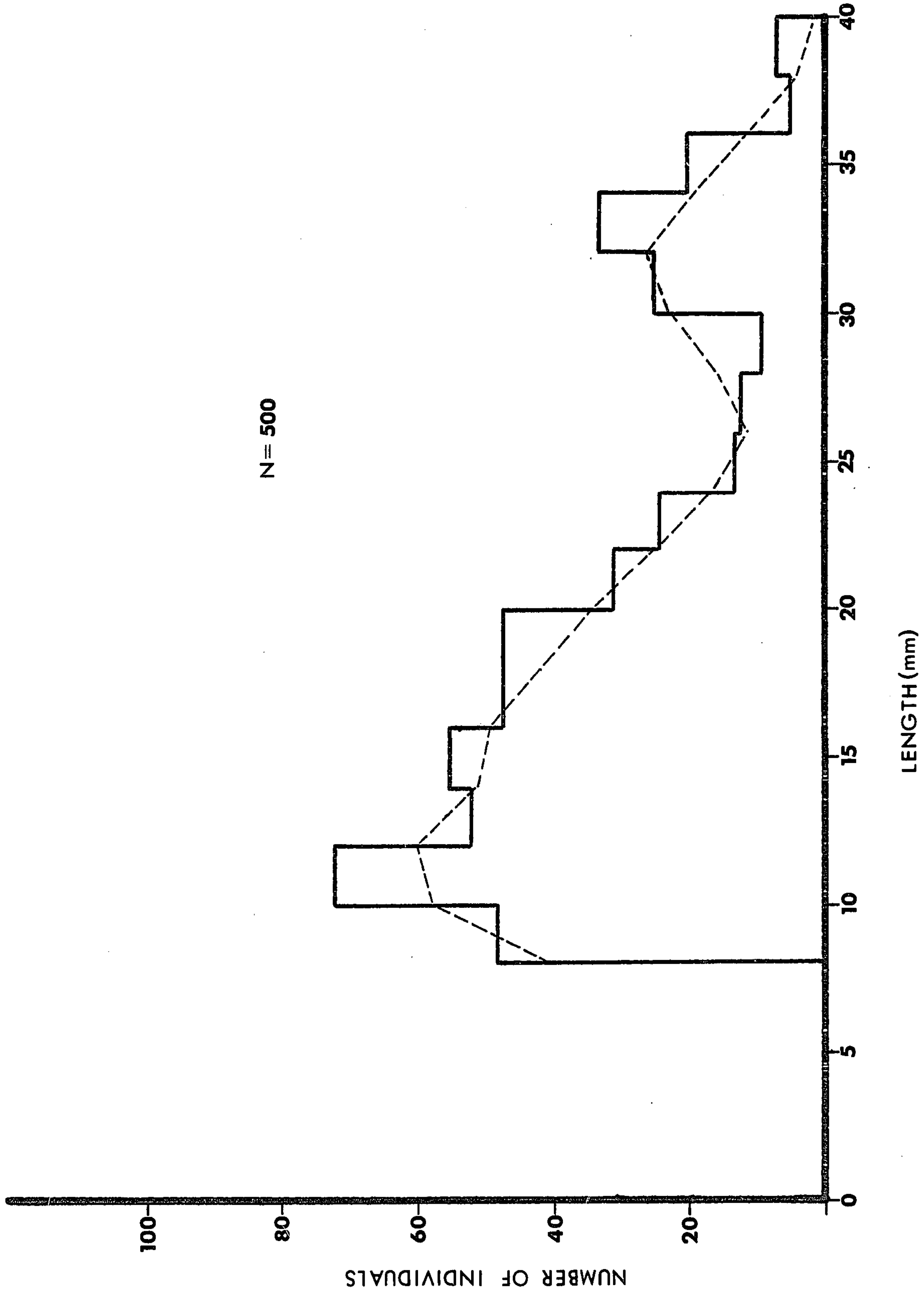
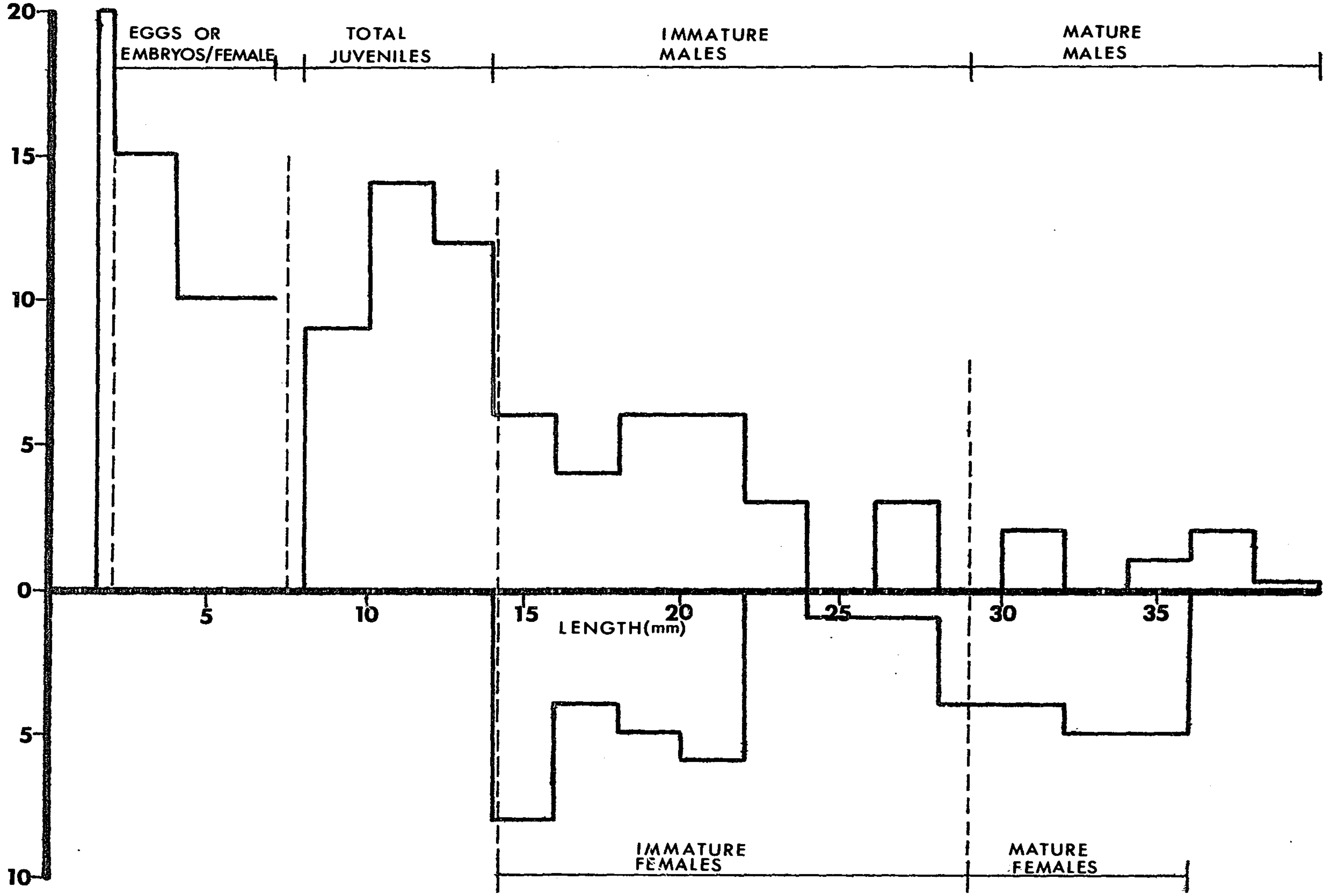

N = 500
NUMBER OF INDIVIDUALS
100
80
60
40
20
LENGTH (mm)
0
5
10
15
20
25
30
35
40

Figure 32

Size-sex-maturity histogram of *B.nobilis* population in September, 1970.



20
15
10
5
0
5
10
EGGS OR EMBRYOS/FEMALE
TOTAL JUVENILES
IMMATURE MALES
MATURE MALES
5
10
15
20
25
30
35
LENGTH(mm)
IMMATURE FEMALES
MATURE FEMALES

familiarity with the appropriate measurement criteria rather than a reflection of changes in environmental characteristics between July and September. Ata Sound animals, minus the telson, were slightly larger before secondary sexual characters became apparent but again, it is a rather subjective evaluation in many cases and therefore there may be more similarity than is apparent between the two populations.

(3) There appeared, in the Bonne Bay population, to be a larger number of mature females than males. This, it had in common with the Ata Sound population.

There is however, a difference in the size of animals at release from the brood pouch which cannot be adequately accounted for by differences in measurement technique.

(B) Boreomysis arctica

Boreomysis arctica showed a population structure in the late spring of 1971 consisting of a large number of immatures, few mature individuals and very few juveniles. The second, large, cohort was almost normally distributed about a mean of 10.6 mm. while the first cohort, consisting of mature individuals, showed a mean at approximately 25 mm. None of the females of the first cohort were carrying eggs or embryos at the time, however, they did possess fully developed brood pouches and approximately 50% had developing eggs in the gonads (Figure 33).

Juveniles were not found in the water column at this time of the year as indicated by oblique zooplankton hauls. Occurrences of small numbers of mysids of this species at appropriate locations throughout the summer seasons of 1969, 1970, and 1971 showed females carrying eggs and embryos in proportionately small numbers in June and July only. Small juveniles were very rare during summer seasons. September collections were poor and shed no light on the problem.

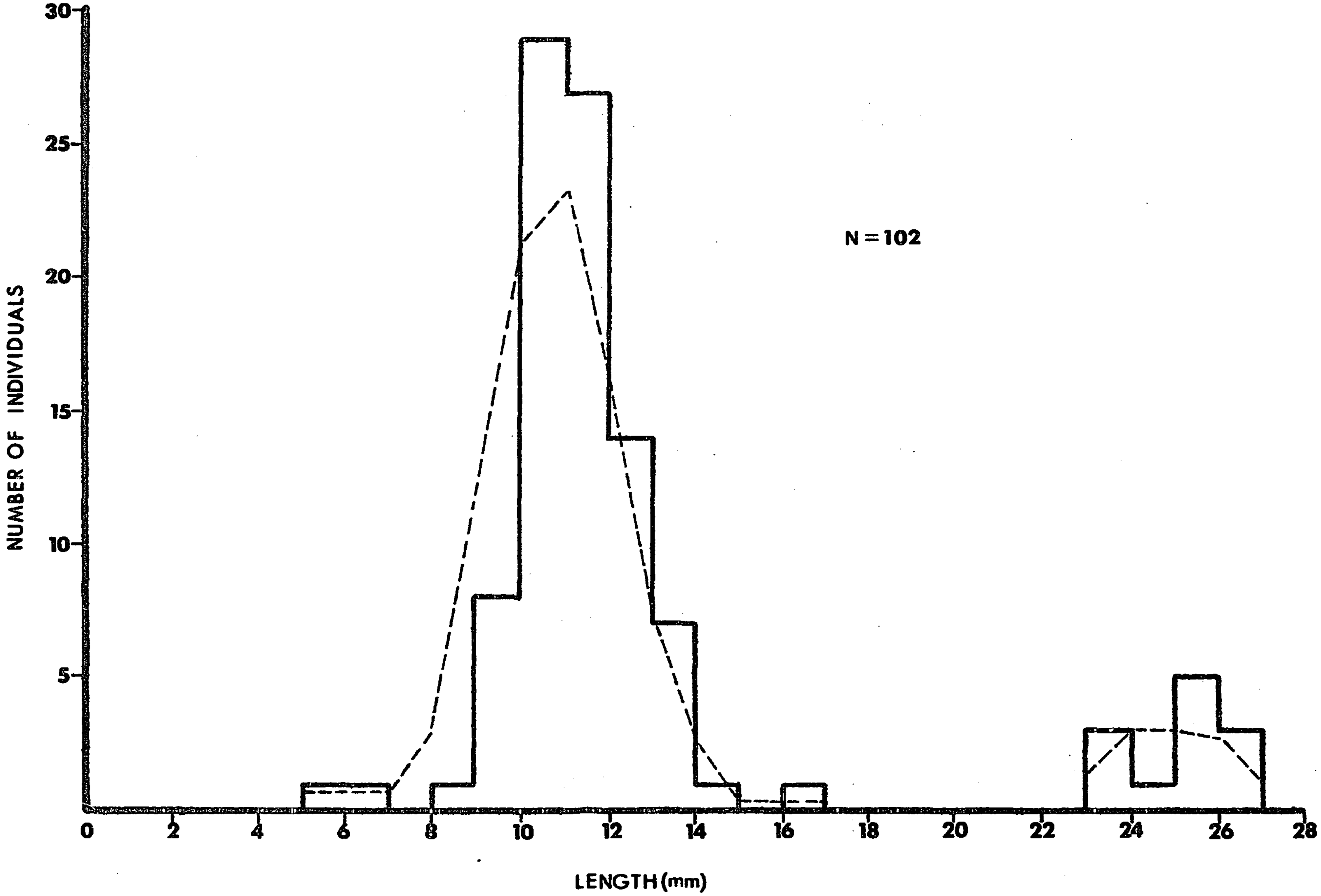
Since bimodality is so obvious, it is probable that breeding occurs in a single yet extended period, probably in late fall. An individual should potentially persist for two years since the first cohort is the only one which could likely reproduce that season. If the second cohort was a product of the previous late summer and fall, then its growth rate would appear to be insufficient to allow the size at maturity to be reached within the next 3-6 months. This group would quite likely mature the following season and reproduce at that time.

Additional collections would be necessary in order to clarify this problem.

Figure 33

Size-frequency distribution of Boreomysis arctica population in May, 1971.

Broken line represents the moving average.


N = 102
NUMBER OF INDIVIDUALS
LENGTH (mm)
0
5
10
15
20
25
30
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28

(iii) Mysis mixta

Mysis mixta of the Magdalen Shallows shows two distinct year classes, the bulk of the members of each year class always being separate. No females carrying eggs or embryos were encountered in these summer collections and no young juveniles were present in collections. Therefore it is evident that reproduction occurs between autumn and spring, likely in the late winter or early spring as judged by the advancement of the first year mode during June, July, and August. Therefore it would appear that the life cycle is identical to that of Mysis mixta in the Bras d'Or Lakes and in the Baie des Chaleurs area.

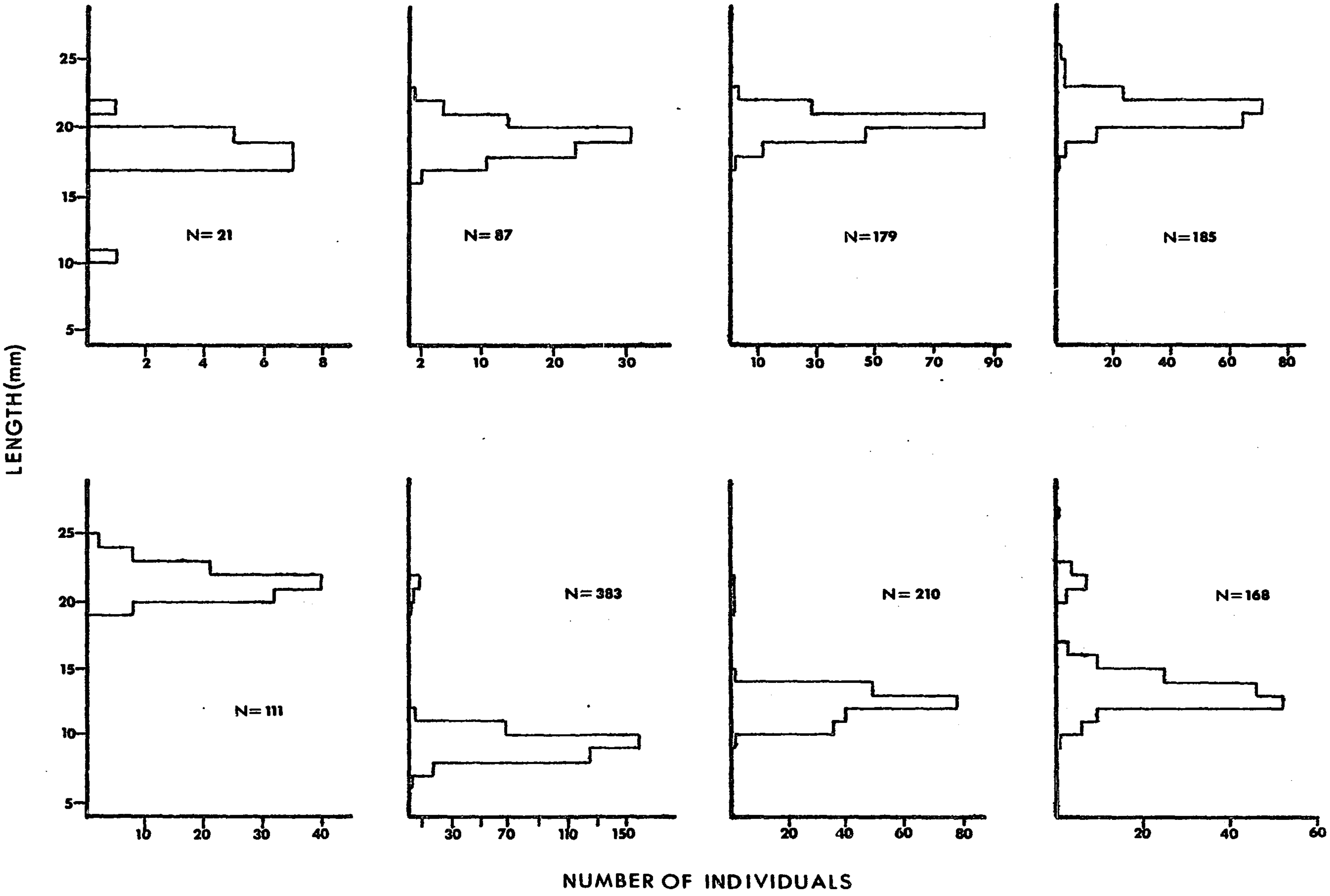
No growth data could be extracted due to the large geographical range over which the individual collections were made.

It is apparent, and noteworthy, that the various subpopulations of Mysis mixta of the Magdalen Shallows do show very similar population structures. It will suffice to say that the life cycle of this species over the total Magdalen Shallows area appears to be identical. Breeding occurs at approximately the same time, the young are released at approximately the same time, and they appear to grow and mature at approximately the same rate at the widely spaced locations (Figure 34).

Figure 34

Mysis mixta populations at widely spaced locations in the Magdalen Shallows and at different time of the sampling season.

(a) HB No. 41; 7/5/71 ; 70 m.
(b) HB No. 44; 13/5/71 ; 85 m.
(c) HB No. 45; 14/5/71 ; 63 m.
(d) HB No. 53; 11/6/71 ; 59 m.
(e) HB No. 54; 21/6/71 ; 70 m.
(f) HB No. 55; 22/6/71 ; 65 m.
(g) HB No. 56; 13/7/71 ; 53 m.
(h) HB No. 61; 30/8/71 ; 91 m.


LENGTH (mm)
25
20
15
10
5
N= 21
2
4
6
8
N= 87
2
10
20
30
N=179
10
30
50
70
90
N=185
20
40
60
80
N= 111
10
20
30
40
N= 383
30
70
110
150
N= 210
20
40
60
80
N=168
20
40
60
NUMBER OF INDIVIDUALS

PART 11

(4) Mysids as Plankton

(a) Introduction

The Mysidacea are now commonly considered to be hyperbenthic (hypopelagic or bottom planktonic) forms. Holt and Tattersall (1905) described mysids as crustaceans which are "never far from the bottom". On the other hand, certain mysids are not uncommon in the plankton, particularly at night.

Stephensen (1912) includes a number of arctic mysids with the plankton of Greenland waters but claims that this is to make summary easier. He feels that they will certainly prove to be 'rather bottom animals'. He did, however, capture them as part of the plankton. Apstein (1906 p.250) was the first to suggest that *Mysis mixta* made vertical migrations in the Baltic Sea. Otterstrom (1910) followed this up and found it to be so (Tattersall and Tattersall, 1951). Waterman (1939), in a study of deep water plankton of the U.S. coast, found *Boreomysis microps* to migrate diurnally over a distance of 400 meters. Many other workers have shown that *Mysidacea spp*. do undertake vertical migrations.

Some species, it seems, are more pelagic than others and can cover greater distances over a daily period (Russell, 1931). *Anchialina agilis*, in British waters migrated more suddenly and more rapidly than the other species of mysids in the same area. Fish (1925) (Tattersall and Tattersall, 1951) found *Neomysis americana* to be a pelagic form, swarming in the surface waters of the Woods' Hole region. Fish and Johnson (1937) found the same phenonemon for *Neomysis americana* in April in Passamaquoddy Bay.

Many species of mysids may also exhibit ontogenic migrations Tattersall (1938) found peaks in mysid concentrations in the water column using tow nets in the Plymouth area. In July and August males and breeding females of *Leptomysis gracilis* became somewhat planktonic. Tattersall and Tattersall quote Fage as having collected night plankton at Concarneau over a yearly period and that the adults only reach the surface region during breeding season. Swarming of *Neomysis americanus* (Fish, 1925; and Fish and Johnson, 1937) seemed to be related to breeding period.

Russell (1927) pointed out that the young may show different migratory patterns from the adults. Southern and Gardiner (1926) found *Mysis relicta* young at all depths during the day.

Therefore it is unlikely that no mysids should be found in plankton samples of the Gulf of St. Lawrence at any time, assuming that some species may be more pelagic than others and that some samples were taken by plankton nets at night and during late spring and summer when some breeding might be expected to occur.

(b) Results & Discussion

(i) Bottom Planktonic Species

From the limited data obtained from these zooplankton samples it is evident that the following species were caught predominantly in close association with the bottom, that is when the net actually struck the bottom.

Erythrops erythropthalma was present in reasonably large numbers in sample No.074, 1969, from station 21 in the Magdalen Shallows. One hundred and fifty specimens were sorted from this collection, a collection which was obviously made by dragging the net along the bottom for some distance, judging by the size of the sample itself, the amount of sediment present, and the condition of the net (Appendix 11).

In 1970, 10 of the 11 specimens and in 1971, 31 of the 13 specimens present in collections were taken when the net struck bottom.

Fish and Johnson (1937) did not find *Erythrops erythropthalma* to be a component of the plankton in the Gulf of Maine and Passamaquoddy Bay. Gardiner (1934) working in Nova Scotia waters caught this species using zooplankton nets, but also, only when the net touched the bottom. Brunel (1968) finds *Erythrops erythropthalma* to be hyperbenthic in nature in the Gulf of St. Lawrence and Poirier (M.Sc. 1971 thesis) finds also that the species has a daytime vertical distribution which may be considered hyperbenthic.

Meterythrops robusta and *Pseudomma truncatum* were present also in this one collection (No.074) which touched bottom and

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Meterythrops robusta and *Pseudomma truncatum* were present also in this one collection (No.074) which touched bottom and

Table 4

Mysids captured in zooplankton collections

(A) 1969.

(B) 1970.

(C) 1971.

NUMBER OF ANIMALS PER SPECIES IN SPLIT SAMPLES

Species Represented	Day Planktonic	Struck Bottom	Night Planktonic
A			
Erythrops erythropthalma	1	150	7
Erythrops microps	1		
Erythrops abyssorum	3		2
Boreomysis tridens	1	3	1
B.arctica	144	47	34
Boreomysis nobilis	64		
Mysis mixta	100		62
Meterythrops robusta	1	7	
Pseudomma truncatum	3	1	
Pseudomma roseum		2	
Pareythrops obesa	1		
B			
Erythrops erythropthalma		10	1
B.arctica	5	3	
Boreomysis nobilis	5		
Mysis mixta	7		8
Amblyops abbreviata		1	
C			
Erythrops erythropthalma	2	3	8
Erythrops abyssorum		1	
B.arctica	15	9	9
Mysis mixta	12	1	95

yielded 7 of 8 specimens of the former species captured. Poirier finds that both of these species in the Baie des Chaleur area exhibit daytime hyperbenthic distributions.

From the deeper waters, Amblyops abbreviata, Boreomysis tridens, and Pseudomma roseum were present in collections either exclusively or primarily when the sampling net touched bottom.

Erythrops abyssorum, Erythrops microps and Parerythrops obesa were taken in the day plankton exclusively or in equivalent numbers with other catch categories but in such small numbers that they must be assumed to be distributed near the bottom and/or they were not well sampled.

(ii) Nocturnally Migrating Species

(A) Erythrops erythropthalma, although showing concentrations near the bottom during the day, were seen to have been captured more often at night, night being defined here as 2400 G.M.T. to 0600 G.M.T. when any vertically migrating species might be expected to occur in the plankton, than in the day plankton despite the fact that 50% of the total number of samples made for the three years were daytime collections.

(B) Mysis mixta, was commonly captured at night, as Table 4 indicates. Of 221 specimens taken over the period of three summers, 175 specimens were captured at night, and one specimen when the net struck bottom. Since the Magdalen Shallows were well sampled in 1971, sufficient day and night sampling was done to allow the drawing of the following comparison.

In 1971, of the seven stations in the Magdalen Shallows at which Mysis mixta was captured, all but one was visited once or more during the day at which time no mysids were taken in the

TABLE 5

TIME VISITED

STATION	DAY SAMPLES		NIGHT SAMPLES		
	≠ with Mysids	≠ without Mysids	≠ with Mysids	≠ without Mysids	
21		1	2	1	
23		2	1		
82		1	1		
83		1	1		
85	1	1		1	
86		2	1		
163	-	-	1		
TOTAL	1	8	7	2	18

zooplankton collections. Two of these stations were visited once each at night when no mysids were captured. (Table 5).

The difference in success between day and night catches is significant at better than the .02 level of significance (Appendix XI).

Thus one could speculate that Mysis mixta undertakes nocturnal migrations. Otterstrom in 1910 showed that Mysis mixta in the Baltic did regularly undergo these vertical migrations, beginning in the evening. Poirier (1971) has shown that Mysis mixta, particularly those animals of the first year class, undergo strong migrations. M.mixta was the only one of these species found to undergo migrations in U.S. Atlantic coast waters (Wigley & Burns, 1971).

Other species in the collections, such as Erythrops spp., Parerythrops obesa, Boreomysis tridens, Meterythrops robusta, Pseudomma roseum and Amblyops abbreviata, may undergo very minor migrations which may be so small or the water column so deep that the vertical movements are masked relative to such sampling techniques.

Since Mysis mixta was taken as far as 42 meters above the bottom in May, 1971, and other workers, for example Juday and Birge (1927), reported that Mysis relicta was present in the upper waters of Wisconsin Lakes at night, some as far as the surface, and Russell (1925, 1927, 1928, 1931) observed Leptomysis graciles, Gastrosaccus normani, Acanthomysis longicornis, Erythrops sp., and Schistomysis spiritus to migrate an average of 18 meters from the bottom at night, particularly then would it seem that the poor representation of most species is due to the fact that they are hyperbenthic during the entire day and at no time were present in large numbers in the plankton.

(iii) Common Planktonic Forms

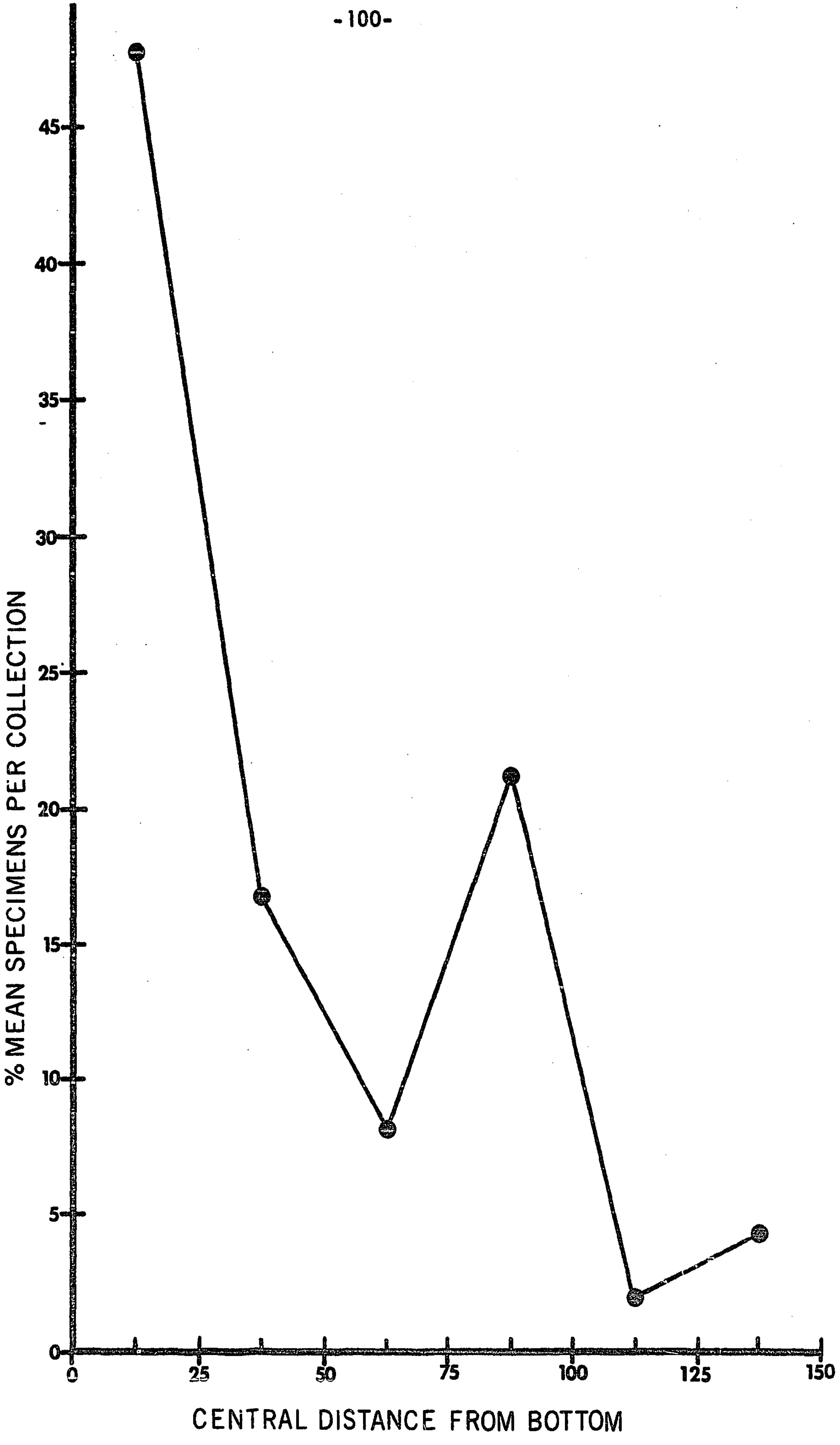
Boreomysis arctica and *Boreomysis nobilis* are quite common in the plankton. The small numbers of animals in the collections is due only to the relatively few good, deep samples made at the appropriate stations. Boreomysids were not an uncommon find in the 1969 collections considering that 52 of the total 72 samples containing mysids, actually contained Boreomysids; 49 exclusively Boreomysids.

Particularly common was *Boreomysis arctica*. These creatures were found at depths from the bottom to as far as 150 meters from the bottom during daylight hours. This figure is based on collections from stations 16, 17, and 19 taken in June, July and August of 1969 and 1970. In July of 1970 at station 36 over a depth of 365.5 meters, one immature and two juveniles were taken in an oblique haul which originated at 222 meters and was towed to the surface.

Of a total of 266 *Boreomysis arctica* captured with zooplankton gear over the three sampling seasons, 164 of them, more than one half, were taken above the bottom and during the daylight hours. The number of *Boreomysis arctica* in the oblique samples from stations with depths greater than 300 meters and known existing populations of the species were corrected for sample split size and the number of specimens in collections initiated within each of six 25 meter intervals above the bottom were calculated. The percentage of specimens in each depth interval over the three

Figure 35

Density distribution of Boreomysis arctica relative to the bottom at stations where the species was known to occur.


% MEAN SPECIMENS PER COLLECTION
45
40
35
30
25
20
15
10
5
0
0
25
50
75
100
125
150
CENTRAL DISTANCE FROM BOTTOM

sampling seasons (Fig. 35 & Appendix XII) was plotted.

Since many collections were made at these stations which did not contain Boreomysis arctica, these were necessarily included for the sake of accuracy although the result was a very low specimens per sample mean at each interval. The result, however, showed a very indicative trend. 47.77% of the population was found within 25 meters of the bottom. A total of 93.68% of the population was found within 100 meters of the bottom at all times of day during the summer seasons.

The greatest source of error in this analysis is the exact depth of the bottom at the location of each separate collection. This value was not recorded each time and therefore it was represented by the approximate value listed for the station in the IBP data.(Appendix 1).

This leaves two possible explanations.

The first is that they are very powerful swimmers, exhibiting extensive migrations from the bottom, which for some stragglers, linger on into the day. Waterman etal in 1939 found Boreomysis microps, in the western Atlantic, 300 miles off Cape May, New Jersey was capable of migrating vertically as much as 400-600 meters, which he feels may be in response to light intensities but light intensity may not be the only motivating factor.

The second possibility is that they are bathypelagic rather than bottom dwelling. Brunel (1970) states that this species can be taken with zooplankton nets as well as with benthic or hyperbenthic gear. He bases this on records of captures made in Saguenay fjord. Boreomysis microps of the U.S. coast is bathypelagic with its maximum of abundance apparently at 600-800 meters over a depth of 2200 meters during the day. (Waterman etal 1939).

From the present collections it cannot be determined whether or not Boreomysis arctica was actually taken right at the bottom. Even if the net actually struck the bottom the mysids were not necessarily caught at that point but could have been captured anywhere between the bottom and the upper limit of the 0-25 meter interval. Since no Boreomysids were ever taken in the upper parts of the water column in 1969 shallow horizontal tows, it may be concluded that they do not occur in the upper waters. They were captured in deep horizontal hauls in the 1969 season when these were part of the sampling program. It is likely that they are restricted to the deep water mass of the Gulf of St. Lawrence, characterized by high temperatures and salinities. At the stations where Boreomysis arctica occurred the temperature minimum ($0^{o}C$ - $1.5^{o}C$) was found between 100 and 150 meters and below this depth the temperature would begin to show an increase, in a few cases showing almost a reverse thermocline between 150 and 200 meters, although it was not as sharp as this at most of the stations in the summer of 1969. Generally speaking, the 3^{o} isotherm would be passed between the 150 and 200 meter marks at these stations. The stations in the Cabot Strait had temperatures of $4^{o}C$ to $5^{o}C$ between these depths in the summer months. (Appendix 11). Therefore there was probably a definite boundary to these mysids at approximately the 150 to 200 meter level through which further migration could not occur.

One further point could be made here which would support the earlier statement that B.arctica was not necessarily taken when the net touched bottom. During the cruise of Sackville in March of 1971, hyperbenthic sampling in the Laurentian Channel captured only two specimens of this variety in two samples collected when the apparatus was working on the bottom. Since the sampler was not fitted with an opening and closing mechanism, it is difficult to say whether or not these specimens were captured on the bottom, or on the way up or down. Judging by the number of specimens collected, it is doubtful that they were collected at the bottom due to the greater sampling time at the bottom level. In a subsequent collection in an adjacent area during which the hyperbenthic sampler did not ride on the bottom, as judged by the absence of characteristic bottom dwelling forms and sediments, only Boreomysis arctica was captured. Similarly in another hyperbenthic collection (≠ 47; 16.5.71) in deep water when there was insufficient cable to reach bottom, the only species represented was Boreomysis arctica, and was present in large numbers. The latter collection was made within 25 meters of bottom but not actually on it.

It is suggested therefore, based on available evidence, that Boreomysis arctica is bathypelagic rather than hyperbenthic. Boreomysis tridens on the other hand would appear to be truly hyperbenthic and very difficult to capture by the zooplankton method. The former is distributed close to the bottom but, as it appears from collections in Cabot Strait, not right at the bottom. There appears to be a vertical separation between the ranges of the two forms and it is felt that good synoptic collections from an area in the Laurentian Channel would probably prove this to be true. The two forms have occurred in the same hauls at a number of the Laurentian Channel zooplankton stations, but only when the net was very close to or actually struck the bottom. As has been shown, however, it was not necessary to strike the bottom with the net in order to catch Boreomysis arctica.

Thus, it is felt that the two forms, by virtue of their high degree of morphological similarity, are in competition and therefore ecologically distinct.

Boreomysis nobilis, found in Bonne Bay east arm, was also quite commonly taken in the zooplankton collections. All tows in which mysids were present from the Bonne Bay east arm were made during the day. The depth of the station was 227 meters and 3 of the 6 oblique hauls made in 1969, ranging from 185 meters to 210 meters through to surface, contained Boreomysis nobilis. Early in the month of June, 1969, 9 specimens were present in a sample from 205 meters to the surface while none were taken in a horizontal collection at a level of 125 to 150 meters at 1800 hr. G.M.T. In mid July, at this station, 2 horizontal tows were made, one at 125-136 meters and the other at 160-200 meters. Only the latter contained Boreomysis nobilis suggesting that they were found only in the lower portion of the water column. Boreomysis nobilis has been captured in the plankton elsewhere. Stephensen (1912) captured Boreomysis nobilis off the coast of Greenland and as was mentioned earlier included it with the zooplankton. Two specimens of this species were found by the author in plankton collections made by Tidmarsh in Northern Baffin Bay (75° 45.3' N) at a distance of at least 570 meters from the bottom. This probably represented the upper range of the distribution in the area. The temperature at 450 meters from the surface was 2.4°C but the salinity and curve was seen to be homogeneous from 400 meters to the bottom.

Subsequent hyperbenthic sampling showed that Bonne Bay fjord does support a large population of Boreomysis nobilis which are found in association with the bottom. Therefore it would seem that this species is a bottom planktonic form which is capable of moving over fairly large distances within the water column, being aided in its ability, perhaps, by its large size. Night samples may show this animal to migrate much higher in the water column during the dark hours. The temperature regime is quite constant; from 0.3°C at the bottom to 1.5°C at 50-75 meters and salinities between 31°/oo and 32°/oo (Figure 39). The temperature then rises to as high as 17°C at the surface in late summer. It would seem that such homogeneity of the deep layer with regard to temperature and salinity would not restrict any such migrations if they actually exist. One specimen of Meterythrops robusta and three of Pseudomma truncatum were present in collections from 185 and 210 meters respectively. The capture of representatives of these two species in the plankton was a phenomenon found nowhere else in the Gulf although hyperbenthic sampling proved that there were populations elsewhere. This fact is probably related to the homogeneity of this deep water layer in Bonne Bay east arm. Stephensen (1912) in the deep waters of West Greenland, considered these to be planktonic forms.

(5) Mysids as Hyperbenthos

(a) General Considerations

It has already been suggested that the Mysidacea are commonly bottom planktonic forms both by other workers (e.g. Holt and Tattersall (1905), Black, (1956) (who took no mysids at all in his midwater tows) and by virtue of the present results of zooplankton collecting for Mysids in the Gulf of St. Lawrence. A large proportion of the animals taken with zooplankton nets were taken when those nets actually hit the bottom. This does not imply that the nets must hit the bottom in order to catch mysids but when they do it is definitely established that the net had sampled from the bottom upward. The hyperbenthic net, set six inches from the bottom, captured very large numbers of mysids in some cases, not by hitting the bottom but by sampling the water layer just above the bottom.

As others have found (Russell, 1928; Black, 1956) extremely large numbers of mysids may be taken on occasion employing this seemingly efficient means of sampling the bottom planktonic fauna. On the other hand, good population estimates could probably be established using zooplankton nets to sample such species as *Mysis mixta* at night if the nets were set quite close to the bottom. Also, bathypelagic forms such as *Boreomysis microps* in the Western Atlantic or *Boreomysis arctica* in the Gulf of St.Lawrence would best be sampled as part of the plankton in the latter fashion. During peak migratory seasons it is doubtful that achieving an accurate population estimate for certain species e.g. *Neomysis americana* (Fish and Johnson, 1937) could be accomplished using only hyperbenthic gear.

In the Gulf of St. Lawrence though, the majority of mysid species are sampled well by the hyperbenthic method and would appear to be bottom planktonic forms.

The following reasoning is assumed.

Sixty-one hyperbenthic collections were made in 1970 and 1971. Of the 61 collections, five did not sample the bottom plankton and four resulted in torn nets. Therefore mysids were found in 44 of 52 satisfactory hyperbenthic samples, representing an efficiency of 86%, as compared with 109 of 783 or 14% of the "selected" zooplankton collections. (Appendices 11 & 111).

It is not necessarily a valid assumption to expect mysids to occur everywhere and therefore to expect mysids in every sample taken.

Also a contrast between the two methods of collecting is found in the difference in the numbers of animals captured. There is a difference in the mouth areas of the two types of nets as well as in the length of the tows. There would seem to be insufficient difference though, to account for such large differences in concentrations of animals. The largest volume of mysids in a zooplankton sample, independent of the bottom, was one in which 68 *Mysis mixta* were taken at night. The largest volume of animals of this species in a hyperbenthic haul was more than 15,000.

Again it would appear appropriate to consider the Mysidacea to be primarily bottom plankton, as the hyperbenthic zone is where the largest concentrations of animals are generally found to occur.

(6) Geographical and Bathymetric Distributions

On the basis of bathymetry, the Gulf of St.Lawrence can be loosely divided into three regions- (1) the shallow areas of depth from 30 meters down to 150 meters (2) a boundary area incorporating the 200 meter line (3) the Channel region, with depths at 250 meters and greater. The extremities of the Mingan and Esquiman Channels fall into this intermediate catagory, the bottom rising gradually. These three bathymetric regimes generally possess the hydrographic conditions found in the corresponding water layers of the Gulf (1) cold intermediate layer (2) boundary layer (3) warmer, deep layer. The surface layer has its greatest effect on the fauna found at depths less than 30 meters and this study does not consider this zone to any large extent.

In the Gulf proper, each mysid species is seen to fall loosely into one of these catagories. It is particularly evident for the genera Erythrops and Pseudomma which are each represented by three species in the Gulf.

Appendices II and III contain raw data listing station numbers, coordinates, species present, numbers of individuals and physical data for zooplankton and hyperbenthic collections.

(i) Genus Erythrops

(A) General Bathymetric Distribution

Erythrops erythropthalma, an arctic-boreal species, appears to have a very wide depth range in the Gulf. It is not found in large numbers in the shallow area, represented in this study primarily by the Magdalen Shallows, but has been found from depths of 70 meters down to 222 meters in the Gulf (Figure 36). W.Tattersall (1951) states that he has recorded Erythrops erythropthalma in the Gulf of St. Lawrence from 40 meters to 275 meters but most of his records are from the Bay of Islands. Wigley and Burns (1971) have found this species from 18 to 421 meters from collections in the Gulf of Maine area.

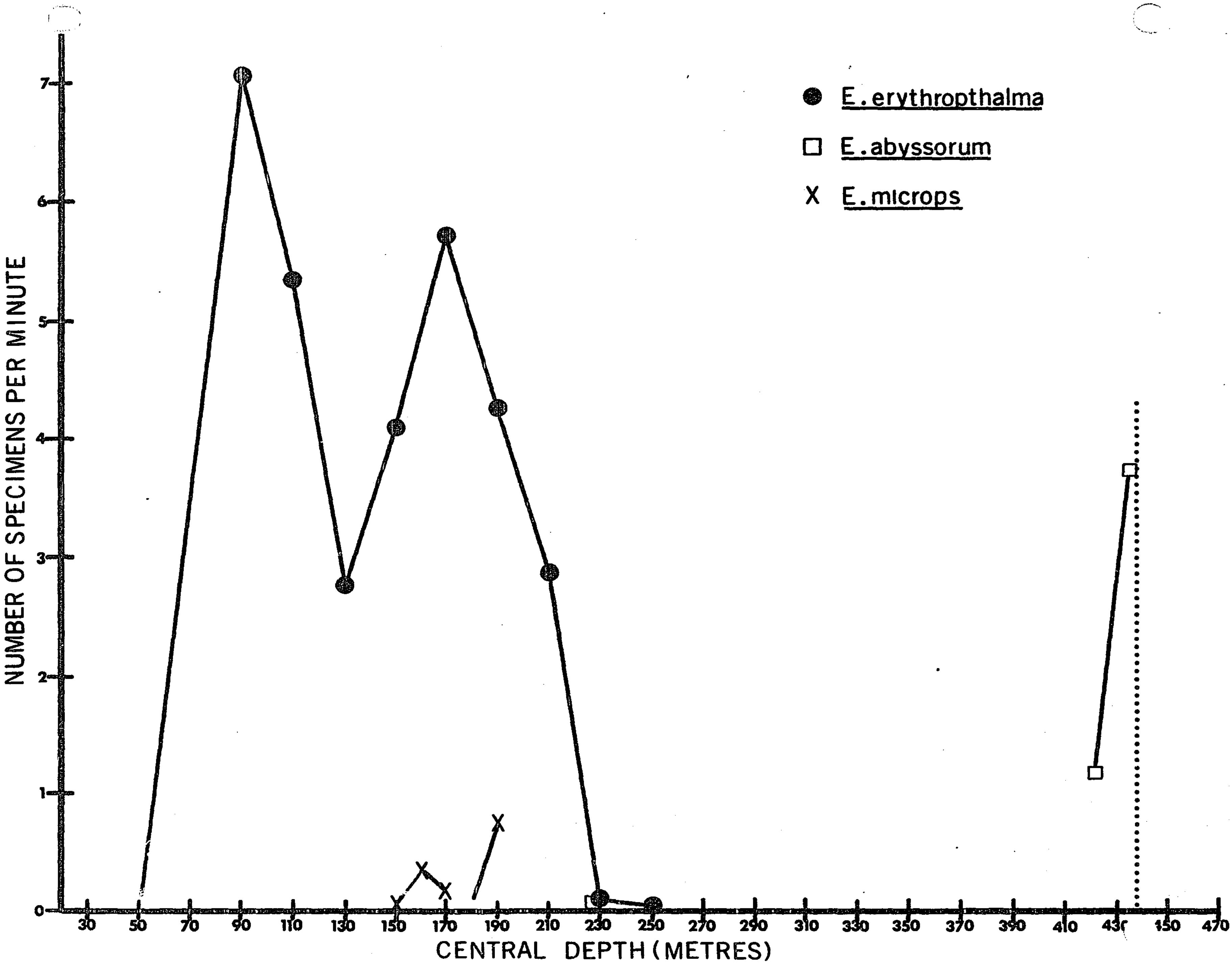
The range displayed by this species tends to overlap the upper two regimes described above (≠ 1 and ≠ 2) and in the boundary zone overlaps the distribution of Erythrops microps which has been found in a narrow band from 150 to 183 meters (Figure 35). This species has been taken on very few occasions in comparison with Erythrops erythropthalma and has never been found above the 150 meter mark. The range of Erythrops erythropthalma continues right through that of Erythrops microps and both species have been taken together in four instances. Erythrops microps was more abundant in only one instance (5/1). In two instances, Erythrops microps was captured in the absence of Erythrops erythropthalma.

Erythrops microps has not been previously recorded from the Gulf but is widely distributed in northeastern Atlantic-boreal waters. It might be recalled that Calman (1901) included in his catalogue a specimen taken off Labrador at 183 meters and since specimens have now been collected from the Gulf of St. Lawrence, it seems likely that Calman's identification was correct.

One specimen was recorded from Albatross Station ≠2046 (Cape May to Nantucket) in deep water (depth unknown) (Tattersall,1951). It is thought to be a deep water form in its known range and is said to have a general distribution like that of Erythrops abyssorum. Both were taken at Albatross Station ≠2046. Neither

Figure 36

Depth-density distribution of *Erythrops spp*. over the Gulf of St. Lawrence.


● E. erythropthalma
□ E. abyssorum
X E. microps
NUMBER OF SPECIMENS PER MINUTE
0
1
2
3
4
5
6
7
CENTRAL DEPTH (METRES)
30
50
70
90
110
130
150
170
190
210
230
250
270
290
310
330
350
370
390
410
430
450
470

species was present in the collections of Wigley and Burns.

In the Gulf of St. Lawrence, its main depth distribution appears, from the present collections, to be shallower and non overlapping with that of Erythrops abyssorum which appears in the Gulf to be a much deeper living form (Figure 36).

However Erythrops abyssorum was captured in the same tow with Erythrops erythropthalma and could potentially overlap in distribution with Erythrops microps as well, particularly in an area such as that on the south coast of Newfoundland where the incline from the shallow and intermediate water to the Laurentian Channel deep water was quite rapid.

Erythrops abyssorum was collected at depths from 209 to 475 meters; collections at depths greater than 400 meters in the Cabot Strait area being the most common. Only 2 specimens of a total of 92 taken were present at 209 meters. Concentrations of the population would appear to occur at relatively great depth (i.e. 300 meters). In other areas this species has been taken at lesser depths, but Stephensen (1910) in East Greenland recorded it from 380 meters and Tattersall (1911) recorded it from 580-600 fathoms in the Faroe Channel.

(B) Geographical Distribution

It is likely that Erythrops abyssorum, as a boreal species, is restricted to the warm deep waters of the Channel, possibly finding the colder waters of the boundary layer and more obviously the cold intermediate layer uninhabitable. Present records show specimens in water with temperature of 4.8°C and salinities of

$34.5^{o}/oo$. It probably has strong Atlantic slope affinities with a distribution extending from this area well into the inhabitable warm waters of the Laurentian Channel bottom. Only one specimen, a mature male, was captured well inside the Gulf at approximately 320 meters but this is an indication that the distribution of the species may be continuous along the Laurentian Channel (Figure 37).

The state of Erythrops microps in this regard is difficult to estimate. The records of Tattersall (1951), and Tattersall and Tattersall (1951) do not report temperatures in the various regions of occurrence but implications are that it is also a boreal species with the cold intermediate layer of the Gulf defining its upper limit of distribution. In the Gulf it has been associated with temperatures of 2.54 to $4.6^{o}C$ and salinities of 32.47 to $34.12^{o}/oo$. The lower limit of its distribution is uncertain but the data available points to the possibility that it may not and/or perhaps cannot co-exist with Erythrops abyssorum in the Channel waters.

The distribution of this species in the Gulf may be estimated for it was collected as far west as the estuary at the intermediate depths of the Channel slope. It is possible to say that its range extends along the margin of the Magdalen Shallows from Cape Breton (Cabot Strait) up into the estuary. Its presence on the North Shore and around Ile d'Anticosti has not been recorded but no tows were made on the North Shore which were in the narrow zone of 150-185 meters. However, tows were made at 146 meters, 201 meters, and 212 meters but no specimens were present. It may be noted that Erythrops erythropthalma was present in the collections at 146 meters and 201 meters.

Erythrops microps was seen, on one occasion (H B ≠35), to occur in the northern Esquiman Channel at 183 meters, beyond the influence of the deep layer. The bottom temperature was approximately the same, 4°C as that at H B ≠5 (Cape Breton side of Cabot Strait on the slope at 160 meters. Collections were made adjacent to H B ≠35 at 209 meters, 200 meters, 173 meters and 150 meters with no representative specimens present.

It is possible, if not likely that Erythrops microps occurs at the appropriate depths along the west coast of Newfoundland adjacent to the Esquiman Channel. No samples in the narrow band have been made along here but Sackville 1971 collections record the species on the southern Newfoundland side of the Channel. These records, along with that of H B ≠35 just west of Bonne Bay Newfoundland, would support the possibility of a loose but perhaps continuous distribution between the two points over a bottom composed of compacted sediments.

It would seem from this data that it is perhaps a species with a very weak hold in the Gulf along with a very sporadic and narrow distribution. Its small numbers in the Gulf may be attributed to the relatively variable conditions of the narrow band which it appears to inhabit. Due to the small number of collections made, it is impossible to determine whether or not it is always present in these areas. Temperature and salinity values from April through September, 1969, indicate that fluctuations do occur at station H B ≠5, for example. The temperature ranged from 1°C to 4.88°C near the bottom and salinities ranged from 32.5‰ to more than 34‰. At its zone of occurrence in the upper Esquiman, the temperature varied from 2.5°C to 4.2°C and the salinities fluctuated between 32.8‰ and 34‰. It is likely that such changes in environmental conditions modify the distribution of Erythrops microps.

Erythrops erythropthalma, on the other hand, was found to be one of the dominant mysid species of the Gulf of St. Lawrence and the one most frequently encountered throughout the area. It was recorded by Tattersall (1939), Black (1956), Lacroix and Bergeron (1962), Brunel (1970) and Poirier (1971). Besides having a relatively very wide depth distribution, as was reported previously by both Tattersall and myself, it was found to occur in every area of appropriate depth that was sampled during the programme with the exception of the southwestern coast of Newfoundland where only one collection was made. Its presence has also gone unrecorded on the lower North Shore and Belle Isle regions, where no hyperbenthic sampling was carried out. Erythrops erythropthalma should, however, also be expected to occur in these areas.

It is a widely distributed species taken most notably from the cold waters of the Arctic seas, the White Sea, Murman Sea, Spitzbergen, Greenland, Belle Isle, and along the coast of Norway as well as on the east coast of North America (Tattersall and Tattersall, 1951; & Wigley and Burns, 1971).

It would appear to be a "cool" water (Arctic-boreal) species from these records and, in the Gulf of St. Lawrence, is distributed somewhat in this way. It has been taken at depths characterized by a temperature of 3.8°C as well as at locations with temperatures as low as - 0.25°C. Its maximum of abundance is found between 70 meters and 185 meters, the true value lying somewhere intermediate to these extremes. Poirier (1971) found that the maximum of abundance for this species occurred at his deepest station, 119 meters, while Wigley and Burns found the greatest concentration to be between 60 and 100 meters. Poirier's analysis showed that their distribution depended upon both temperature and sediment conditions.

This species does seem to find life over a mud bottom more suitable than over other substrates. This was also pointed out by Gardiner (1934). Wigley & Burns found the greatest concentrations in areas of sand covered by a thin layer of silt. In this study the species was most abundant in the areas of soft sediment (silt-clay) incursions at either end of the Magdalen Shallows, the Cape Breton, Chaleur and Shediac troughs. Fifteen samples were taken in the Magdalen Shallows. Seven contained <u>Erythrops erythropthalma</u>. None of the <u>Erythrops erythropthalma</u> were ever captured in areas without a proportion of clay in the sediments, based on the chart of Loring & Lahey (1964) and on data concerning bottom sediments taken with the samples, except one collection made directly adjacent to an area which Loring & Lahey find to be mainly sand and gravel. It is so close, in fact, that it is really not possible to say that there was no measure of clay in the mixture and that, in fact, a portion of the sampling was not carried out over small pockets of soft sediment.

On the North Shore, for example, large concentrations of this species were present near the western end of Anticosti Island. It is seen that this location also corresponds closely to an isolated region of soft sediment (Loring, 1962). On the other hand, on the south coast of Newfoundland, the numbers of animals caught was low, and the bottom was of sandstone, sand and gravel.

There is also a correlation between the presense of soft sediments and the deeper areas of the Shallows, in the light of sedimentation patterns. The stations where Erythrops erythropthalma was present were also the deepest areas sampled in the southwestern Gulf and reflect different temperature and salinity conditions than shallower regions.

However, considering the wide temperature range which this species has been reported, in this study and others, to be capable of tolerating, it is likely that sediment type plays a more important role in determining distribution than does temperature.

Temperature undoubtedly plays a major role in determining the general pattern of distribution while sediment type probably accounts for the distribution within the broad limits defined by temperature and salinity.

The distribution on the North Shore likely depends on the presence of clay sediments. Although the area is considered rocky and jagged, it cannot be determined at this time what sediment types are actually present.

Figure 37

Geographical distribution of <u>Erythrops</u> <u>spp</u>. in the Gulf of St. Lawrence.


68
57
50
46
67
58
ERYTHROPS ERYTHROPTHALMA
1</MINUTE
1.1-4.0
4.1-10
>10.1
NON-QUANTITATIVE RECORDS
E. MICROPS
E. ABYSSORUM

(ii) Genus Pseudomma

(A) General Bathymetric Distribution

Genus Pseudomma is represented in the Gulf by three species which seem to be separated quite distinctly by bathymetric region.

Pseudomma truncatum has been present in tows from 80 meters down to 201 meters (only one specimen was taken at 201 meters). Over most of its range, the temperatures are from .45 to 3.1°C. Pseudomma truncatum was also present at a depth of 227 meters in Bonne Bay East Arm but this area appears to be a special case and does not possess the same water stratification characteristics as does the rest of the Gulf. Here, the temperature is slightly less than 0°C (as was previously described, and is homogeneous over a large vertical range). Tattersall (1951) considers it to be a circumpolar boreal species and Stephensen (1912) records its presence in the cold arctic water of the Polar Ocean and the deep northern basin of West Greenland. It is evident that the species inhabits the greater depths of Bonne Bay East Arm because of the appropriate temperature and salinity characteristics, not found at these depths in the rest of the Gulf. It might be noted that the author examined a large number of predominantly mature male specimens of Pseudomma truncatum from a head rope tow in Hawke Channel on the Labrador coast. The depth of the tow was 273 meters and the bottom temperature was 1.45°C.

Therefore it appears that its distribution in the Gulf of St. Lawrence corresponds largely to that of the cold intermediate layer and in some instances, the upper boundary layer.

The next species, less often encountered than Pseudomma truncatum, was Pseudomma affine, found at intermediate depths. This species has been recorded in the area previously only by Klawe (1955) off the Nova Scotia coast and by Wigley & Burns (1971) in the Gulf of Maine from 146 to 329 meters. It is known in the eastern Atlantic from Norway to the Bay of Biscay, from Iceland and Greenland (Tattersall, 1951), as well as near southwestern Ireland from 108-728 fathoms (Tattersall and Tattersall, 1951). It was not recorded by Stephensen from Arctic waters in 1912. In the Gulf of St. Lawrence it appears to be characteristic of the Channel Slope depths and is recorded from 160 meters to 222 meters.

In two instances it was found with Pseudomma truncatum; at 164 and 166 meters. In both cases, Pseudomma affine outnumbered Pseudomma truncatum and thus the area of occurrence probably represented a simple zone of overlap and competition. In only two collections was it found co-existant with Erythrops microps while Pseudomma truncatum and Pseudomma affine were commonly found with Erythrops erythropthalma. The salient temperature and salinity characteristics are those of the lower part of the boundary layer, (3^{o}) to 4.6^{o}C and 33^{o}/oo to 34^{o}/oo.

Pseudomma roseum, a boreal Atlantic species (Tattersall, 1951) first recorded in the Gulf by Whiteaves (1874) was collected on four occasions, from 358 meters down to 417 meters. If sampling had been done extensively in the Laurentian Channel, it is quite likely that large numbers would have been found along the length of the Laurentian Channel. Again, only two specimens were captured inside the Gulf but incorporating the records of Whiteaves into the pattern of occurrence, there is an indication that they do occur throughout the deep soft sediment area of the Gulf. Present samples showed that a large population including ovigerous females is found in Cabot Strait.

(B) Geographical Distribution

Pseudomma truncatum, captured in small numbers in the frequently sampled areas of the Gulf, might be expected to occur in other regions at which no sampling was done. From the records of Poirier (1971), it is evident that fairly large populations exist in the Baie des Chaleurs area. Good sampling in the Magdalen Shallows showed that Pseudomma truncatum does not occur there, but is found only in the Chaleur, Shediac, and Cape Breton troughs (Figure 39).

This eyeless form has always been observed in this study to occur over a substrate containing a high proportion of clay. Poirier (1971) has shown in the Chaleur area that its distribution corresponds to areas where the bottom is largely clay in nature and its distribution is determined by temperature in the broad sense only.

Present collections extend the records of this species to the upper North Shore of the Gulf, both the north and south shores of the lower estuary and the area of suitable depth around Ile d'Anticosti.

Sampling on the lower North Shore of the Gulf and the West coast of Newfoundland would probably indicate its presence there as well, depending perhaps on the suitability of the bottom and its distribution might be expected to be continuous from the Labrador coast, through the Strait of Belle Isle.

Pseudomma affine has a distribution intermediate between those of *Pseudomma truncatum* and *Pseudomma roseum*, in a similar band to that inhabited by *Erythrops microps*. A continuous distribution along the margin of the Magdalen Shallows is assumed to be likely on the basis of its presence in the only two tows made along this margin. It is also likely to occur along the Channel slope of the Estuary as does *E.microps*. Its presence has also been recorded on the north side of the Channel near Ile d'Anticosti just below the range of *Pseudomma truncatum* and it is thought likely that extensive sampling at the appropriate depth on the lower North Shore would prove its presence as a viable population there as well. Its presence on the north side of the Channel off the south coast of Newfoundland indicates that it is potentially found on the west coast of Newfoundland as well. It is obvious though that more sampling is required in the northeast portion of the Gulf before this can be proven.

Pseudomma roseum has been considered to be a deep dwelling form found throughout the Laurentian Channel's warmer waters.

Figure 38

Geographical distribution of Pseudomma spp. in the Gulf of St. Lawrence.


68
57
50
46
67
58
● PSEUDOMMA TRUNCATUM
□ P. AFFINE
▲ P. ROSEUM

(iii) Genus Boreomysis

(A) Geographical and Bathymetric Distribution

All three species of Boreomysis appear to be deep water forms, two of which inhabit only the Laurentian Channel. Boreomysis arctica was often collected between Anticosti Island and the Gaspé. The species was present in collections from the estuary and is very common in the deep plankton probably as far west as the Saguenay fjord where Prefontaine (1933) records its presence.

On only two occasions were these Boreomysids taken over depths of 250 meters and they were never captured in any less water. The two 250 meter stations at which they were present were directly adjacent to areas of greater depth where the species was present in quite large numbers and thus the specimens captured probably represented expatriots from the bulk of the population present at the deeper stations. The numbers of specimens captured at the 250 meter stations were small, in one case, zooplankton station 18, only one animal was present in collections over the summer months.

All other stations where Boreomysis arctica were present were greater than 300 meters in depth, the deepest being 475 meters. This was the deepest station sampled in the program (Figure 41).

Stations in the Mingan Channel and stations in the Esquiman Channel were both sampled regularly and well for zooplankton. In neither area was Boreomysis arctica found. Both stations were 250 meters in depth and possibly too shallow for the presence of this species. One would expect it to occur, at least, a short distance northeastward from the Laurentian Channel, to the limits of the 300 meter contour. At both zooplankton stations 7 and 10, temperatures and salinities were well in the same range as those at zooplankton stations 16, 17, and 19 where large numbers of Boreomysis arctica occurred. Temperatures of the near bottom water at the former stations were greater than $4^{o}C$ and salinities from 33.2^{o}/oo to 34.4^{o}/oo, corresponding quite closely to those of stations at which the species did occur. Perhaps due to the somewhat shallower nature of Stations 7 and 10, the animals were restricted more closely to the waters near the bottom and were not sampled by the zooplankton gear. This however, seems unlikely.

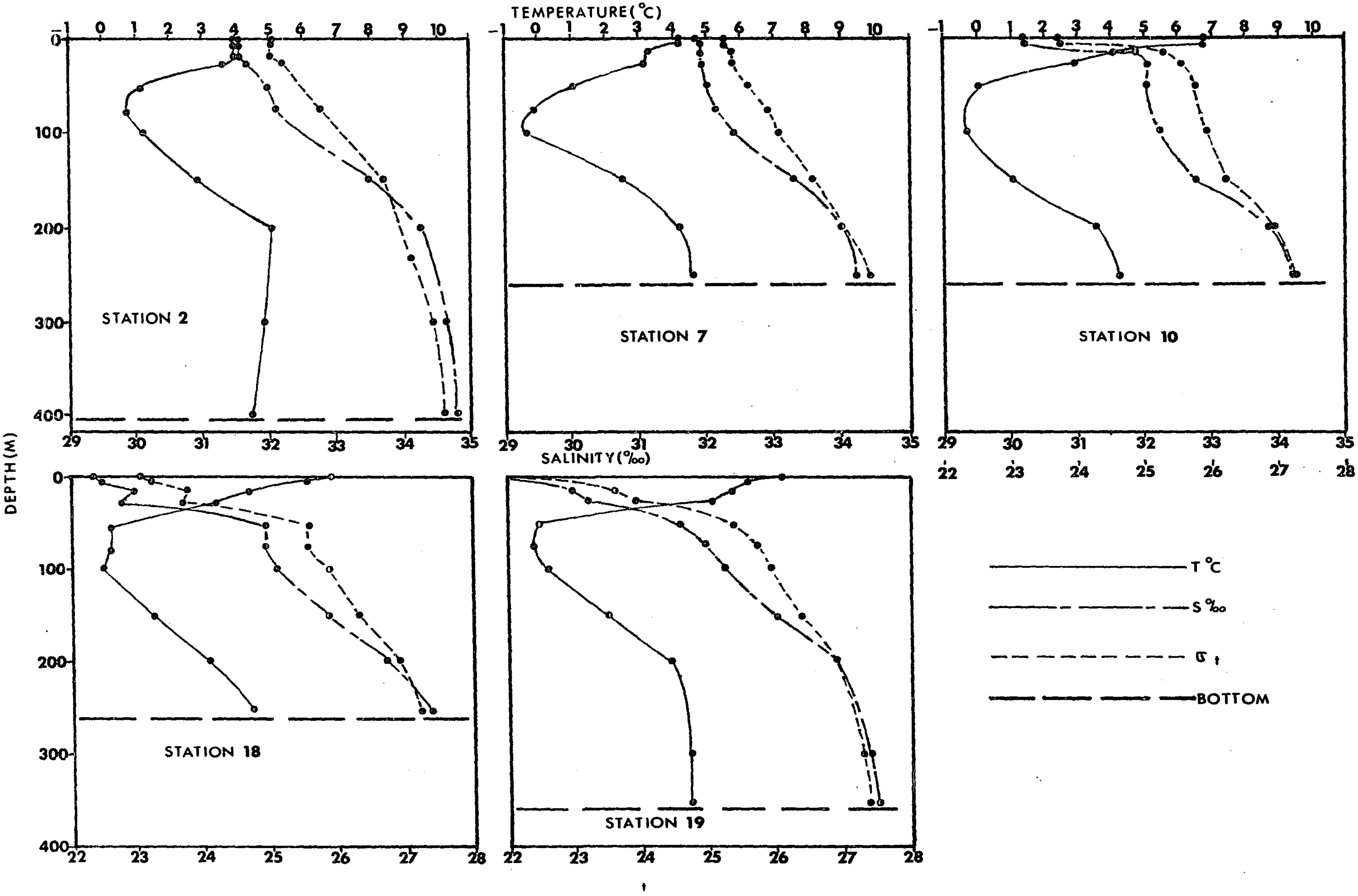
Hyperbenthic sampling, showed their presence in both Cabot Strait and the Laurentian Channel near Anticosti Island. The numbers captured were fairly large despite the fact that the apparatus did not sample the bottom. A hyperbenthic collection made near but above the bottom, at 249 meters, in the Esquiman Channel contained no representatives of this species. Therefore it is felt that the species does not occur in the deep water of the northwestern portion of the Gulf.

Looking at Temperature-depth, Salinity-depth, and σ_t -depth curves it will be seen that only at the Laurentian Channel Stations with depths greater than 300 meters is there a significant proportion of the water column which appears homogeneous (Figure 39).

Therefore the major difference between the areas at which the species is present and those at which it is not, is not found in the presence or absence of suitable environmental conditions but rather in their vertical extent.

Figure 39

Temperature, salinity, and sigma-t characteristics of deep water stations of the Gulf.


TEMPERATURE(°C)
-1 0 1 2 3 4 5 6 7 8 9 10
DEPTH (M)
0 100 200 300 400
SALINITY (‰)
29 30 31 32 33 34 35
22 23 24 25 26 27 28
STATION 2
STATION 7
STATION 10
STATION 18
STATION 19
T °C
S ‰
σ t
BOTTOM

Thus *Boreomysis arctica* would appear to require access to a stable water column of some minimal depth in order to properly function as a reproducing population.

Boreomysis tridens, a North Atlantic species found from the Bay of Biscay to Norway, Iceland, Greenland, and the coast of New England (Wigley & Burns, 1971; Tattersall, 1951) is a true hyperbenthic form and was therefore less frequently caught than the previous species. It was, however, caught in sufficient locations in the Laurentian Channel to suspect that it occurs well into the Gulf and has a distribution which is continuous from the Continental Shelf to, at least, the Estuary. Brunel (1970) records its presence in the Channel between Anticosti and the Gaspé and Tattersall (1939) records one specimen from this same region. It is likely, then, that *Boreomysis tridens* has a distribution similar to that of *Boreomysis arctica* but is hyperbenthic rather than bathypelagic. *B.arctica* has been widely recorded over the same geographical area as *B.tridens* and this is likely to be the reason why they have been found together.

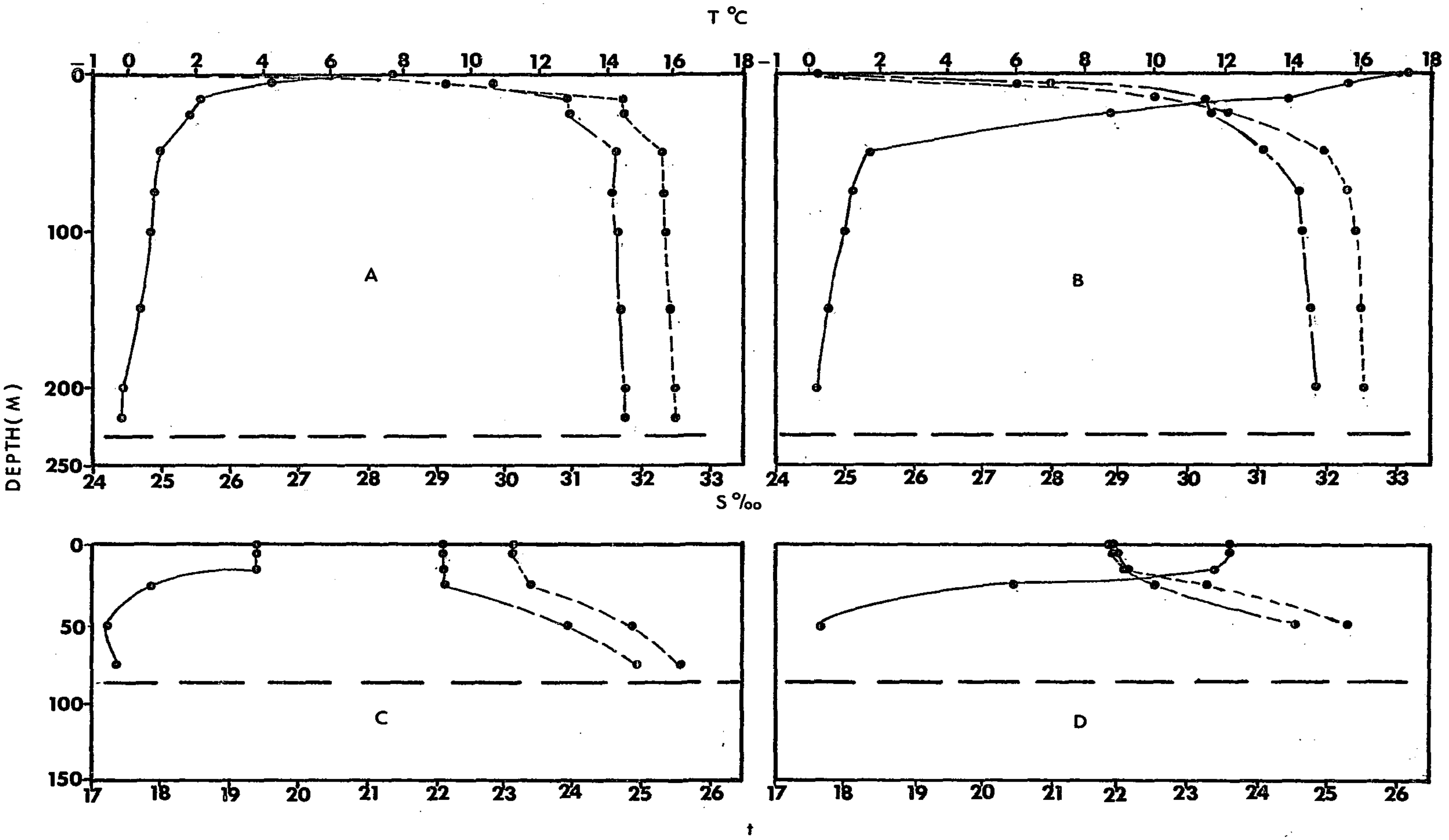
Boreomysis tridens was found only in the Laurentian Channel at depths of 270 meters or more in waters with temperatures greater than 4°C. The occurrence referred to by Tattersall was a specimen captured at 355 meters. Prefontaine (1933) records its presence in the St. Lawrence estuary at 325 m.

Boreomysis nobilis, discussed earlier, was present only in

Figure 40

Temperature, salinity, and sigma-t characteristics of

- (A) Bonne Bay, east arm; June 3/69
- (B) Bonne Bay, east arm; August 20/69
- (C) Station 21; May 20/69
- (D) Station 21; September 19/69


T °C
-1 0 2 4 6 8 10 12 14 16 18
DEPTH (M)
0
100
200
250
A
B
24 25 26 27 28 29 30 31 32 33
S ‰
C
D
0
50
100
150
17 18 19 20 21 22 23 24 25 26
t

collections from the east arm of Bonne Bay. It is definitely an Arctic-like species only, and all records of its occurrence were from waters of approximately 0°C. It was taken by Stephensen (1912) and by Dunbar (1941) in Greenland waters and was personally observed in collections taken by Tidmarsh in northern Baffin Bay. Tattersall (1939) recorded its presence in the Bay of Islands, another fjord on the west coast of Newfoundland as well as in the Bay of Exploits, East Newfoundland. Depths of occurrence in these fjords were 210 meters and 300 meters respectively. Therefore it would seem that *Boreomysis nobilis* is an Arctic relict perhaps widely distributed in the cold water fjords of Newfoundland.

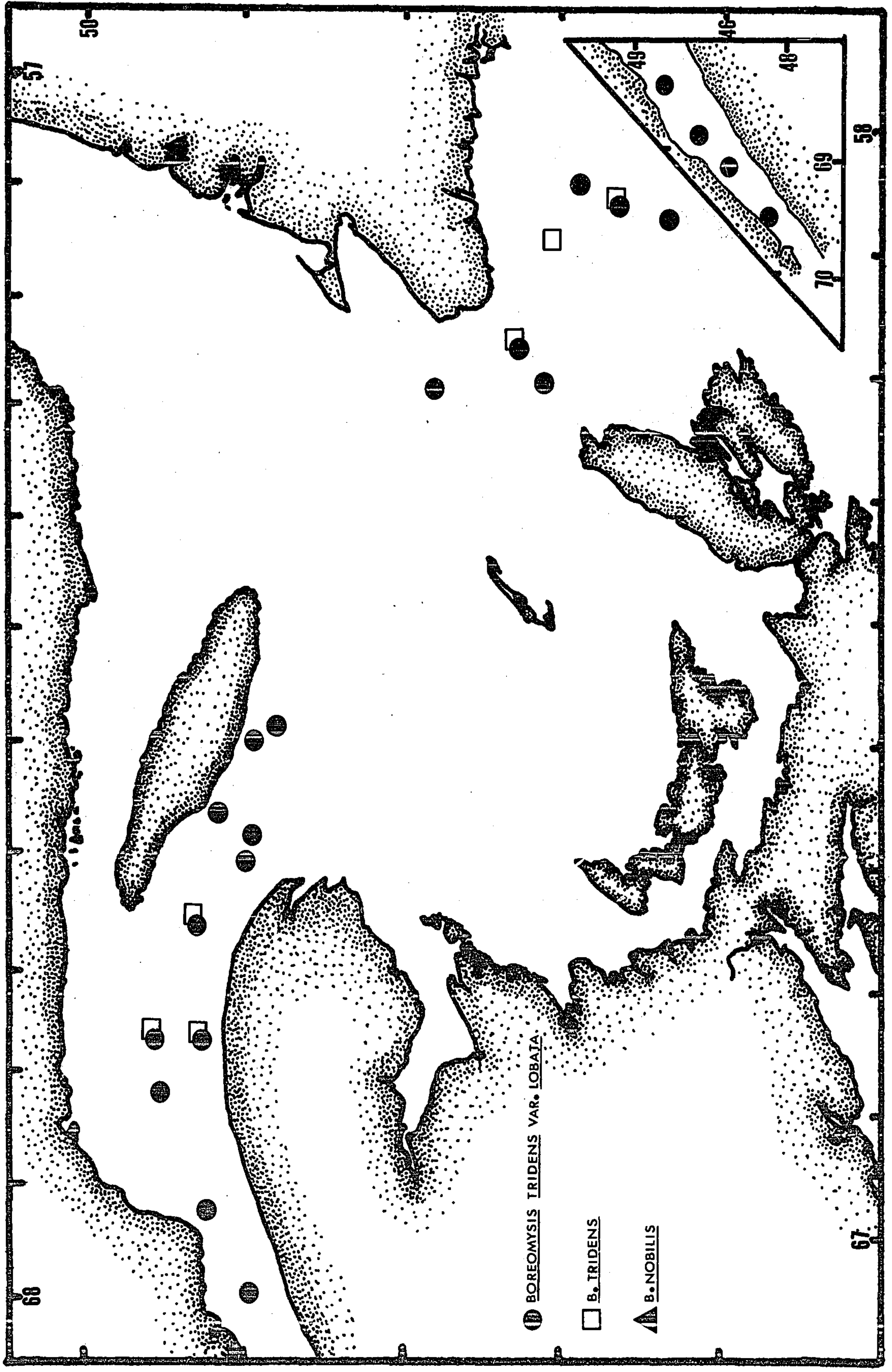
Both *Pseudomma truncatum* and *Meterythrops robusta* were present in Bonne Bay East Arm but were also widely distributed throughout the rest of the Gulf. This is not the case for *Boreomysis nobilis*. It is not found associated with the cold intermediate layer in the Gulf and would seem then to be a true deep living form incapable of inhabiting areas of the Gulf proper which are shallower than 200 meters even though characteristics of temperature and salinity may be suitable at lesser depths. It is possible that it is restricted more closely to zones of the proper σ_t than the others. It is also possible that as a form which undergoes extensive vertical movement, as established in a previous section, that there is a minimum depth requirement in operation. That is, *Boreomysis nobilis* must have at its disposal a homogeneous water column of specific temperature and salinity characteristics which has a suitable depth within which it may move up and down (Figure 40).

The other two forms, *Pseudomma truncatum* and *Meterythrops robusta* do not require this as they have been shown to be weak migrators.

All of the species of *Boreomysis* were found to occur in deep areas, with bottoms characterized by soft sediment substrates.

Figure 41

Geographical distributions of _Boreomysis_ _spp_. in the Gulf of St. Lawrence.


◐ BOREOMYSIS TRIDENS VAR. LOBATA
☐ B. TRIDENS
▲ B. NOBILIS
50
57
68
67
49
46
48
58
69
70

(iv) Other Channel Dwelling Forms

At present, three deep, channel dwelling species have been discussed, all of which are likely to co-exist in the hyperbenthic community. For example, at stations HB ≠20 and HB ≠31, *Pseudomma roseum*, *Boreomysis tridens* and *Erythrops abyssorum* were present together in suitable numbers.

Also present in these collections, as well as at HB ≠30, were specimens of *Amblyops abbreviata*. This species was taken on these three occasions in March 1971 at depths of 400 meters in the Laurentian Channel near Cabot Strait. Tattersall and Tattersall (1951) and Tattersall (1951) refer to this species as a bathypelagic form normally living on the sea bottom, making short, occasional excursions into the lower water levels and being found from 130 to 750 fathoms. Specimens have been recorded from Greenland, Iceland, Davis Strait, Norway, Denmark and the Bay of Biscay as well as Ireland in the eastern Atlantic. In the western Atlantic it has been recorded at the $39^{\circ}40''$ to $39^{\circ}55''$ latitudes on the U.S. east coast and off Cape Cod in 235 meters of water. Wigley & Burns (1971) recorded it from 189-329m. in the Gulf of Maine. It is a circumpolar species which has penetrated the boreal waters of the Pacific as well. It has been recorded from the coast of Washington and the Japanese coast.

The present record is the first for the Gulf of St. Lawrence area and indications are that it occurs throughout the deep water of the Laurentian Channel. One zooplankton tow made in July 1970, hit bottom at Station 18, 250 meters, and produced one specimen of *Amblyops abbreviata* in very poor condition. It appeared to be a mature female, with the oostegites in a battered condition. The implication is that there is a continuous distribution of the species from the Cabot Strait to Station 18, and probably further into the Gulf (Figure 42). The conditions of temperature and salinity at Station 18 are of above 4°C temperature and May to September salinities of 34.13°/oo to 34.42°/oo with one variable value of 33.77°/oo in August, 1969. Similar conditions are present between Station 18 and Cabot Strait.

Sympatric with Amblyops abbreviata in Cabot Strait at 400 meters was Amblyops kempii. This form was never taken inside the Gulf proper and nothing is known of its degree of penetration into the Laurentian Channel. In all three collections from the Channel during March 1971, the two forms were present together in small but approximately equal numbers.

Two possibilities arise here. The first is that they are both of the same species and present discrete phenotypic variants.

If this is the case, then it would be expected to occur inside the Gulf as well, as is speculated for Amblyops abbreviata.

If they are separate species, then we would expect that they would not be completely sympatric but that the area surrounding Cabot Strait in the Laurentian Channel would represent a zone of overlap of the two species. Since Amblyops abbreviata was present inside the Gulf at 250 meters then it is quite likely that it would be the shallower water species and the latter the deeper water form, found only close to Cabot Strait and on the Continental Shelf.

Tattersall and Tattersall (1951) state that Amblyops kempii, off the Irish coast, shows a maximum of abundance at 350 fathoms and make special mention of the fact that the areas of distribution of the two species definitely overlap. In the latter case Amblyops abbreviata is the shallower dwelling form of the two.

Since insufficient collections exist to combine or separate the two forms present in the Laurentian Channel on ecological grounds, the problem was approached on morphological ones. The two forms were concluded to be modified representatives of their respective species and therefore it is thought to be likely that Amblyops kempii is not found throughout the Gulf unless A.abbreviata inhabits a zone further up the Laurentian slope than does A.kempii. Further deep collections in the Gulf would be necessary in order to clarify this situation.

The other species encountered in the deep water collections of the Laurentian Channel was Mysidetes farrani (Figure 42). Only nineteen specimens were collected from the Cabot Strait area in March 1971 and all were taken in the warm deep layer. Specimens were present in all deep hyperbenthic collections made and therefore it is likely to be present in viable numbers, although small numbers in comparison with Pseudomma roseum, Boreomysis tridens, or Erythrops abyssorum. Tattersall and Tattersall (1951) state that for British waters it "is not uncommon at suitable depths". It seems to have a wide boreal distribution but has only been previously found on the northeast Atlantic slope, the Bay of Biscay, the Mediterranean and at an oceanic station 33°43N, 11°22W. Over this range it has occurred from 200 to 900 fathoms.

Figure 42

Occurrences of *Amblyops spp*. and *Mysidetes farrani*.


● AMBYLOPS ABBREVIATA
□ A. KEMPII
▲ MYSIDETES FARRANI

Again, since good collections were made only in the Cabot Strait area it is impossible to say how far into the Gulf of St.Lawrence it can be found. It may not be as likely to penetrate the Laurentian Channel as _Boreomysis tridens_, _Boreomysis tridens_ var. _lobata_, _Amblyops abbreviata_, _Erythrops abyssorum_, and _Pseudomma roseum_, judging by the proportionately small number of individuals captured. It should be pointed out that this is the first record of _Mysidetes farrani_ outside of eastern Atlantic waters, therefore it is likely that it will sooner or later be found in other locations in boreal waters of Eastern North America.

(v) Other Forms of the Laurentian Slope Zone

(Below cold intermediate layer but above deep layer)

Another species, hitherto, unrecorded from the western Atlantic region but present in limited numbers in these collections is Parerythrops obesa (Figure 43). This species is common in the Norwegian fjords and the Irish coast. Records of its presence by Lo Bianco (1903) in the deeper, intermediate waters of the Mediterranean are yet unconfirmed.

In the Gulf, it was recorded on only four occasions, from 160 to 402 meters. Only one specimen was captured in the Laurentian Channel at 402 meters. Little can be said about its distribution except that it too is probably distributed along the margin of the Magdalen Shallows and possibly along the west coast of Newfoundland. Temperatures were $2.8^{\circ}C$ to $4.6^{\circ}C$ and salinities were from 33 to $34.12^{\circ}/oo$.

Its upper limit is likely to be determined by the cold intermediate water and perhaps by Meterythrops robusta which is morphologically similar.

Figure 43

Occurrences of *Parerythrops obesa*.

(vi) Other Forms from the Cold Intermediate Layer or Upper Zone

One species captured on only two occasions in the Gulf of St. Lawrence was Stilomysis grandis, a circumpolar-arctic species. It was taken by Rodger (1895) off the Labrador coast and by Tattersall (1933) off the British Columbia coast. It is common in the Bering Sea and Stephensen (1912) records it as arctic bottom form from Greenland waters. Its greatest recorded depth, 284 fathoms, comes from the Bering Sea. (Tattersall, 1951).

In the Gulf of St. Lawrence, mature specimens were present at 122 meters and 150 meters. Brunel (1970) and Poirier (1971) list this species as occurring in Baie des Chaleurs from the upper limit of the thermocline to the 100 fathom line. These few records imply that the species is restricted in its distribution to the areas where the cold intermediate water is present at the bottom. In the two areas, at the depths where Stilomysis grandis was present, the temperature ranged from 0°C to 2.5°C over the summer period of 1969. Salinities ranged from 32°/oo to 33°/oo.

Thus, Stilomysis grandis has been observed in three widely spaced areas of the Gulf of St. Lawrence, the west coast of Newfoundland, the eastern tip of Anticosti Island on the north shore and the Baie des Chaleurs in the southeastern Gulf (Figure 44). This wide distribution pattern indicates that perhaps populations are present in many of the areas of appropriate temperature and salinity in the Gulf. It would appear though to be one of the species of low abundance, possibly due to the fluctuations in temperature experienced in some of the shallower areas.

Meterythrops robusta, a species whose type specimens are from the southeastern Gulf of St. Lawrence, has been recorded by Tattersall from the British Columbia coast, from the U.S. east coast; the Gulf of Maine, Cape Cod, and Greenland's northern deep basin (Stephensen, 1912). It is likely to be a circumpolar, arctic-boreal species.

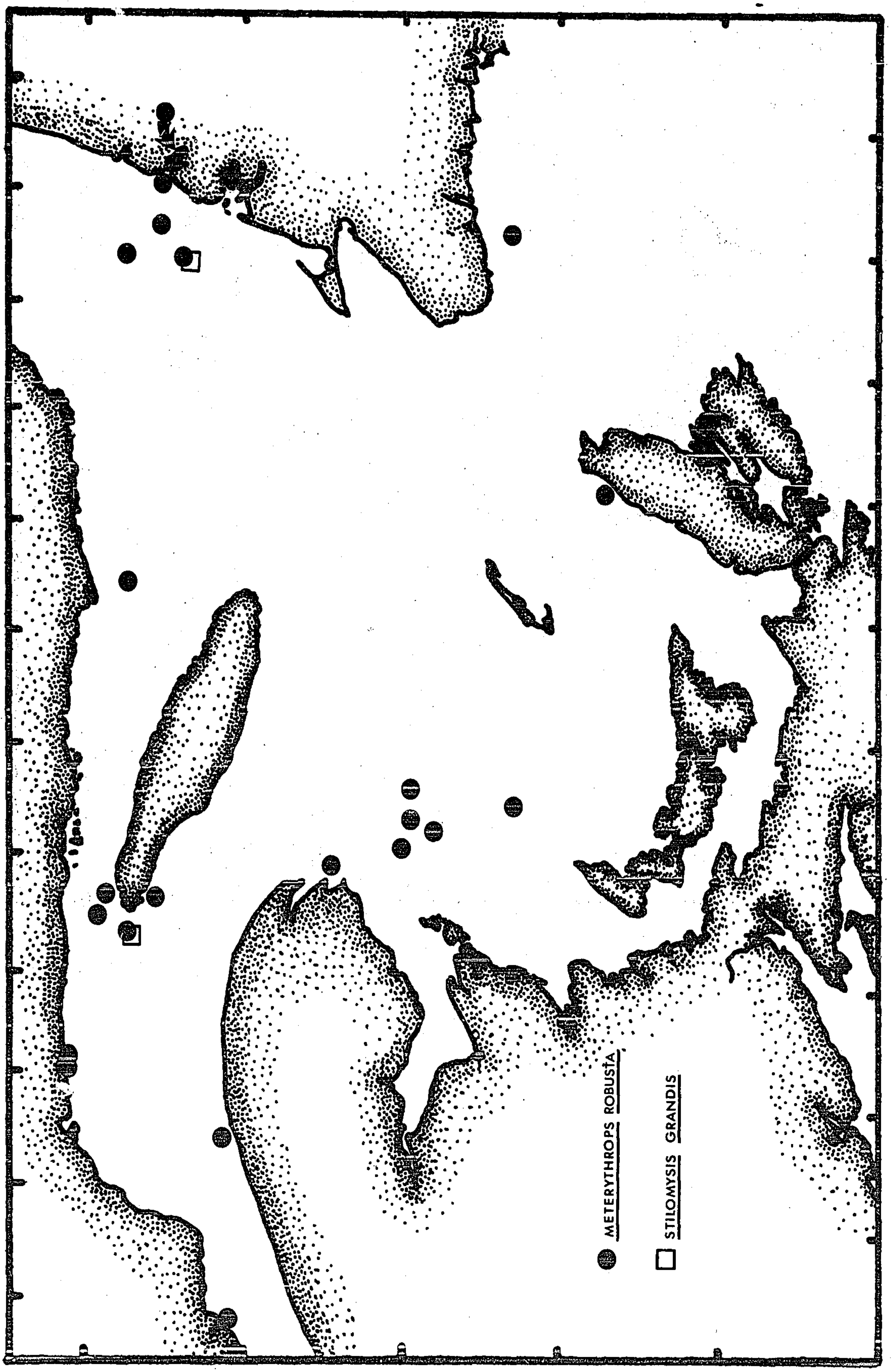
In the Gulf of St. Lawrence it has a distribution very similar to that of Erythrops erythropthalma but it was not found to occur at depths as great as those at which the latter occurred. The bathymetric range observed from these collections was 62 to 183 meters, only three specimens being present at 183 meters. Tattersall (1951) states its bathymetric range, in the other waters mentioned above, to be from 60 meters to 275 meters. Meterythrops robusta occurred at 227 meters in Bonne Bay East Arm, again for this species, due to the presence of low temperatures at greater depths than in the Gulf proper.

The maximum temperature at which Meterythrops robusta was found in this study, at Station HB ≠35, was approximately 3.1°C. As was pointed out above, only the three specimens were present and it was outnumbered by P.obesa. In general, its distribution maximum is associated with the cold intermediate layer throughout the Gulf of St. Lawrence (0 to 1.5°C, occasionally up to 3.0°C; 31.85 to 33.10°/oo).

Occurrence of this species in collections indicate that

Figure 44

Geographical distribution of Meterythrops robusta and occurrences of Stilomysis grandis.


● METERYTHROPS ROBUSTA
□ STILOMYSIS GRANDIS

Meterythrops robusta is potentially present in all areas of the Gulf with suitable temperature, salinity and possibly substrate (Figure 44). It is found in the Magdalen Shallows in the silt trough areas near Gaspé, the Cape Breton trough, and in the silt-sand (to sand and gravel) area at HB ≠41 north-northeast of the western tip of Prince Edward Island in or near the Shediac trough in 62-75 meters of water. Meterythrops robusta was captured on the north and south shores of the estuary, in Moisie Bay and off the western tip of Anticosti Island on the North Shore, and along the west coast of Newfoundland (over a rough sandstone bottom). This implies the possibility of a continuous or semi-continuous distribution in the appropriate water layer between these points.

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(vii) Mysis mixta

Mysis mixta, according to Tattersall (1951) has a distribution which extends from the Woods Hole region, up the eastern U.S. coast into the Gulf of St. Lawrence waters, Greenland waters, Icelandic waters and across to Scandinavia. Apstein (1906) studied the species in great detail in the Baltic.

The present collections show that Mysis mixta is widely distributed in the south eastern portion of the Gulf of St.Lawrence, particularly in the Magdalen Shallows (Figure 46). Brunel (1970) records its presence in Baie des Chaleurs as does Lacroix (1961). Poirier (1971) studied the Biology of Mysis mixta at the entrance to Baie des Chaleurs and Black (1956) studied it in the Bras d'Or Lakes. Lacroix and Bergeron (1962) recorded the species on Banc de Bradelle in the Magdalen Shallows. Tattersall (1939) recorded Mysis mixta from three locations in the Magdalen Shallows; from 8 to 80 meters.

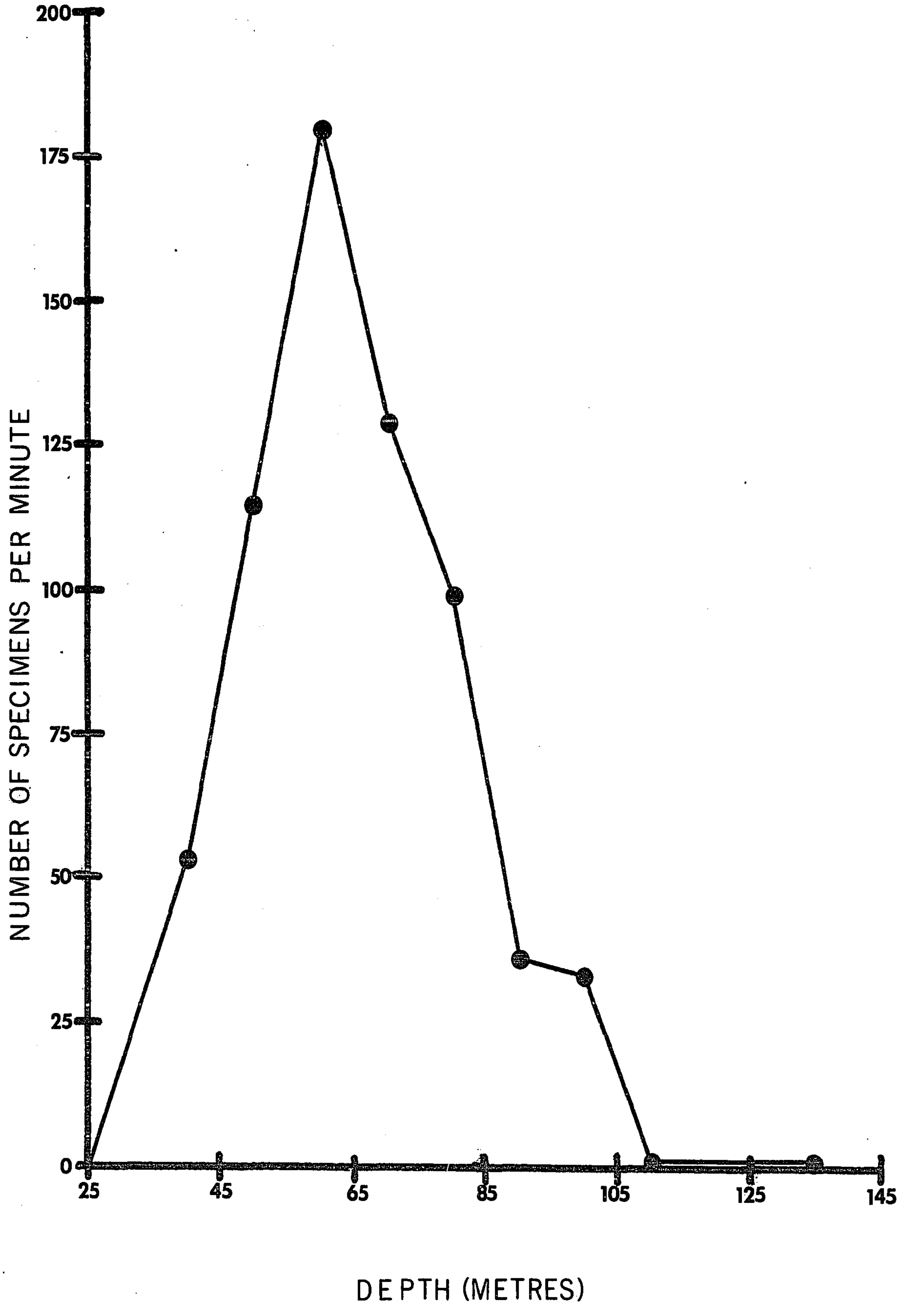
This species was recorded from 18 locations in the Magdalen Shallows in the IBP collections. It is shallower in its bathymetric range than are Erythrops erythropthalma, Meterythrops robusta and Pseudomma truncatum.

Mysis mixta was present in collections from 30 meters to 135 meters. At 135 meters, at the eastern end of the shallows, only 3 specimens were present in the collection.

It is clear that the mode of abundance occurs between 45 and 85 meters. Similar results for zooplankton collections in the Magdalen Shallows are obtained. Specimens were present in the

Figure 45

Depth-density distribution of Mysis mixta over the Magdalen Shallows.


200
175
150
125
100
75
50
25
0
NUMBER OF SPECIMENS PER MINUTE
25
45
65
85
105
125
145
DEPTH (METRES)

water column at stations with depths of 31 to 85 meters (Figure 45).

Mysis mixta occurs most frequently over sand substrate while it was not as common over mud bottoms. This is likely to be due to the general relationship of sediments to depth found in these waters and it is quite difficult from this data to separate the effects of bathymetry (a complex gradient) and sediment preference. Wigley & Burns (1971) find the species over all bottom types.

Besides being widely distributed in very high concentrations in the sublittoral waters of the Magdalen Shallows, it has been taken on the North Shore near Sept Iles at 150 meters (sand bottom) and off the western tip of Anticosti at 140 meters over a mud and sand mixture. In this area the number of specimens was small. It was present in a zooplankton collection from the eastern end of Anticosti in 75 meters of water as well. One specimen was captured in a zooplankton collection on the west coast of Newfoundland and Tattersall (1939) records its presence slightly south of the former collection near the Bay of Islands. Tattersall (1939) also records its presence on the north shore at 61°W. and in the Strait of Belle Isle entrance. It appears that this species may be quite common on the North Shore although it has not been recorded in this study in numbers comparable to those of the Magdalen Shallows. The area has not been well sampled, even by zooplankton nets, between the lower North Shore and the area north of Anticosti, (60°W. to 63.5°W.) where the species was reported by Tattersall. A number of stations were sampled in the lower North Shore region from 60°W., east to the Strait of Belle

Isle. No animals were captured. On the other hand, no mysids of any species were present in these collections and therefore it is likely that sampling for mysids was of inadequate quality. Further sampling of inshore waters on the west coast of Newfoundland and the Gulf north shore would be desirable.

At zooplankton station 21 where *Mysis mixta* was present in the plankton collections of May, July, and August (1971), bottom temperatures were observed to be -0.11°C to 0.95°C from April to September. Temperatures should not be expected to change considerably over the winter months. Recorded temperatures at other locations where *Mysis mixta* was present were low, from 0°C to 1°C except in two instances when specimens were captured at stations with bottom temperatures of 3.07°C and 3.20°C.

The salinities at the stations of *Mysis mixta* occurrence varied from 30.8°/oo to 33.8°/oo, the majority of observations being in the range of 31°/oo to 32°/oo.

If these animals were totally stenothermal, they would not be capable of the migrations which they have been observed to carry out in the month of August. There are three good records of the presence of *Mysis mixta* within 10 meters to 32 meters of the surface in the Magdalen Shallows, well into the warm waters (> 13°C) of the Thermocline and upper layer. One occurrence recorded the presence of 34 specimens within 10 meters of the surface over a depth of 30-40 meters on August 13, 1971. Poirier (1971) points out that the young are more commonly found in the warmer inshore waters and the animals present in the warm upper water in the present collections are all immature animals. Those animals of the second year class showed a maximum of abundance at Poirier's deep station (119 meters) in the Baie des Chaleurs area.

On the Magdalen Shallows, there was also a definite segregation of the year classes. (Figure 34). Poirier's evidence that the separation of the year classes is due to temperature, the young being found in warm waters and the second year class in cold waters, is quite clearly related to bathymetry.

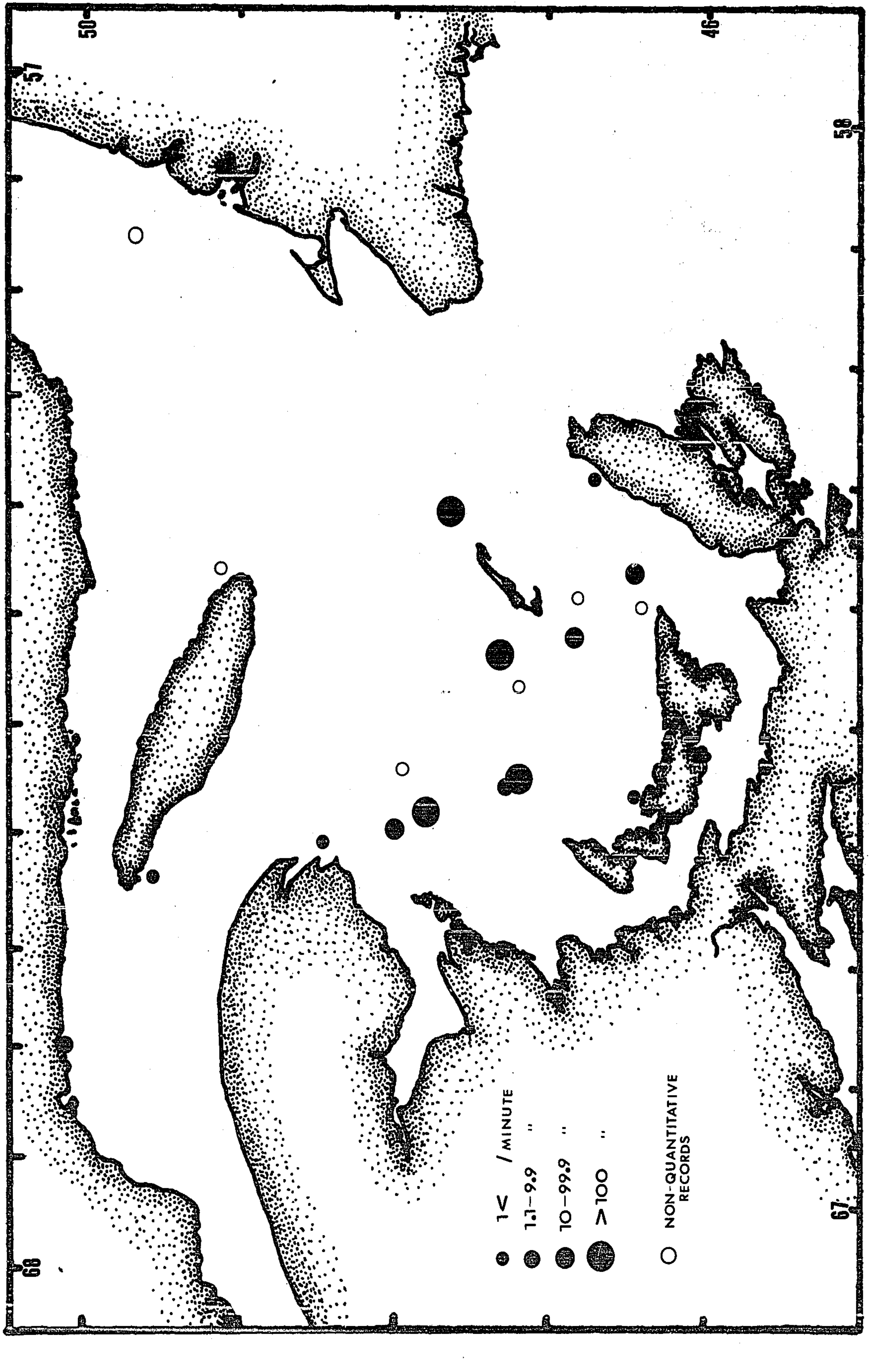
Over the Magdalen Shallows, however, this was not so. Concrete explanations of the almost complete segregation of year classes could not be based on correlations with different physical parameters. Likewise in Moisie Bay on the North Shore at 128 meters, the Mysis mixta population sampled consisted almost entirely of members of the second year class.

It is clear, however, that year classes are segregated in response to some stimulus. The principle that separates the year classes is likely to be a response to reduce intraspecific competition. The stimulus involved may simply be that of a form of schooling behaviour as has been found for other mysid species in other areas. (Steven, 1961; Clutter, 1969).

There will be no further attempt to interpret the data as it could lead to erroneous conclusions.

Figure 46

Geographical distribution and density considerations of _Mysis mixta_, particularly on the Magdalen Shallows.


50
57
46
58
68
67
● 1< /MINUTE
● 1.1–9.9 "
● 10–99.9 "
● >100 "
○ NON-QUANTITATIVE RECORDS

Summary and Conclusions

(1) Sixteen sublittoral species of mysids are considered in this study of which 7 species are new records to the Gulf of St. Lawrence.

Amblyops abbreviata
Amblyops kempii
Erythrops abyssorum
Erythrops microps
Mysidetes farrani
Parerythrops obesa
Pseudomma affine

Two other species, *Mysis gaspensis* and *Mysis stenolepis* were represented in catches; the former encountered accidentally along the shoreline of Moisie Bay and the latter (1 specimen) in a hyperbenthic collection from 146 m., well outside its known bathymetric range.

(2) The mysidacea are not well sampled as a component of the plankton. Although they may be found above the bottom itself, it is impractical to risk delicate zooplankton capturing equipment while attempting to make extended hauls just above the bottom. The exceptions would be for *Boreomysis arctica*, night sampling for *Mysis mixta*, and sampling in areas where the water column is homogeneous over distances of, perhaps, 100 meters or more.

Some form of near bottom sampling device is necessary in order to study in detail the majority of the mysid species of the Gulf of St. Lawrence.

(3) The relatively warm deep waters of the Laurentian Channel would appear to support populations of Boreomysis tridens, Amblyops abbreviata, Erythrops abyssorum, Mysidetes farrani, Pseudomma roseum, Boreomysis arctica, and possibly Amblyops kempii. These forms are all bathyal and hyperbenthic in distribution with the exception of Boreomysis arctica which appears to be more bathypelagic and possibly restricted in the extent of its vertical distribution by the physical nature of the water column.

The degree of penetration into the Laurentian Channel by some of these forms is uncertain and their occurrence in the Esquiman and Mingan Channels is completely unknown, with the exception of Boreomysis arctica which is thought to be restricted to the Laurentian Channel.

Further collections from the Laurentian Channel and the Mingan and Esquiman Channels would be desirable in order to qualify the populations of each species and estimate their relative and total contributions to the production of the community. In order to do so properly, each region of the Gulf would have to be studied separately at regular intervals in order to obtain data on population densities, seasonal fluctuations and life histories i.e. turnover rates of these animals in this little known zone. This is clearly a problem of great magnitude and one which is worthy of special consideration.

(4) The Gulf of St. Lawrence also has a slope fauna found along the margins of the Channels at depths where the boundary layer meets the bottom. The mysid fauna characteristic of this zone appears to consist of Parerythrops obesa, Erythrops microps, and

Figure 47

Summary of mysid species occurrence relative to water masses of the Gulf of St. Lawrence.

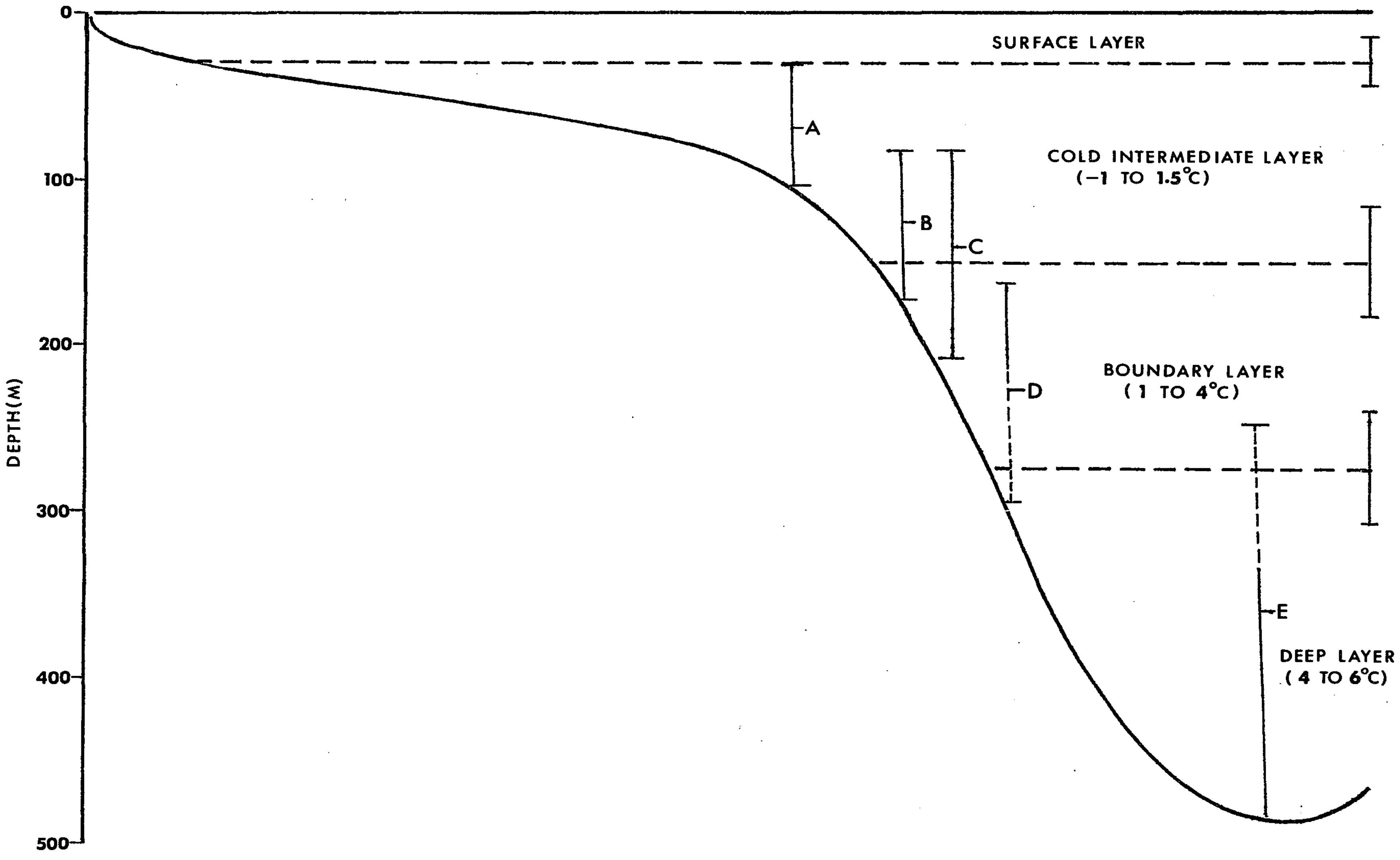
(A) *Mysis mixta*.

(B) *Meterythrops robusta*, *Pseudomma truncatum*, *Stilomysis grandis*.

(C) *Erythrops erythropthalma*.

(D) *Erythrops microps*, *Parerythrops obesa*, *Pseudomma affine*. (*Amblyops abbreviata*)?

(E) *Amblyops abbreviata*, *Amblyops kempii*, *Boreomysis arctica*, *Mysidetes farrani*, *Boreomysis tridens*, *Erythrops abyssorum*, *Pseudomma roseum*.


0
100
200
300
400
500
DEPTH(M)
SURFACE LAYER
A
B
C
COLD INTERMEDIATE LAYER
(−1 TO 1.5°C)
D
BOUNDARY LAYER
(1 TO 4°C)
E
DEEP LAYER
(4 TO 6°C)

Pseudomma affine. Erythrops erythropthalma, Meterythrops robusta, and Pseudomma truncatum are also found, at times, in this area; their occurrence likely depending upon the momentary physical characteristics. For Parerythrops obesa/ Meterythrops robusta, and Pseudomma affine/Pseudomma truncatum there appears to be a discontinuity in their relative bathymetric distributions but Erythrops erythropthalma seems to completely overlap in range with Erythrops microps.

This zone is particularly evident, in these collections, along the margin of the Magdalen Shallows and the west coast of Newfoundland. Additional sampling along the southern Laurentian Slope as well as along the eastern Esquiman Slope are necessary in order to better define the area. Very little information, other than mere occurrences, was obtained for these characteristic mysids which leaves open the possibility of much more detailed study of the zone, particularly towards the bottom of the Channel, in order to define its lower limits and the interaction of species from the slope zone and the deep zone.

(5) The Magdalen Shallows is the area with the cold intermediate layer at the bottom which received the most attention in this study. The three troughs at the extremities of the Shallows were characterized by Erythrops erythropthalma, Pseudomma truncatum and Meterythrops robusta. All three species had distributions determined by temperature, (salinity), and sediment type. Temperature and salinity defined the broad limits of their distributions while sediment type, particularly for Pseudomma truncatum, defined the areas of highest population densities.

Stilomysis grandis belongs in the cold intermediate zone but no details of its distribution are possible. None of the three former species showed strict temperature tolerances and, as was mentioned, occur into the upper boundary layer.

(6) Approximately 80% of the Magdalen Shallows is less than 80 meters in depth and over most of this area, Mysis mixta is the only sublittoral mysid species present. The Magdalen Shallows represents an area of very high productivity and a region where a large proportion of the gulf fisheries is carried on. An area of prime concern and one which would be well worthwhile approaching would be the estimation of the secondary production of this species in the Magdalen Shallows. Large concentrations of animals were encountered, estimated (on the basis of mouth area of the hyperbenthic sampler, towing time and ship speed) to range between 10 and 25 specimens / m^3 in some areas sampled. Brunel (1968) evaluates this species as being very important in the diet of cod, and presumably also of other groundfish species. If the species is present over large areas of the Shallows in concentrations approaching this order of magnitude, then the subject of its contribution is certainly worthy of further consideration.

(7) Boreomysis nobilis is a cold water relict form found in restricted areas of southern, eastern Canadian waters. The population structure appears to be very similar to that of more northerly populations and it seems that the species is very

sensitive to the physical nature of the waters which it inhabits. This is a subjective evaluation based on observations of its close resemblance in growth, maturity and life cycle at two spatially isolated areas. It is also likely to be restricted to the coastal fjords of southern Canadian waters by the magnitude of the homogeneity of the water column.

(8) Boreomysis tridens and Boreomysis arctica are morphologically more similar to one another than is either to B.nobilis. However, the two are distinct with respect to several morphological characters, which are evident in the young juveniles.

(1) the shape of the anterior margin of the carapace.
(2) the shape and armature of the telson
   (a) the width to length ratio
   (b) the relative depth of the cleft.
(3) the breadth of the cornea to the body size.
(4) B.arctica has one spine on the vertical surface of the statocyst while B.tridens has two.
(5) the length of the antennal scale to the total body length. It might be noted though that the difference in length of the antennular peduncle to that of the antennal scale is not a good distinguishing characteristic for the Gulf forms, as has been mentioned for B.tridens and B.arctica in the literature.

It might also be noted that the proportion of the unarmed portion of the outer margins of the exopods of the uropods of the two species does not serve as a good distinguishing characteristic.

It has been established that the shoulders of the carapace of

B.arctica become more prominent with age. The young have no shoulders as figured originally by Kroyer (1861) while the adults do.

Since B.arctica appears to be a sibling species of B.tridens, the relationship of B.tridens var. lobata to B.arctica could obviously be questioned.

The serial nature of the armature of the telson of B.arctica was also described and clarified.

In the light of the high degree of morphological similarity between B.tridens and B.arctica, the apparent vertical separation of the two species could qualify their many records of co-occurrence.

(9) The possibility exists that sternal processes are characteristic of the genus Erythrops rather than characteristic of several species of Erythrops only. It is too much of a coincidence that these protuberances should be characteristic of only Erythrops serrata, E.africana and the three Erythrops species of the Gulf of St. Lawrence. It is my contention that examination of many of the other species of the genus would probably reveal their presence and that an understanding of their functional significance would probably shed some light on the life styles of the Erythrops species.

(10) Pseudomma affine is most easily distinguished from Pseudomma roseum by the apical spination of the telson, the degree of denticulation of the lateral margins of the eyeplates, and the size maturity structure of their respective populations, a degree

of difference difficult to account for by differences in environmental characteristics of the deep layer and boundary layer (or slope zone).

(11) Amblyops abbreviata and Amblyops kempii were different in several ways from the type specimens of the eastern Atlantic.

(a) The shape of the anterior portion of the carapace of A.abbreviata.

(b) The relative proportions of the abdominal segments for each species.

(c) The ratios of the uropod length to the telson length for both species.

(d) The setae on the inner margins of the antennular peduncles.

(e) The spinules on the eyeplates which not a good distinguishing characteristic.

(f) Male A.kempii eyeplates possess projection mid-dorsally rather than antero-laterally.

(12) The life histories of E.erythropthalma, M.robusta, P.truncatum and M.mixta have been worked out for populations in the Gulf of St. Lawrence area. Present collections containing M.mixta easily lent themselves to the interpretation that two spatially separate and very distinct year classes exist in the populations of the Magdalen Shallows (as well as other areas e.g. Moisie Bay) with no summer recruitment occurring. Females were not found to carry eggs or embryos during the summer season

and therefore must breed in winter or spring. This supports the evidence of Poirier (1971) and Black (1956).

Boreomysis nobilis exhibits a two year life cycle with continuous breeding throughout the spring, summer and autumn but with a reduction in the number of offspring during the winter months.

The data concerning the life cyclesof *Pseudomma roseum* and *Boreomysis arctica* are inconclusive at best but considering that nothing is known of the dynamics of these populations, it was felt that what little data was available was worth discussing, at least minimally.

Pseudomma roseum is felt to exhibit a one year life span. The population consists of two overlapping classes interpreted as being a spring/summer and summer/fall brood. Each brood reproduces in the same season the following year and disappears from the population. This hypothesis is only tentative, as the data could lend themselves to other interpretations.

Boreomysis arctica is present in the summer months as two distinct cohorts. Due to the absence of large numbers of brooding females and very young juveniles through the sampling season, the species is thought to begin to breed in small numbers in mid-summer, reach a peak in the autumn and decrease again in the winter. The species likely has a two year life cycle.

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APPENDIX 1

IBP Zooplankton Stations: 1969,1970,1971.

Station	Longitude(W)	Latitude(N)	Depth(m)
1	60°15'00"	47°05'55"	150
2	59°57'35"	47°14'35"	400
3	59°39'00"	47°24'30"	450
4	59°25'30"	47°34'43"	300
5	58°22'20"	49°41'30"	75
6	58°41'45"	49°48'50"	150
7	59°04'40"	50°03'40"	250
8	59°29'00"	50°11'30"	100
9	61°30'30"	49°55'15"	75
10	61°35'00"	49°37'00"	250
11	61°38'30"	49°19'30"	75
12	63°23'30"	49°59'36"	125
13	65°37'14"	50°06'40"	150
14	65°34'00"	49°53'55"	175
15	65°32'30"	49°40'05"	250
16	65°32'25"	49°23'30"	300
17	64°36'20"	49°26'50"	300
18	63°37'40"	49°16'12"	250
19	63°46'20"	49°04'45"	350
20	64°02'00"	48°49'40"	100
21	63°20'55"	48°01'45"	75
22	62°37'00"	47°23'05"	50
23	62°00'00"	46°37'00"	50
24	61°54'50"	46°56'00"	50
25	62°55'33"	48°53'05"	350
26	61°48'05"	48°58'00"	100
27	61°30'20"	48°29'00"	400
28	61°17'00"	48°01'20"	75
29	60°59'40"	48°46'25"	150
30	60°16'40"	48°40'15"	250
31	59°34'00"	48°32'40"	75
32	63°09'30"	48°36'00"	240
33	67°19'05"	49°11'00"	320
34	67°33'00"	49°05'00"	300
127	64°21'00"	50°04'22"	150
128	64°05'15"	50°04'20"	113.4
129	63°49'15"	50°02'45"	82.3
130	63°33'00"	50°00'20"	131.0
131	63°26'55"	50°08'55"	49.4
132	66°47'30"	49°24'20"	278.0
133	66°06'00"	49°36'00"	329.2
134	63°27'00"	50°08'20"	54.9
135	66°40'20"	49°08'25"	146.3
136	66°41'50"	49°11'00"	-
137	66°43'10"	49°13'20"	-
138	66°44'10"	49°16'25"	-
139	66°45'10"	49°19'05"	-
140	66°46'05"	49°22'00"	292.6
141	66°46'50"	49°24'45"	-
142	66°48'00"	49°30'20"	-
143	66°47'50"	49°33'10"	-
144	66°48'00"	49°36'00"	-
145	66°49'20"	49°38'20"	-
146	66°50'30"	49°40'00"	219.5
147	66°50'20"	49°43'20"	-
148	66°51'30"	49°45'00"	-
149	66°52'30"	49°47'10"	-
150	66°52'52"	49°50'40"	-
151	66°54'00"	49°52'10"	-
152	66°54'30"	49°54'40"	102.4
153	63°20'30"	48°08'00"	78.7
154	63°22'40"	48°14'30"	85.0
155	63°22'30"	48°18'30"	87.8
156	63°23'30"	48°22'40"	87.0
157	63°23'00"	48°26'30"	112.0
158	63°22'40"	48°30'00"	122.0
159	63°25'00"	48°34'00"	140.0
160	64°15'30"	48°07'06"	21.0

contin'd...

Station	Longitude(W)	Latitude(N)	Depth(m)	Station	Longitude(W)	Latitude(W)	Depth(m)
35	67°51'30"	48°55'20"	300	161	62°43'00"	47°56'40"	74.0
36	68°20'20"	48°49'10"	370	162	62°28'00"	48°06'48"	74.0
37	63°00'00"	49°51'00"	200	163	63°09'00"	48°20'00"	53.0
38	62°28'00"	49°48'40"	220	164	64°01'00"	49°01'48"	308.8
39	60°15'00"	49°00'45"	275	165	66°18'12"	49°34'30"	335.0
40	64°35'50"	50°05'40"	125	166	62°43'30"	49°43'36"	52.0
41	59°59'00"	48°51'50"	328.5	167	59°20'24"	47°35'48"	226.0
42	59°39'40"	49°01'45"	307.2	168	58°35'00"	48°27'30"	99.0
43	59°36'00"	49°17'45"	256.1	169	59°30'00"	48°00'00"	166.0
44	59°26'00"	49°33'00"	241.3	170	58°51'00"	49°34'30"	145.0
45	59°11'45"	49°44'50"	245.1	171	59°54'42"	50°04'36"	137.0
46	59°19'00"	50°25'50"	91.5	172	60°14'00"	49°24'00"	274.0
47	58°49'30"	50°40'30"	113.0	173	66°44'45"	49°57'00"	-
48	57°56'10"	51°05'00"	157.3	174	57°45'30"	46°03'30"	490.0
49	57°04'50"	51°21'00"	82.3	175	56°54'30"	47°07'12"	321.0
50	57°00'00"	51°16'00"	65.0	176	58°04'00"	46°39'24"	457.0
51	56°54'50"	51°11'00"	53.2	177	58°39'00"	47°01'42"	453.0
52	57°10'15"	51°08'30"	76.9	178	59°09'30"	47°32'30"	100.0
53	57°28'30"	50°59'50"	84.2	179	59°04'30"	47°28'00"	270.0
54	57°31'00"	50°46'30"	148.1	180	58°56'30"	47°27'00"	210.0
55	57°43'00"	50°51'15"	68.5	181	58°58'00"	47°30'00"	172.0
56	57°55'00"	50°41'30"	-	182	58°58'00"	47°26'00"	267.0
57	58°02'45"	50°26'00"	288.9	183	58°46'36"	47°14'30"	413.0
58	57°52'30"	50°10'00"	183.0	184	58°38'00"	47°20'00"	175.0
59	58°16'30"	50°18'00"	320.0	185	58°39'00"	47°25'00"	164.0
60	58°31'30"	50°11'30"	-	186	58°32'00"	47°31'30"	192.0
61	58°43'30"	49°59'00"	223.0	187	58°26'00"	47°34'00"	200.0
62	62°46'55"	49°56'00"	219.5	188	58°18'30"	47°32'00"	223.0
63	63°57'25"	50°09'00"	105.0	189	58°22'30"	47°07'30"	411.0
64	66°00'10"	50°08'30"	146.0	190	58°52'24"	46°37'00"	419.0
65	64°26'00"	49°06'00"	244.7	191	57°31'00"	46°38'00"	-
66	64°20'20"	49°03'00"	-	192	59°33'00"	46°35'00"	-
67	64°15'30"	49°00'00"	-	193	59°25'00"	47°07'00"	-
68	64°11'00"	48°55'50"	-	194	59°43'40"	47°50'00"	-
69	64°05'50"	48°53'55"	-	195	59°45'00"	48°12'20"	-
70	64°00'30"	48°45'30"	-	196	58°57'00"	49°14'00"	-

contin'd...

Station	Longitude(W)	Latitude(N)	Depth(m)
71	63°59'00"	48°41'20"	-
72	63°57'30"	48°36'25"	54.9
73	63°55'45"	48°33'00"	-
74	63°55'00"	48°29'30"	-
75	63°55'00"	48°25'00"	-
76	63°55'30"	48°21'35"	106.0
77	63°54'30"	48°16'20"	-
78	63°55'30"	48°12'20"	-
79	63°53'00"	48°08'40"	69.5
80	63°50'20"	48°03'30"	-
81	63°47'00"	48°00'20"	-
82	63°43'00"	47°43'00"	67.7
83	63°36'00"	47°29'20"	65.9
84	63°33'00"	47°13'50"	56.7
85	63°34'40"	46°55'00"	47.6
86	63°36'30"	46°40'10"	-
87	60°56'00"	46°54'20"	135.3
88	60°34'00"	47°09'20"	171.9
89	60°29'00"	47°29'40"	142.6
90	60°43'20"	47°48'40"	110.6
91	61°37'00"	48°09'30"	137.1
92	62°03'40"	48°15'20"	118.8
93	62°33'30"	48°21'20"	160.9
94	62°59'20"	48°28'20"	210.0
95	63°25'20"	48°39'20"	160.3
96	64°01'00"	48°52'00"	-
97	63°59'40"	48°55'20"	-
98	63°58'00"	48°58'00"	-
99	63°57'20"	49°01'20"	-
100	63°55'40"	49°04'00"	-
101	63°54'30"	49°07'20"	384.1
102	63°53'30"	49°10'20"	-
103	63°52'10"	49°13'40"	-
104	63°51'30"	49°16'40"	-
105	63°50'30"	49°19'40"	-
106	63°50'00"	49°23'20"	-
197	58°34'40"	49°12'00"	-
198	58°27'30"	49°20'15"	-
199	58°21'00"	49°14'00"	-
200	60°10'30"	49°57'00"	-
201	62°20'50"	49°03'00"	-
202	62°17'00"	46°58'00"	-
203	63°00'00"	47°40'00"	-
204	66°16'00"	49°53'50"	-
205	66°20'00"	49°16'00"	-
206	65°56'00"	49°18'00"	-
207	65°11'30"	49°19'40"	-
208	66°24'15"	49°44'15"	-
209	65°05'30"	49°33'30"	-
210	65°05'10"	49°33'40"	-
211			
212	60°05'00"	47°48'20"	-
213	56°42'00"	51°30'00"	-
214	56°24'15"	51°38'30"	-
215	56°04'25"	51°45'35"	-
216	55°48'25"	51°55'15"	-
217	55°28'35"	52°04'50"	-
218	55°04'20"	52°04'40"	-
219	55°10'10"	51°50'00"	-
220	55°31'00"	51°42'05"	-
221	55°55'40"	51°44'20"	-
222	56°09'50"	51°39'50"	-
223	56°08'40"	51°33'10"	-
224	56°23'40"	51°33'25"	-
225	56°37'00"	51°24'10"	-
a	66°36'20"	49°53'15"	274.3
b	66°51'30"	49°42'00"	237.8
c	66°47'30"	49°27'40"	288.9
d	67°15'05"	49°16'10"	332.0
e	67°37'50"	49°12'12"	256.0
f	67°57'10"	49°05'10"	179.2
g	68°15'00"	48°56'50"	343.8

contin'd...

Station	Longitude(W)	Latitude(N)	Depth(m)	Station	Longitude(W)	Latitude(N)	Depth(m)
107	63°48'40"	49°37'00"	-	h	68°34'00"	48°49'10"	329.0
108	63°48'20"	49°30'20"	-	i	68°49'30"	48°38'10"	337.0
109	63°47'50"	49°34'10"	-	j	69°05'05"	48°38'15"	327.4
110	65°36'00"	49°16'40"	-	k	69°22'00"	48°18'35"	329.0
111	65°35'30"	49°20'20"	-	l	69°35'00"	48°07'20"	109.8
112	65°33'50"	49°27'40"	-	m	69°38'35"	48°00'50"	73.2
113	65°33'50"	49°31'30"	-	n	69°17'00"	48°12'30"	54.9
114	65°32'00"	49°35'30"	-	o	69°03'25"	48°21'25"	139.0
115	65°31'40"	49°37'40"	-	p	68°45'10"	48°32'30"	109.7
116	65°32'00"	49°42'20"	-	q	68°20'40"	48°39'50"	105.0
117	65°33'00"	49°45'20"	-	r	68°02'30"	48°46'15"	105.0
118	65°33'20"	49°50'30"	-	s	67°44'35"	48°51'30"	131.7
119	65°34'10"	49°57'50"	-	t	67°26'30"	48°56'10"	160.0
120	65°35'10"	50°01'30"	-	u	67°04'30"	49°01'00"	157.3
121	65°36'10"	50°04'00"	-	v	66°43'10"	49°07'30"	128.8
122	65°44'10"	50°07'20"	-	w	66°18'30"	49°13'10"	128.0
123	65°51'20"	50°07'30"	-	x	65°54'00"	49°16'00"	150.0
124	65°23'10"	50°05'30"	150.0	y	65°10'40"	49°16'00"	96.0
125	65°08'10"	50°05'50"	153.6	z	64°47'50"	49°13'00"	256.0
126	64°53'50"	50°03'36"	171.6				

APPENDIX 11

Data pertinent to Zooplankton collections in which mysids occurred.

STATION NO.	SAMPLE NO.	SAMPLE DEPTH	DATE	TEMPERATURE AT INITIATION PT.	SALINITY AT INITIATION PT.	SPECIES PRESENT	NUMBER OF SPECIMENS
1	554	170m.		/	/	E.microps	1
						P.obesa	1
2	003	384m.		/	/	B.arctica	13
	093	400m.	1/6/69	4.54C	34.77°/oo	B.arctica	6
	232	382m.	21/6/69	4.55C	34.71°/oo	"	1
	396	425m.	15/7/69	4.55C	34.78°/oo	"	3
	696	370m.	18/8/69	4.48C	34.67°/oo	"	3
3	103	450m.	1/6/69	4.78C	34.65°/oo	"	5
	104	450m.	"	"	"	"	2
						E.abyssorum	2
	238	420m.	21/6/69	4.58C	33.47°/oo+	B.arctica	2
	239	465m.	"	4.58C	33.47°/oo	"	6
						B.tridens	1
						E.abyssorum	1
	566	445m.	30/7/69	4.43C	34.80°/oo	B.arctica	6
						B.tridens	1
	969	388m.	24/9/69	4.55C	/	B.arctica	2
6	014	150m.	11/5/69	3.07C	33.49°/oo	E.erythropthalma	1
						M.mixta	1
9	596	72m.	5/8/69	0.19C	32.35°/oo	E.erythropthalma	1
11	463	75m.	21/7/69	0.54C	31.98°/oo	M.mixta	4
	465(H)	75m.	"	"	"	E.erythropthalma	3
13	618	180m.	6/8/69	2.22C	33.51°/oo	"	1
	619	175m.	"	"	"	"	1
	882	157m.	15/9/69	3.20C	33.83°/oo	"	1
15	050	250m.	17/5/69	/	34.20°/oo	B.arctica	1
	493(H)	239m.	22/7/69	2.85C	33.60°/oo	"	1
	630	270m.	8/8/69	4.15C	34.40°/oo	"	2
						B.tridens	1
	895	239m.	16/9/69	2.54C	34 °/oo+	B.arctica	1
16	325	323m.	30/6/69	4.28C	34.48°/oo	"	13
						B.tridens	1

Contin'd...

STATION NO.	SAMPLE NO.	SAMPLE DEPTH	DATE	TEMPERATURE AT INITIATION PT.	SALINITY AT INITIATION PT.	SPECIES PRESENT	NUMBER OF SPECIMENS
	326	323m.	30/6/69	4.28C	34.48°/oo	B.arctica	7
	327(H)	240m.	"	3.34-4.28C	33.99-34.48°/oo	"	9
	498	265m.	23/7/69	4.26C	34.45°/oo	"	1
16	636	240m.	8/8/69	3.38-4.00C	33.98-34.34°/oo	"	8
	786	323m.	28/8/69	/	/	"	1
	902	253m.	16/9/69	3.32-4.37C	34.01-34.53°/oo	"	2
17	181	300m.	12/6/69	4.31C	34.49°/oo	"	5
						E.abyssorum	1
	182	300m.	"	"	"	B.arctica	4
	502	344m.	23/7/69	4.47C+	34.54°/oo+	"	17
						B.tridens	1
	503	345m.	"	"	"	B.arctica	6
	505(H)	290m.	"	"	"	"	1
	643	200m.	9/8/69	3.88C	34.10°/oo	"	1
	644(H)	276m.	"	4.40C	34.52°/oo	"	8
	790	300m.	27/8/69	4.25C	34.24°/oo	"	4
	909	306m.	17/9/69	4.38C	34.52°/oo	"	5
	910	305m.	"	"	"	"	1
	911(H)	213-318m.	"	3.18-4.38C	33.88-34.52°/oo	"	7
18	648	250m.	9/8/69	4.40C	33.77°/oo	"	1
19	192	313m.	12/6/69	4.40C	34.42°/oo	"	5
	193	"	"	"	"	"	2
	346	312m.	1/7/69	4.28C	34.42°/oo	"	7
	347	355m.	"	4.43C	34.51°/oo	"	15
	348	320m.	"	4.28C	34.42°/oo	"	17
	517	319m.	24/7/69	4.32C	34.42°/oo	"	4
	654	340m.	10/8/69	4.45C	33.86°/oo	"	4
	655	345m.	"	"	"	"	4
	657(H)	285m.	"	4.33C	34.56°/oo	"	16
	802	340m.	27/8/69	5.13C	34.34°/oo	"	2
	803	200-335m.	"	3.41-5.13C	33.91-34.34°/oo	"	2
21	070	80m.	20/5/69	-0.25C	31.90°/oo	M.mixta	4
	072(H)	60m.	"	" +	" +	"	2
	074	85m.	"	-0.25C	31.90°/oo	"	19
						M.robusta	7
						P.truncatum	1
						E.erythropthalma	150

Contin'd...

STATION NO.	SAMPLE NO.	SAMPLE DEPTH	DATE	TEMPERATURE AT INITIATION PT.	SALINITY AT INITIATION PT.	SPECIES PRESENT	NUMBER OF SPECIMENS
	530	38m.	25/7/69	/	/	M.mixta	34
	531	47m.	"	0.02C	31.03°/oo	"	20
	532(H)	50m.	"	"	"	"	3
22	076	70m.	21/5/69	0.54C-	31.45°/oo-	"	1
	077	70m.	"	"	"	"	1
	537	64m.	25/7/69	-0.02C	31.53°/oo	"	1
	539(H)	48m.	"	0.12C	31.33°/oo	"	1
23	084	40m.	21/5/69	0.56C	/	"	14
24	551	40m.	25/7/69	2.36C	31.19°/oo	"	1
25	205	350m.	13/6/69	4.43C	34.56°/oo	B.arctica	4
						P.roseum	2
Bonne Bay east arm	117	205m.	3/6/69	-0.28C	31.76°/oo	B.nobilis	9
	426	210m.	18/7/69	-0.01C	31.70°/oo	"	32
						P.truncatum	3
	427	185m.	"	-0.16C	31.74°/oo	B.nobilis	4
						M.robusta	1
	432(H)	160-200m.	"	0.11to-0.16C	31.7-31.74°/oo	B.nobilis	19
16	1178	228m.	13/7/70	3.70C+	34.29°/oo+	B.arctica	1
17	1180	248m.	"	3.35-4.41C	34.11-34.81°/oo	"	3
18	1183	250m.	14/7/70	4.0C	33.80-34.50°/oo	A.abbreviata	1
22	1199	36m.	16/7/70	0.06C	31.81°/oo	M.mixta	2
	1289	45m.	26/8/70	0.20C	32.07°/oo	"	18
24	1055	40m.	4/5/70	0.05C	30.81°/oo	"	5
Bonne Bay east arm	1017	175m.	25/4/70	/	/	B.nobilis	4
	1143	194m.	4/7/70	0.50C	31.80°/oo	"	1
36	1164	222m.	12/7/70	/	/	B.arctica	3
40	1157	100m.	9/7/70	0.77C	32.53°/oo	E.erythropthalma	10
87	1099	118m.	12/6/70	/	33.40°/oo	"	1
D	1262	250m.	10/8/70	4.28C	/	B.arctica	1

Contin'd...

STATION NO.	SAMPLE NO.	SAMPLE SEPTH	DATE	TEMPERATURE AT INITIATION PT.	SALINITY AT INITIATION PT.	SPECIES PRESENT	NUMBER OF SPECIMENS
3	1385	456m.	10/4/71	4.50C+	34.54°/oo	<u>B.arctica</u>	1
17	1419	293m.	20/4/71	/	/	"	1
13	1423	150m.	21/4/71	2.46C	33.50°/oo	<u>E.erythropthalma</u>	5
133	1428	293m.	24/4/71	/	/	<u>B.arctica</u>	1
J	1443	243m.	27/4/71	3.50C	/	"	4
33	1465	294m.	3/5/71	3.0C+	/	"	3
16	1472	319m.	5/5/71	/	34.0°/oo+	"	1
83	1487	28m.	7/5/71	/	/	<u>M.Mixta</u>	9
85	1490	40m.	7/5/71	/	/	"	1
17	1514	337m.	16/5/71	/	/	<u>B.arctica</u>	7
19	1597	300m.	13/6/71	/	/	"	4
I	1611	299m.	16/6/71	/	/	"	1
K	1612	287m.	"	/	/	"	1
81	1638	80m.	21/6/71	/	/	<u>E.erythropthalma</u>	1
212	1655	475m.	12/7/71	/	/	<u>B.arctica</u>	3
35	1760	245m.	9/8/71	/	/	"	2
86	1788	10m.	13/8/71	/	/	<u>M.mixta</u>	34
23	1795	38m.	20/8/71	/	/	"	1
21	1808	82m.	21/8/71	/	/	"	5
163	1810	32m.	"	/	/	"	10
17	1818	248m.	22/8/71	/	/	<u>B.arctica</u>	3
K	1830	228m.	26/8/71	/	/	"	1
35	1840	220m.	27/8/71	/	/	"	1
						<u>E.erythropthalma</u>	1
82	1861	25m.	31/8/71	/	/	<u>B.mixta</u>	24
21	1809	85m.	21/8/71	/	/	"	12
						<u>E.erythropthalma</u>	3

Hawke Channel 53°23'00"N 54°39'00"W 7/11/65 Headrope tow 1.45C 273m. <u>P.truncatum</u> /

APPENDIX III

Data pertinent to Hyperbenthic Collections

* Estimated number of mysids in a collection appears below the number examined in a collection.

HB Station	Date 1970	Depth(m)	Longitude & Latitude	°C Temperature	°/oo Salinity	A.abbreviata	A.kempii	B.nobilis	B.tridens	B.arctica	E.abyssorum	E.erythrop	E.microps	M.farrani	M.mixta	M.robusta	P.obesa	P.affine	P.roseum	P.truncatum	S.grandis	Total mysids examined	Estimated total mysids
1	3-7	173	49°29'40"N 58°55'40"W	3.80	34.01							4 4											
2	3-7	/	49°43'50"N 58°32'10"W	/	/			Sampler didn't reach the bottom															
3	4-7	227	Bonne Bay east arm	0.50	34.80			80 80								1 1				2 2		83	83
4	5-7	209	49°54'50"N 58°47'50"W	/	/			Sampler didn't reach the bottom															
5	3-9	160	47°04'10"N 60°14'10"W	4.60	34.12								25 25				38 38	25 25				88	88
6	4-9	109	48°28'50"N 59°31'40"W	/	/			Sampler didn't reach the bottom															
7	4-9	168	49°16'25"N 59°02'55"W	/	/																	/	/
8	4-9	150	49°30'25"N 58°51'40"W	/	/							79 79				11 11				3 3		93	93
9	5-9	227	Bonne Bay east arm	0.45	31.85			113 452								1 4				3 12		117	468
10	6-9	200	49°40'00"N 58°45'20"W	/	/																	/	/
11	7-9	212	49°49'00"N 62°31'20"W	/	/																	/	/
12	7-9	160	49°59'00"N 63°23'30"W	/	/																	/	/

	HB Station	Date	Depth(m)	Longitude & Latitude	°C Temperature	°/oo Salinity	A.abbreviata	A.kempii	B.nobilis	B.tridens	B.arctica	E.abyssorum	E.erythrop	E.microps	M.farrani	M.mixta	M.robusta	P.obesa	P.affine	P.roseum	P.truncatum	S.grandis	Total mysids examined	Estimated total mysids
1970	13	8-9	146	50°04'30"N 64°32'30"W	1.65	33.10							179/179				19/19				14/14		213	213
	14	9-9	201	50°06'30"N 65°41'30"W	0.62- 1.50	32.54- 33.20							1/1								1/1		2	2
	15	9-9	128	50°12'30"N 65°57'00"W	1.30	32.38							418/418			182/182	26/26				7/7		633	633
	16	11-3	62	47°08'00"N 57°45'00"W																			/	/
	17	13-3	155	47°23'00"N 58°40'00"W	2.54	32.47								1/1			2/2						3	3
	18	14-3	264	47°27'00"N 58°55'30"W			Net torn(some samples)																/	/
	19	14-3	Net torn (no samples)																				/	/
1971	20	14-3	413	47°14'00"N 58°46'00"W	4.00	34.00	6/12	4/8		34/68		71/142			3/6					97/194			215	430
	21	15-3	173	47°25'00"N 57°00'00"W																			/	/
	22	15-3	173	47°30'00"N 58°42'00"W																			/	/
	23	15-3	202	47°32'00"N 58°34'00"W																			/	/
	24	16-3	209	47°33'00"N 58°24'00"W								1/1	7/7						1/1				9	9
	25	16-3	209	47°31'50"N 58°22'50"W								1/1	3/3										4	4

HB Station	Date 1971	Depth(m)	Longitude & Latitude	°C Temperature	°/oo Salinity	A.abbreviata	A.kempii	B.nobilis	B.tridens	B.arctica	E.abyssorum	E.erythrop	E.microps	M.farrani	M.mixta	M.robusta	P.obesa	P.affine	P.roseum	P.truncatum	S.grandis	Total mysids examined	Estimated total mysids
26	16-3	218	47°30!50"N 58°18!50"W									6/6						3/3				9	9
27	16-3	228	47°30!40"N 58°16!80"W			Sampler didn't reach bottom																/	/
28	16-3	222	47°33!10"N 58°14!80"W									1/1						4/4				5	5
29	16-3	222	47°31!50"N 58°18'00"W									1/1										1	1
30	17-3	402	47°07!30"N 58°25'00"W	4.47	34.00	19/38	17/34			1/2	13/26			4/8			1/2		65/130			120	240
31	17-3	417	46°49'00"N 58°41'00"W	4.47	34.00	4/4	4/4		7/7	1/1	6/6			5/5					32/32			59	59
32	17-3	413 (bottom)	46°35!50"N 58°47!50"W	4.47	34.00	didn't contact bottom				8/8												8	8
33	11-4	249	59°40'00"N 49°20'00"W			didn't contact bottom																/	/
34	15-4	100	49°41'00"N 58°22'00"W	0-.5	31.5- 32.20							7/14				1/2						8	16
35	16-4	183	49°48'00"N 58°42'00"W	4.61	33.7- 34.80							140/420	12/36			1/3	3/9					156	468
36	26-4	146	49°13'00"N 68°06'00"W	3.10	33.3- 34.10							93/372				16/64				2/8		111	444
37	3-5	150	49°11'00"N 66°29'00"W	2.80	33 - 34.00							12/15	1/1			5/6				2/3		20	25
38	5-5	164	49°18'00"N 65°25'00"W	3.30	33.3- 34.10							1/1	5/5				1/1					7	7
39	6-5	60- 80	48°33'00"N 63°59'45"W																			/	/

HB Station	Date 1971	Depth(m)	Longitude & Latitude	°C Temperature	°/oo Salinity	A.abbreviata	A.kempii	B.nobilis	B.tridens	B.arctica	E.abyssorum	E.erythrop	E.microps	M.farrani	M.mixta	M.robusta	P.obesa	P.affine	P.roseum	P.truncatum	S.grandis	Total mysids examined	Estimated total mysids
40	6-5	85-95	47°59'00"N 63°48'00"W	0 to -1	31. - 32.20							21/105				9/45				2/10		32	160
41	7-5	62-75	47°28'45"N 63°35'30"W	-.6	31 - 32.20							20/180			26/234	3/27						49	441
42	7-5	30	46°42'00"N 63°36'00"W	.5 Torn net small sample	32-32.7										42/42							42	42
43	12-5	133-135	46°50'00"N 60°54'00"W	2.5	33-34.00							25/75			3/9	6/18				1/3		35	105
44	13-5	78-98	46°48'00"N 62°03'00"W	.5 to 1.5	32-33.00							1/5			91/455							92	460
45	14-5	62-64	47°24'00"N 62°41'00"W	0 to -.5	31 - 32.20										180/12960							180	12960
46	16-5	164	48°39'00"N 63°31'00"W	N/A	/							4/14	2/7					4/14		2/7		12	42
47	16-5	379-382	49°12'00"N 64°08'00"W	4	33.7-34.80	didn't reach bottom				101/202												101	202
48	17-5	116-146	49°36'00"N 64°28'00"W	1.5 to 2	32.5-33.30							122/317			1/3	5/13				5/13		133	346
49	20-5	122	49°53'00"N 64°56'00"W	.5-1.00	32 - 32.70							20/40				23/46					3/6	46	92
50	31-5	166	50°03'00"N 64°17'00"W	N/A	N/A							201/603				5/15		28/84		2/6		236	708
51	1-6	142	49°52'20"N 61°32'00"W	2.45	33 - 34.00	Net torn small sample						43/43				2/2						45	45
52	2-6	110	49°35'80"N 58°7'50" W	1.8	32.80							2/2				1/1						3	3
53	11-6	59	46°58'00"N 62°17'00"W	-1.0-0	31 - 32.20										186/1116							186	1116

HB Station	Date 1971	Depth(m)	Longitude & Latitude	°C Temperature	°/oo Salinity	A.abbreviata	A.kempii	B.nobilis	B.tridens	B.arctica	E.abyssorum	E.erythrop	E.microps	M.farrani	M.mixta	M.robusta	P.obesa	P.affine	P.roseum	P.truncatum	S.grandis	Total mysids examined	Estimated total mysids
54	21-6	70	48°16'20"N 63°54'30"W	0 to 1.0	31.5-32.70							12/370			110/3388	1/30						123	3788
55	22-6	65	47°27'30"N 63°35'00"W	-.50 to 0	31 - 32.20										386/15440							386	15440
56	13-7	55	47°52'00"N 61°8'00"W	0.00	31.5 - 32.20										217/3472							217	3472
57			49°13'00"N 58°48'00"W	Net torn (no sample)																		/	/
58	31-7	132		1.80	32.5 - 33.30							12/48				1/4						13	52
59	19-8	119	47°04'00"N 60°52'00"W																			/	/
60	30-8	80	48°23'00"N 63°53'00"W	1.45	32.5 - 33.00										1/1	1/1						2	2
61	30-8	91.5	47°56'00"N 63°46'00"W	0.80	32 - 32.70							30/600			170/3400	1/20						201	4020
Total examined						29	25	193	41	111	92	1465	46	12	1595	141	43	66	194	42	6	4102	
Total estimated						54	46	532	75	213	176	3923	75	19	40702	360	50	131	356	86	9		46805

APPENDIX 1V

Cochran and Cox Significance Test

Exopod of Uropod (Length to Width)

A.abbreviata

$N = 9$

$\overline{X}_2 = 4.867$

$\sum (X-\overline{X}_2)^2 = 0.1992$

$S_{\bar{x}_2}^{\ 2} = 0.0027$

A.kempii

$N = 10$

$\overline{X}_1 = 5.775$

$\sum (X-\overline{X}_1)^2 = 0.3560$

$S_{\bar{x}_1}^{\ 2} = 0.0039$

$S_{\bar{x}_1-\bar{x}_2} = 0.08124$

$t = 11.18$ ($P > .001$)

APPENDIX V

Character Ratios for Boreomysis nobilis

No.	Body Width/Length	Antennal Scale Length to Body Length	Antennal Scale Width/ Length	Cornea Width to Body Length
1	0.1404E 00	0.2295E 00	0.2015E 00	0.5137E-01
2	0.1378E 00	0.2083E 00	0.1923E 00	0.4968E-01
3	0.1364E 00	0.2240E 00	0.1884E 00	0.4870E-01
4	0.1344E 00	0.2188E 00	0.1929E 00	0.5312E-01
5	0.1493E 00	0.2127E 00	0.2018E 00	0.5037E-01
6	0.1404E 00	0.2226E 00	0.1923E 00	0.5137E-01
7	0.1374E 00	0.2225E 00	0.1985E 00	0.5236E-01
8	0.1381E 00	0.2125E 00	0.2000E 00	0.5135E-01
9	0.1338E 00	0.2069E 00	0.2020E 00	0.4716E-01
10	0.1475E 00	0.2135E 00	0.2091E 00	0.5311E-01
11	0.1493E 00	0.2201E 00	0.2034E 00	0.5194E-01
12	0.1448E 00	0.2048E 00	0.1983E 00	0.5085E-01
13	0.1434E 00	0.2096E 00	0.2018E 00	0.5206E-01
14	0.1374E 00	0.2029E 00	0.2016E 00	0.5026E-01
15	0.1455E 00	0.2052E 00	0.2091E 00	0.5194E-01
16	0.1447E 00	0.2130E 00	0.1981E 00	0.4920E-01
17	0.1446E 00	0.1977E 00	0.2043E 00	0.5102E-01
18	0.1312E 00	0.1984E 00	0.2047E 00	0.4725E-01
19	0.1349E 00	0.2042E 00	0.2000E 00	0.5369E-01
20	0.1376E 00	0.2064E 00	0.2095E 00	0.5283E-01
21	0.1339E 00	0.1989E 00	0.2143E 00	0.5065E-01
22	0.1425E 00	0.2048E 00	0.1962E 00	0.5214E-01
23	0.1445E 00	0.2132E 00	0.1864E 00	0.5202E-01
24	0.1393E 00	0.2167E 00	0.1964E 00	0.5480E-01
25	0.1473E 00	0.2170E 00	0.2018E 00	0.5255E-01
26	0.1256E 00	0.2195E 00	0.2029E 00	0.5191E-01
27	0.1325E 00	0.2007E 00	0.2062E 00	0.4967E-01
28	0.1413E 00	0.2138E 00	0.1949E 00	0.5130E-01
29	0.1327E 00	0.1931E 00	0.2160E 00	0.5212E-01
30	0.1313E 00	0.2013E 00	0.1920E 00	0.5042E-01
31	0.1301E 00	0.2106E 00	0.1912E 00	0.4932E-01
32	0.1471E 00	0.2033E 00	0.1889E 00	0.5190E-01
33	0.1241E 00	0.1947E 00	0.2016E 00	0.4673E-01
34	0.1346E 00	0.2072E 00	0.1969E 00	0.4759E-01
35	0.1338E 00	0.2071E 00	0.1912E 00	0.5103E-01
36	0.1389E 00	0.2140E 00	0.1937E 00	0.5045E-01
37	0.1296E 00	0.2001E 00	0.1829E 00	0.5213E-01
38	0.1336E 00	0.1965E 00	0.1872E 00	0.5283E-01
39	0.1347E 00	0.2096E 00	0.1971E 00	0.5120E-01
40	0.1316E 00	0.2007E 00	0.1928E 00	0.4974E-01
41	0.1366E 00	0.2040E 00	0.2026E 00	0.5210E-01
42	0.1342E 00	0.2262E 00	0.2034E 00	0.5337E-01
43	0.1311E 00	0.2011E 00	0.2014E 00	0.5259E-01
44	0.1422E 00	0.2163E 00	0.1778E 00	0.5577E-01
45	0.1402E 00	0.2140E 00	0.1912E 00	0.5455E-01

Contin'd...

Telson Length to Body Length	Telson Width (Minimum) to Telson Length	Telson Cleft Depth to Telson Length	Uropodal Exopod Length to Body Length	Uropodal Exopod Width to Length
0.1969E 00	0.1670E 00	0.1795E 00	0.2140E 00	0.7840E 00
0.1635E 00	0.1882E 00	0.2024E 00	0.2019E 00	0.7857E 00
0.1818E 00	0.1971E 00	0.1757E 00	0.2143E 00	0.8333E 00
0.1812E 00	0.1945E 00	0.1738E 00	0.2281E 00	0.7740E 00
0.1810E 00	0.2128E 00	0.1781E 00	0.2220E 00	0.7983E 00
0.1712E 00	0.2112E 00	0.1920E 00	0.2055E 00	0.8500E 00
0.1931E 00	0.1912E 00	0.1790E 00	0.2094E 00	0.7734E 00
0.1717E 00	0.2029E 00	0.1979E 00	0.2178E 00	0.7805E 00
0.1735E 00	0.1735E 00	0.1735E 00	0.2111E 00	0.8119E 00
0.1786E 00	0.2087E 00	0.1878E 00	0.2368E 00	0.7869E 00
0.1828E 00	0.1959E 00	0.1812E 00	0.2276E 00	0.7951E 00
0.1766E 00	0.1872E 00	0.1728E 00	0.2189E 00	0.7823E 00
0.1801E 00	0.1959E 00	0.1861E 00	0.2224E 00	0.7603E 00
0.1718E 00	0.2057E 00	0.1874E 00	0.2078E 00	0.8268E 00
0.1791E 00	0.2000E 00	0.1900E 00	0.2183E 00	0.8034E 00
0.1809E 00	0.2080E 00	0.2080E 00	0.2191E 00	0.8257E 00
0.1807E 00	0.2033E 00	0.1920E 00	0.2105E 00	0.7778E 00
0.1625E 00	0.2077E 00	0.2077E 00	0.2031E 00	0.8077E 00
0.1687E 00	0.2072E 00	0.1971E 00	0.2077E 00	0.8291E 00
0.1730E 00	0.2127E 00	0.1800E 00	0.2142E 00	0.8073E 00
0.1725E 00	0.2146E 00	0.1976E 00	0.2131E 00	0.8095E 00
0.1870E 00	0.1966E 00	0.1783E 00	0.2137E 00	0.7833E 00
0.1951E 00	0.1911E 00	0.1689E 00	0.2240E 00	0.8306E 00
0.1800E 00	0.2013E 00	0.1858E 00	0.2245E 00	0.8103E 00
0.1831E 00	0.2035E 00	0.1826E 00	0.2209E 00	0.8018E 00
0.1892E 00	0.1855E 00	0.1815E 00	0.2258E 00	0.8239E 00
0.1759E 00	0.2202E 00	0.1976E 00	0.2132E 00	0.8058E 00
0.1739E 00	0.2150E 00	0.1900E 00	0.2246E 00	0.7984E 00
0.1617E 00	0.2149E 00	0.2221E 00	0.2003E 00	0.8434E 00
0.1681E 00	0.2000E 00	0.1900E 00	0.2101E 00	0.7917E 00
0.1781E 00	0.1846E 00	0.1569E 00	0.2192E 00	0.8125E 00
0.1730E 00	0.2100E 00	0.1920E 00	0.2163E 00	0.8000E 00
0.1665E 00	0.1992E 00	0.2038E 00	0.2104E 00	0.7910E 00
0.1664E 00	0.2145E 00	0.1940E 00	0.2125E 00	0.8000E 00
0.1686E 00	0.2191E 00	0.1983E 00	0.2144E 00	0.7949E 00
0.1764E 00	0.1991E 00	0.1838E 00	0.2196E 00	0.7778E 00
0.1734E 00	0.1846E 00	0.1952E 00	0.2134E 00	0.7857E 00
0.1749E 00	0.1996E 00	0.1942E 00	0.2103E 00	0.8037E 00
0.1740E 00	0.2013E 00	0.1910E 00	0.2171E 00	0.8017E 00
0.1743E 00	0.1992E 00	0.1766E 00	0.2171E 00	0.8030E 00
0.1815E 00	0.1979E 00	0.1831E 00	0.2208E 00	0.7797E 00
0.1879E 00	0.1959E 00	0.1812E 00	0.2262E 00	0.7712E 00
0.1688E 00	0.1991E 00	0.1940E 00	0.2173E 00	0.7769E 00
0.1803E 00	0.1973E 00	0.1867E 00	0.2163E 00	0.8056E 00
0.1856E 00	0.1959E 00	0.1812E 00	0.2197E 00	0.7931E 00

Cont in'd...

No.	Body Width/Length	Antennal Scale Length to Body Length	Antennal Scale Width/ Length	Cornea Width to Body Length
MEAN:	0.1378E 00	0.2093E 00	0.1981E 00	0.5130E-01
SUM:	0.6202E 00	0.9418E 01	0.8917E 01	0.2308E 01
VAR.:	0.3857E-04	0.7820E-04	0.6203E-04	0.3852E-05
ERR.:	0.8571E-06	0.1738E-05	0.1378E-05	0.8561E-07

Telson Length to Body Length	Telson Width (Minimum) to Telson Length	Telson Cleft Depth to Telson Length	Uropodal Exopod Length to Body Length	Uropodal Exopod Width to Length
0.1770E 00	0.2002E 00	0.1877E 00	0.2163E 00	0.7998E 00
0.7965E 01	0.9011E 01	0.8448E 01	0.9731E 01	0.3599E 02
0.6752E-04	0.1267E-03	0.1370E-03	0.5497E-04	0.4083E-03
0.1500E-05	0.2815E-05	0.3044E-05	0.1222E-05	0.9072E-05

Character Ratios for Boreomysis tridens

No.	Body Width/Length	Antennal Scale Length to Body Length	Antennal Scale Width/ Length	Cornea Width to Body Length
1	0.1462E 00	0.1769E 00	0.2267E 00	0.6840E-01
2	0.1435E 00	0.1690E 00	0.2466E 00	0.6481E-01
3	0.1544E 00	0.1618E 00	0.2727E 00	0.6706E-01
4	0.1449E 00	0.1648E 00	0.2648E 00	0.6250E-01
5	0.1447E 00	0.1645E 00	0.2784E 00	0.6474E-01
6	0.1468E 00	0.1579E 00	0.2700E 00	0.6316E-01
7	0.1444E 00	0.1406E 00	0.2800E 00	0.5437E-01
8	0.1607E 00	0.1500E 00	0.2571E 00	0.6429E-01
9	0.1574E 00	0.1556E 00	0.2490E 00	0.7405E-01
10	0.1500E 00	0.1352E 00	0.2796E 00	0.5656E-01
11	0.1384E 00	0.1696E 00	0.2368E 00	0.6920E-01
12	0.1435E 00	0.1644E 00	0.2434E 00	0.6111E-01
13	0.1475E 00	0.1675E 00	0.2537E 00	0.6840E-01
14	0.1484E 00	0.1693E 00	0.2462E 00	0.6750E-01
15	0.1552E 00	0.1469E 00	0.2676E 00	0.6621E-01
16	0.1484E 00	0.1667E 00	0.2325E 00	0.6625E-01
17	0.1477E 00	0.1619E 00	0.2611E 00	0.6273E-01
18	0.1518E 00	0.1479E 00	0.2754E 00	0.6214E-01
19	0.1586E 00	0.1702E 00	0.2740E 00	0.6604E-01
20	0.1645E 00	0.1579E 00	0.2417E 00	0.7170E-01
21	0.1636E 00	0.1582E 00	0.2759E 00	0.7690E-01
22	0.1685E 00	0.1658E 00	0.2675E 00	0.6652E-01
23	0.1563E 00	0.1719E 00	0.2473E 00	0.6875E-01

Contin'd...

Telson Length to Body Length	Telson Width (Minimum) to Telson Length	Telson Cleft Depth to Telson Length	Uropodal Exopod Length to Body Length	Uropodal Exopod Width to Length
0.1557E 00	0.2121E 00	0.2727E 00	0.2005E 00	0.7882E 00
0.1597E 00	0.2029E 00	0.2643E 00	0.1898E 00	0.8415E 00
0.1482E 00	0.2500E 00	0.2619E 00	0.2012E 00	0.8246E 00
0.1568E 00	0.2087E 00	0.2435E 00	0.1875E 00	0.8333E 00
0.1516E 00	0.2083E 00	0.2813E 00	0.1911E 00	0.8347E 00
0.1532E 00	0.2165E 00	0.2990E 00	0.1879E 00	0.7983E 00
0.1519E 00	0.2222E 00	0.2716E 00	0.1725E 00	0.8587E 00
0.1500E 00	0.2429E 00	0.2571E 00	0.1757E 00	0.8171E 00
0.1556E 00	0.2124E 00	0.2930E 00	0.1867E 00	0.8214E 00
0.1462E 00	0.2586E 00	0.3017E 00	0.1697E 00	0.8116E 00
0.1652E 00	0.1946E 00	0.2465E 00	0.1987E 00	0.8202E 00
0.1505E 00	0.1994E 00	0.2732E 00	0.1875E 00	0.8025E 00
0.1525E 00	0.1967E 00	0.2361E 00	0.1975E 00	0.7975E 00
0.1536E 00	0.1953E 00	0.2359E 00	0.2057E 00	0.8101E 00
0.1593E 00	0.2131E 00	0.3329E 00	0.1821E 00	0.8068E 00
0.1563E 00	0.1920E 00	0.2320E 00	0.1979E 00	0.8026E 00
0.1563E 00	0.1920E 00	0.2444E 00	0.1903E 00	0.8358E 00
0.1436E 00	0.2388E 00	0.3443E 00	0.1714E 00	0.8125E 00
0.1563E 00	0.2006E 00	0.2436E 00	0.1796E 00	0.8961E 00
0.1647E 00	0.2177E 00	0.2528E 00	0.2008E 00	0.8315E 00
0.1855E 00	0.2186E 00	0.2488E 00	0.1991E 00	0.8219E 00
0.1630E 00	0.2000E 00	0.2400E 00	0.2147E 00	0.7595E 00
0.1536E 00	0.2034E 00	0.2522E 00	0.2057E 00	0.7722E 00

Contin'd...

No.	Body Width/Length	Antennal Scale Length to Body Length	Antennal Scale Width/ Length	Cornea Width to Body Length
MEAN:	0.1515E 00	0.1606E 00	0.2586E 00	0.6580E-01
SUM:	0.3486E 01	0.3694E 01	0.5948E 01	0.1513E 01
VAR.:	0.6178E-04	0.1102E-03	0.2674E-03	0.2493E-04
ERR.:	0.2686E-05	0.4793E-05	0.1162E-04	0.1084E-05

Telson Length to Body Length	Telson Width (Minimum) to Telson Length	Telson Cleft Depth to Telson Length	Uropodal Exopod Length to Body Length	Uropodal Exopod Width to Length
0.1560E 00	0.2129E 00	0.2665E 00	0.1910E 00	0.8173E 00
0.3589E 01	0.4897E 01	0.6129E 01	0.4393E 01	0.1880E 02
0.7039E-04	0.3502E-03	0.9230E-03	0.1445E-03	0.7903E-03
0.3060E-05	0.1523E-04	0.4013E-04	0.6283E-05	0.3436E-04

Character Ratios for Boreomysis arctica

No.	Body Width/Length	Antennal Scale Length to Body Length	Antennal Scale Width/ Length	Cornea Width to Body Length
1	0.1450E 00	0.1525E 00	0.2361E 00	0.4800E-01
2	0.1400E 00	0.1525E 00	0.2282E 00	0.4920E-01
3	0.1518E 00	0.1468E 00	0.2483E 00	0.4615E-01
4	0.1442E 00	0.1454E 00	0.2698E 00	0.5077E-01
5	0.1403E 00	0.1494E 00	0.2623E 00	0.5265E-01
6	0.1419E 00	0.1569E 00	0.2514E 00	0.5259E-01
7	0.1576E 00	0.1335E 00	0.2784E 00	0.4359E-01
8	0.1428E 00	0.1451E 00	0.2710E 00	0.4494E-01
9	0.1502E 00	0.1429E 00	0.2685E 00	0.4884E-01
10	0.1422E 00	0.1348E 00	0.2880E 00	0.4824E-01
11	0.1406E 00	0.1380E 00	0.2626E 00	0.4500E-01
12	0.1418E 00	0.1466E 00	0.2754E 00	0.4846E-01
13	0.1394E 00	0.1490E 00	0.2555E 00	0.5077E-01
14	0.1406E 00	0.1354E 00	0.2677E 00	0.4500E-01
15	0.1425E 00	0.1500E 00	0.2240E 00	0.4680E-01
16	0.1368E 00	0.1627E 00	0.2296E 00	0.5094E-01
17	0.1394E 00	0.1563E 00	0.2437E 00	0.4731E-01
18	0.1701E 00	0.1367E 00	0.3056E 00	0.4557E-01
19	0.1457E 00	0.1304E 00	0.3167E 00	0.4681E-01
20	0.1401E 00	0.1336E 00	0.2857E 00	0.4491E-01
21	0.1389E 00	0.1597E 00	0.2435E 00	0.5222E-01
22	0.1444E 00	0.1471E 00	0.2657E 00	0.4790E-01
23	0.1406E 00	0.1458E 00	0.2657E 00	0.5000E-01
24	0.1419E 00	0.1544E 00	0.2632E 00	0.5259E-01
25	0.1410E 00	0.1543E 00	0.2566E 00	0.4979E-01
26	0.1388E 00	0.1433E 00	0.2483E 00	0.5165E-01
27	0.1408E 00	0.1500E 00	0.2682E 00	0.5324E-01
28	0.1363E 00	0.1672E 00	0.2511E 00	0.5679E-01
29	0.1346E 00	0.1368E 00	0.2977E 00	0.4976E-01
30	0.1426E 00	0.1660E 00	0.2625E 00	0.5477E-01
31	0.1451E 00	0.1411E 00	0.2790E 00	0.4669E-01
32	0.1460E 00	0.1437E 00	0.2756E 00	0.4789E-01
33	0.1389E 00	0.1481E 00	0.2756E 00	0.4842E-01
34	0.1389E 00	0.1490E 00	0.2766E 00	0.5026E-01
35	0.1513E 00	0.1490E 00	0.2761E 00	0.4995E-01
36	0.1509E 00	0.1563E 00	0.2566E 00	0.5043E-01
37	0.1426E 00	0.1530E 00	0.2833E 00	0.5161E-01
38	0.1551E 00	0.1574E 00	0.2840E 00	0.5345E-01
39	0.1495E 00	0.1454E 00	0.2726E 00	0.4812E-01
40	0.1418E 00	0.1602E 00	0.2597E 00	0.5420E-01
41	0.1412E 00	0.1491E 00	0.2695E 00	0.5397E-01
42	0.1484E 00	0.1500E 00	0.2884E 00	0.5095E-01
43	0.1460E 00	0.1380E 00	0.2604E 00	0.4715E-01
44	0.1404E 00	0.1449E 00	0.2981E 00	0.4839E-01
45	0.1495E 00	0.1348E 00	0.2646E 00	0.4569E-01
46	0.1411E 00	0.1487E 00	0.2685E 00	0.5202E-01
47	0.1574E 00	0.1511E 00	0.2856E 00	0.5311E-01

Contin'd...

Telson Length to Body Length	Telson Width (Minimum) to Telson Length	Telson Cleft Depth to Telson Length	Uropodal Exopod Length to Body Length	Uropodal Exopod Width to Length
0.1600E 00	0.1800E 00	0.1875E 00	0.1975E 00	0.7722E 00
0.1600E 00	0.1800E 00	0.1800E 00	0.1950E 00	0.7949E 00
0.1506E 00	0.1855E 00	0.2177E 00	0.1923E 00	0.7368E 00
0.1563E 00	0.1846E 00	0.2215E 00	0.1995E 00	0.7711E 00
0.1607E 00	0.1829E 00	0.2362E 00	0.1964E 00	0.7922E 00
0.1668E 00	0.1719E 00	0.2078E 00	0.2092E 00	0.8452E 00
0.1513E 00	0.1780E 00	0.2119E 00	0.1870E 00	0.7857E 00
0.1639E 00	0.1577E 00	0.2126E 00	0.1990E 00	0.8235E 00
0.1599E 00	0.1745E 00	0.2036E 00	0.1986E 00	0.8415E 00
0.1569E 00	0.1725E 00	0.1950E 00	0.1985E 00	0.8395E 00
0.1536E 00	0.1708E 00	0.1953E 00	0.1849E 00	0.7887E 00
0.1731E 00	0.1667E 00	0.1867E 00	0.2091E 00	0.8621E 00
0.1683E 00	0.1646E 00	0.1783E 00	0.2139E 00	0.7865E 00
0.1510E 00	0.1821E 00	0.2069E 00	0.1875E 00	0.8056E 00
0.1550E 00	0.1858E 00	0.2013E 00	0.1925E 00	0.8442E 00
0.1627E 00	0.1600E 00	0.2017E 00	0.2028E 00	0.8140E 00
0.1465E 00	0.1890E 00	0.2205E 00	0.2019E 00	0.8214E 00
0.1709E 00	0.2111E 00	0.2333E 00	0.2032E 00	0.8411E 00
0.1630E 00	0.1982E 00	0.1709E 00	0.1739E 00	0.8625E 00
0.1620E 00	0.2078E 00	0.1801E 00	0.1839E 00	0.8690E 00
0.1690E 00	0.1710E 00	0.1907E 00	0.2083E 00	0.7778E 00
0.1628E 00	0.1703E 00	0.2013E 00	0.1864E 00	0.9014E 00
0.1589E 00	0.1731E 00	0.1967E 00	0.2031E 00	0.8077E 00
0.1668E 00	0.1791E 00	0.2006E 00	0.2092E 00	0.8214E 00
0.1516E 00	0.1853E 00	0.2021E 00	0.1941E 00	0.7945E 00
0.1522E 00	0.2059E 00	0.2262E 00	0.1679E 00	0.8667E 00
0.1708E 00	0.1757E 00	0.2432E 00	0.2077E 00	0.8222E 00
0.1672E 00	0.1625E 00	0.2068E 00	0.2186E 00	0.8000E 00
0.1632E 00	0.2009E 00	0.2494E 00	0.2051E 00	0.7957E 00
0.1660E 00	0.1725E 00	0.1875E 00	0.2101E 00	0.8148E 00
0.1571E 00	0.1864E 00	0.1981E 00	0.1821E 00	0.7941E 00
0.1527E 00	0.1870E 00	0.1990E 00	0.1922E 00	0.8037E 00
0.1611E 00	0.1886E 00	0.2004E 00	0.2019E 00	0.7890E 00
0.1686E 00	0.1908E 00	0.1848E 00	0.2059E 00	0.8571E 00
0.1662E 00	0.1945E 00	0.1945E 00	0.1949E 00	0.8333E 00
0.1616E 00	0.1760E 00	0.1840E 00	0.2128E 00	0.3889E 00
0.1651E 00	0.1876E 00	0.1876E 00	0.2094E 00	0.8269E 00
0.1702E 00	0.1922E 00	0.1922E 00	0.2149E 00	0.8317E 00
0.1601E 00	0.1886E 00	0.1945E 00	0.2025E 00	0.8273E 00
0.1681E 00	0.1725E 00	0.2025E 00	0.2022E 00	0.3865E 00
0.1517E 00	0.1738E 00	0.2069E 00	0.1909E 00	0.3945E 00
0.1631E 00	0.2004E 00	0.1886E 00	0.1894E 00	0.8416E 00
0.1620E 00	0.1940E 00	0.1732E 00	0.1818E 00	0.8916E 00
0.1803E 00	0.1773E 00	0.1964E 00	0.2212E 00	0.7619E 00
0.1630E 00	0.1914E 00	0.2119E 00	0.1870E 00	0.8721E 00
0.1588E 00	0.1829E 00	0.1981E 00	0.1991E 00	0.8228E 00
0.1662E 00	0.1931E 00	0.2064E 00	0.1986E 00	0.8587E 00

Cont in'd...

No.	Body Width/Length	Antennal Scale Length to Body Length	Antennal Scale Width/ Length	Cornea Width to Body Length
MEAN:	0.1442E 00	0.1477E 00	0.2673E 00	0.4952E-01
SUM:	0.6777E 01	0.6943E 01	0.1256E 02	0.2328E 01
VAR.:	0.4273E-04	0.7636E-04	0.3754E-03	0.9429E-05
ERR.:	0.9091E-06	0.1625E-05	0.7988E-05	0.2006E-06

Telson Length to Body Length	Telson Width (Minimum) to Telson Length	Telson Cleft Depth to Telson Length	Uropodal Exopod Length to Body Length	Uropodal Exopod Width to Length
0.1616E 00	0.1825E 00	0.2015E 00	0.1984E 00	0.7932E 00
0.7597E 01	0.8577E 01	0.9472E 01	0.9324E 01	0.3728E 02
0.4851E-04	0.1534E-03	0.2955E-03	0.1291E-03	0.1251E-01
0.1032E-05	0.3264E-05	0.6288E-05	0.2746E-05	0.2662E-03

APPENDIX VI

Comparisons of the Ratios for the three species, using a Cochran & Cox t-test.

	B.nobilis to B.tridens	B.nobilis to B.arctica	B.tridens to B.arctica
Body Width/Length	-0.7289E 01	-0.4794E 01	0.3876E 01
Antennal Scale Length to Body Length	0.1904E 02	0.3357E 02	0.5092E 01
Antennal Scale Width/ Length	-0.1677E 02	-0.2261E 02	-0.1971E 01
Cornea Width to Body Length	-0.1341E 02	0.3322E 01	0.1436E 02
Telson Length to Body Length	0.9811E 01	0.9650E 01	-0.2766E 01
Telson Width (Minimum) to Telson Length	-0.2980E 01	0.7204E 01	0.7074E 01
Telson Cleft Depth to Telson Length	-0.1198E 02	-0.4515E 01	0.9530E 01
Uropodal Exopod Length to Body Length	-0.9212E 01	-0.8971E 01	0.2451E 01
Uropodal Exopod Width to Length	-0.2667E 01	0.3936E 00	0.1390E 01

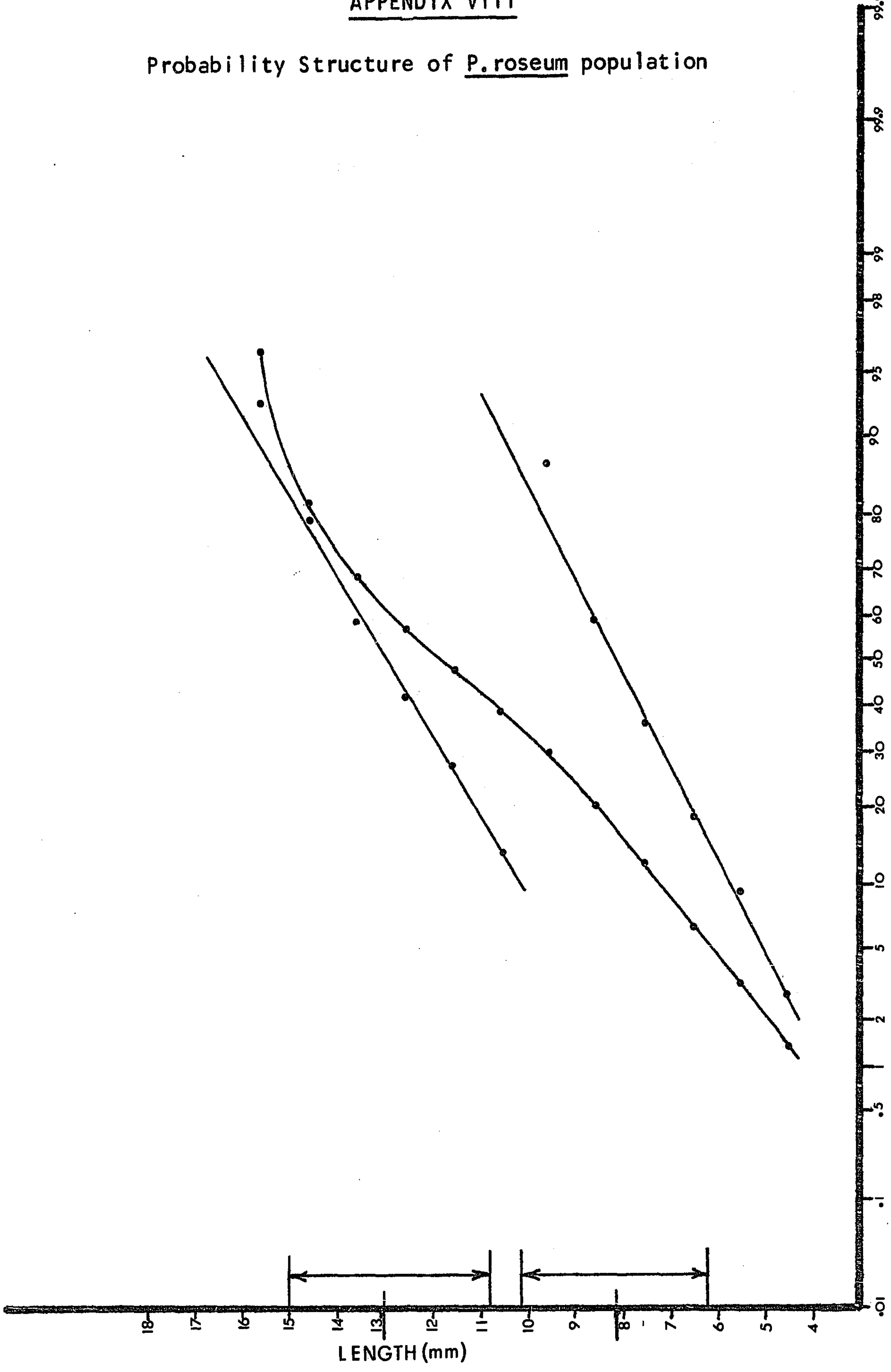
APPENDIX VII

Data for Lines describing principal axis plots (as per Sokol & Rolhf, .)

Character	Species	Var.	Lamda	B.Slope
Body Width/Length	B.nobilis	0.1171E 01	0.2110E 02	0.5596E 01
	B.tridens	0.4412E 01	0.6472E 02	0.6886E 01
	B.arctica	0.3508E 01	0.5218E 02	0.6788E 01
Antennal Scale Length to Body Length	B.nobilis	0.2379E 01	0.2193E 02	0.1117E 00
	B.tridens	0.6021E 01	0.6577E 02	0.9317E 01
	B.arctica	0.4091E 01	0.5252E 02	0.7891E 01
Antennal Scale Width/ Length	B.nobilis	0.1158E 00	0.1312E 01	0.8988E 01
	B.tridens	0.2639E 00	0.2426E 01	0.1116E 00
	B.arctica	0.1517E 00	0.1437E 01	0.1082E 00
Cornea Width to Body Length	B.nobilis	0.4622E 00	0.2088E 02	0.2216E 01
	B.tridens	0.2109E 01	0.6377E 02	0.3314E 01
	B.arctica	0.1291E 01	0.5135E 02	0.2519E 01
Telson Length to Body Length	B.nobilis	0.1839E 01	0.2149E 02	0.8726E 01
	B.tridens	0.4986E 01	0.6506E 02	0.7759E 01
	B.arctica	0.3992E 01	0.5246E 02	0.7704E 01
Telson Width (minimum) to Telson Length	B.nobilis	0.6023E 01	0.8395E 00	0.7281E 01
	B.tridens	0.1330E 00	0.1641E 01	0.8218E 01
	B.arctica	0.9240E 01	0.1315E 01	0.7101E 01
Telson Cleft Depth to Telson Length	B.nobilis	0.5554E 01	0.8369E 00	0.6727E 01
	B.tridens	0.1697E 00	0.1670E 01	0.1042E 00
	B.arctica	0.1263E 00	0.1338E 01	0.9637E 01
Uropodal Exopod Length to Body Length	B.nobilis	0.2166E 01	0.2174E 02	0.1020E 00
	B.tridens	0.6571E 01	0.6621E 02	0.1014E 00
	B.arctica	0.5343E 01	0.5345E 02	0.1022E 00
Uropodal Exopod Width to Length	B.nobilis	0.3978E 00	0.1662E 01	0.2983E 00
	B.tridens	0.1120E 01	0.4608E 01	0.3028E 00
	B.arctica	0.8184E 00	0.3664E 01	0.2895E 00

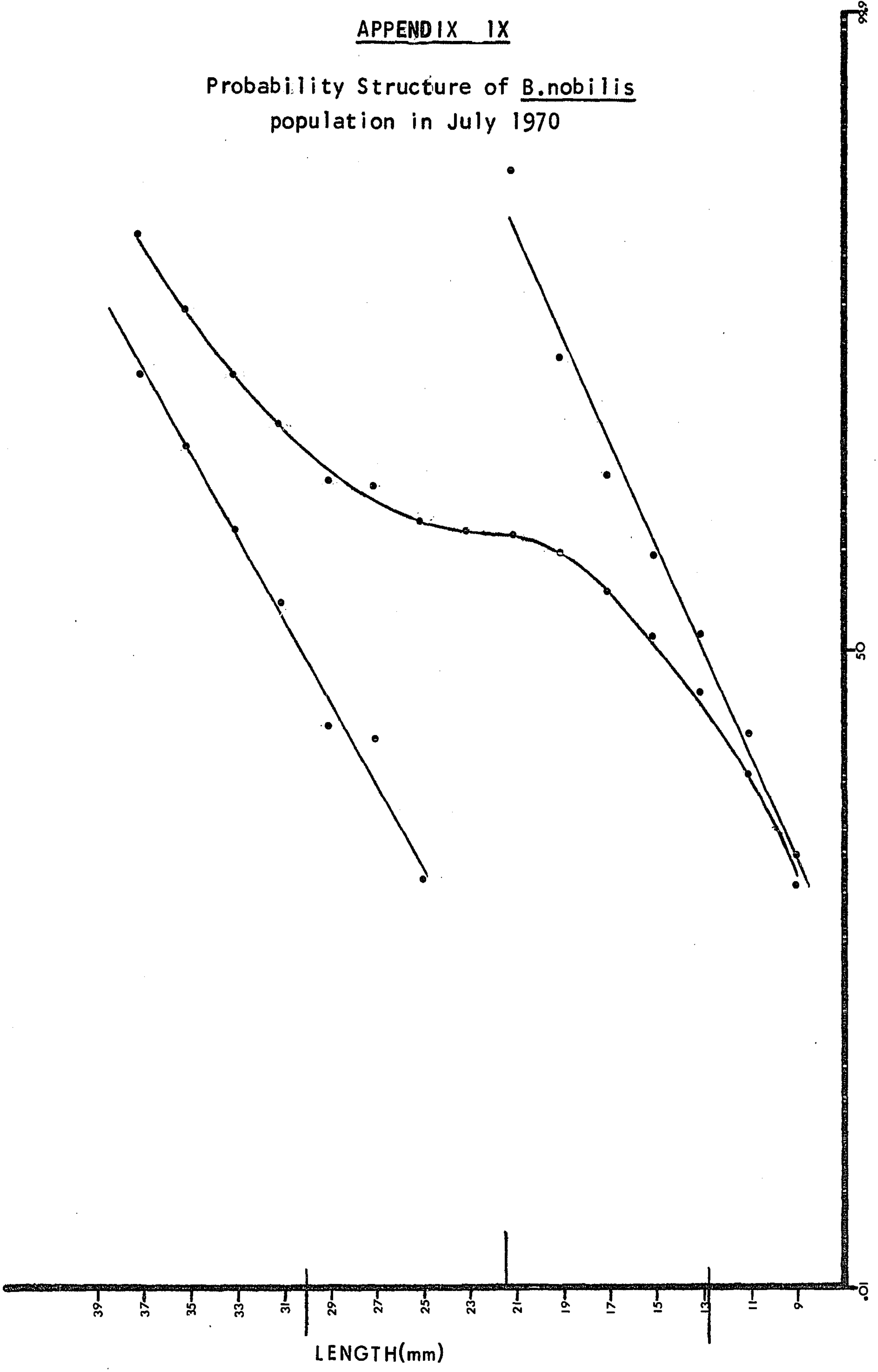
APPENDIX V111

Probability Structure of <u>P. roseum</u> population



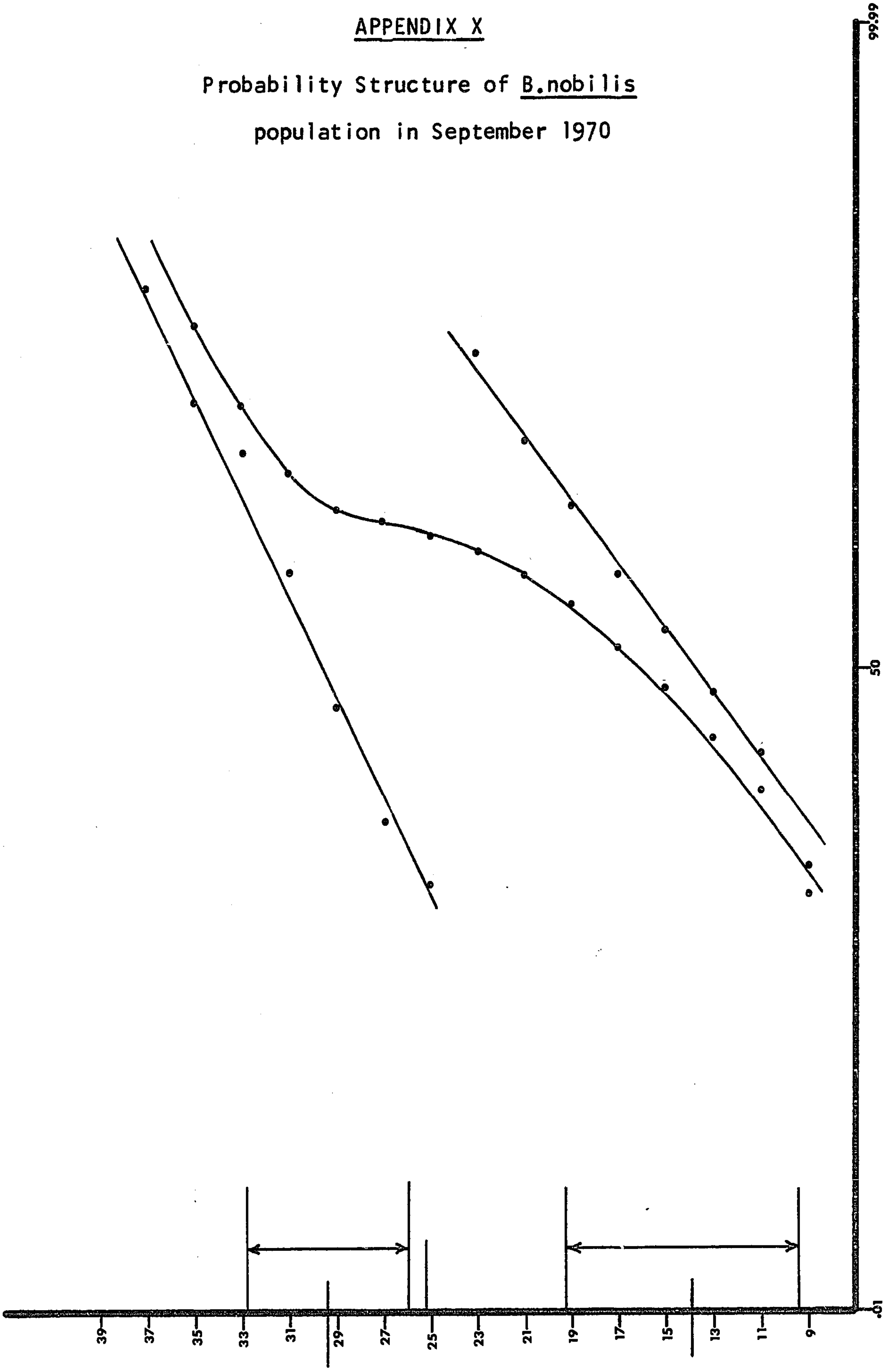
APPENDIX IX

Probability Structure of B.nobilis population in July 1970



APPENDIX X

Probability Structure of B.nobilis population in September 1970



APPENDIX X1

X^2-test with a Yates correction (Small N values) for difference between day and night collections of *Mysis mixta* in Magdalen Shallows, 1970.

	Mysids	No Mysids	
Night	7 (A)	2 (B)	9
Day	1 (C)	8 (D)	9
	8	10	18

$$X^2 = \frac{N(\left| AD - BC \right| - N/_2)^2}{(A+B)(C+D)(A+C)(B+D)}$$

$$= \frac{18\ (54 - 9)^2}{6480}$$

$$= 5.625$$

i.e. there is a significant difference at the .02 level.

APPENDIX XII

(B.arctica for zooplankton hauls 1969, 1970 & 1971)

Interval (m) from bottom	0-25	25-50	50-75	75-100	100-125	125 to surface
No. of individuals, correcting for sample split size	213.667	62	26.667	13	2	6
No. of samples initiated in the interval (with or without specimens)	54	30	19	12	8	35
Mean No. of specimens/haul	3.9567	2.0666	1.4035	1.0833	0.250	0.1714
No. of individuals per haul in each interval	1.8901	0.6631	0.3202	0.8333	0.0786	0.1714
°/o of total in each interval	47.77	16.76	8.09	21.06	1.99	4.33

* Due to the small number of specimens, these calculations serve only to indicate trends.

APPENDIX XIII

Raw data for depth-density graphs

(a) E.erythropthalma

HB Sample Number	Depth(m)	Total Number of Specimens	Minutes Towing at Depth	Number of Specimens/ Minute
1	173	4	32*	.125
8	150	79	32*	2.47
13	146	179	32*	5.6
14	201	1	32*	.03
15	150	418	60	6.9
24	209	7	20	.35
25	209	3	19	.16
26	218	6	17	.35
28	222	1	20	.05
29	222	1	15	.07
34	100	14	33	.42
35	183	420	50	8.40
36	146	372	29	12.83
37	150	15	26	.58
38	164	1	32	.03
40	90	105	52	2.02
41	70	180	26	6.92
43	135	75	32	2.34
44	85	5	26	.19
46	164	14	41	.34
48	125	317	35	9.06
49	122	40	34	1.18
50	166	603	37	16.30
51	142	43	35	1.23
52	110	2	51	0.04
54	70	370	37	10.0
58	135	12	29	1.66
61	91.5	600	17	35.29

* Based on average towing time.

Contin'd...

(b) E.microps

HB Sample Number	Depth(m)	Total number of Specimens	Minutes Towing at Depth	Number of Specimens/ Minute
5	160	25	45	.56
17	155	1	10	.10
35	183	36	50	.72
37	150	1	26	.04
38	164	5	32	.16
46	164	7	41	.17

(c) E.abyssorum

HB Sample Number	Depth(m)	Total number of Specimens	Minutes Towing at Depth	Number of Specimens/ Minute
20	413	142	20	7.1
24	209	1	20	.05
25	209	1	19	.05
30	402	26	22	1.18
31	417	6	20	.30

Contin'd...

E.erythropthalma

Appendix X111 Continued

Depth Interval	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240
No. of Specimens per minute	6.92 10.0	2.02 .19 35.29	.42 .04	2.34 9.06 1.18	2.47 12.83 .58 1.23 5.6	.03 .34 16.30 .125	8.40	.35 .16 .35 .03	.06
Mean Specimens per minute	8.46	12.50	.23	3.56	4.54	4.20	8.40	.22	.06
Moving Average	7.06	5.33	2.78	4.10	5.7	4.27	2.89	.09	.06

APPENDIX XIV

Raw data for density-depth histogram of M.mixta in the Magdalen Shallows.

HB Sample Number	Depth(m)	Total Number of Specimens (estimated)	Minutes Towing at Depth	Number of Specimens/ Minute
40	90	0	52	0.00
41	68	234	26	9.00
42	30	42	42	1.00
43	135	9	32	0.28
44	85	455	26	17.50
45	63	12,960	40	324.00
46	164	0	41	0.00
53	59	1,116	20	55.81
54	70	3,388	37	91.57
55	65	15,440	33	467.90
56	55	3,472	22	157.82
59	119	0	/	0
60	80	1	32	0.03
61	91.5	3,400	17	200.00