AN ECOLOGICAL STUDY OF SOME LITTORAL FRESHWATER MICROCRUSTACEANS (CLADOCERA AND COPEPODA) IN NEWFOUNDLAND

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AN ECOLOGICAL STUDY OF SOME LITTORAL FRESHWATER MICROCRUSTACEANS (CLADOCERA AND COPEPODA) IN NEWFOUNDLAND

by

© Rollin F. Daggett, B.Sc.

A Thesis
Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science in Biology

Memorial University of Newfoundland
St. John's, Newfoundland

August, 1973

ABSTRACT

Samples were obtained in the littoral region of 74 waters from various parts of the Province of Newfoundland and Labrador. The Cladocera and Copepoda found in the collections are listed. Sixty-two species were recorded which included 47 species of Cladocera and 15 species of Copepoda. Twenty-six species of Cladocera and 12 species of Copepoda represent new records for the Province. In addition, a new cyclopoid copepod species was described, *Paracyclops yeatmani* n. sp.

A quantitative study was made of the littoral microcrustaceans in a bog pond and a marsh located on the Avalon Peninsula from May, 1972 to May, 1973. The maximum standing stocks were similar in the two localities. The dominant forms in the summer and fall in the marsh were Cladocera: *Acantholeberis curvirostris, Biapertura intermedia, Chydorus sphaericus,* and *Ilyocryptus spinifer.* In the winter the copepod, *Macrocyclops albidus*, was dominant, while *Cyclops varicans rubellus* was the most abundant species in the spring. The bog pond also was dominated by Cladocera in the summer and fall; namely; *Acroperus alonoides, Alona rustica, Alonella excisa, Chydorus sphaericus,* and *Sida crystallina.* The copepods, *Eucyclops agilis* and *Macrocyclops albidus*, were dominant in the winter and early spring.

Qualitative seasonal succession and the relative abundance of Cladocera and Copepoda were studied in 10 waters on the Avalon Peninsula. This provided seasonal data for 38 species. Such studies showed that sampling on one date seldom revealed all species known for a particular water body.

Plant and microcrustacean associations were investigated. The results suggest that some microcrustaceans are associated with particular plant species (or types). Also, some Cladocera may utilize particular parts of a plant.

Observations were made on the feeding habits and predators of some littoral microcrustaceans.

ACKNOWLEDGEMENTS

The author is particularly indebted to Dr. Charles C. Davis, Professor at Memorial University, for his supervision and support throughout the course of this study. He also provided several samples which were used in this study.

Sincere thanks are extended to Dr. David G. Frey of Indiana University, Indiana, for verifying many of the cladoceran identifications, and to Dr. Harry C. Yeatman, University of the South, Sewanee, Tennessee, for confirmation of the copepod identifications.

My appreciation is extended to Drs. Cater W. Andrews and John Evans for reading the manuscript and making helpful comments.

Thanks are also extended to the following persons associated with the Department of Biology, Memorial University of Newfoundland: Dr. Guy Brassard for identification of bryophyte specimens; Mrs. Hilda Smith for verifying the vascular plant identifications; Dr. Don H. Steele for the sample from Labrador; Dr. V. J. Steele for translating several Russian papers; and Mr. Roy Ficken, photographer, for his assistance in the preparation of plates.

I wish to express my sincere thanks for fellowship assistance from Memorial University, and for research support from my supervisor's operating grant from the Canadian Fisheries Service, (St. John's Branch).

Finally, I wish to express my appreciation to my wife, Renee, who assisted me on numerous field trips and for typing the thesis.

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INTRODUCTION

Of the eight families of Cladocera, representatives of Sididae, Macrothricidae, Chydoridae, Polyphemidae, and certain species of Daphnidae are found primarily in the littoral zone of lakes and small bodies of water, especially amongst aquatic vegetation. On occasions limnetic species of Bosminidae and Daphnidae are collected in littoral habitats. From investigations in the Volga Reservoirs, Smirnov (1963a) found that littoral Cladocera constitute an essential part of the inshore invertebrate fauna in terms of their biomass. Of the three free-living suborders of Copepoda, the Cyclopoida and Harpacticoida are common littoral inhabitants. However, their population density is not usually high (Pennak, 1953).

The range of habitats of littoral microcrustaceans are quite diverse, including bottom substrates, plant-surfaces, the water column, or combinations of the three (Pennak, 1966). They play an important role in the biological transformations that take place in the littoral zone of lakes, ponds, and pools. Studies have shown that fish and numerous invertebrates (e.g., hydra, *Chaetogaster*, some copepods, and many aquatic insects) utilize Cladocera in their diet (Goulden, 1971). Since littoral Cladocera depend largely upon detritus as food, they help transform detritus at various stages of decomposition into animal food (Smirnov, 1969a). Littoral Copepoda represent trophic levels between bacteria, algae, detritus, and microscopic animals on the one hand, and fish and macroinvertebrates on the other (Pennak, 1953).

Another important characteristic of Cladocera is the persistence of their integuments in the sediments of lakes. Initial studies by Frey (1958, 1959) have stressed the importance of chydorid microfossils in determining the past history of a lake. However, Goulden (1971) emphasized that "the fossil record simply represents a picture of the outcome of species' relationships with the physical, chemical, and biotic environments." The interpretation of such paleontological studies requires a thorough understanding of the ecology of Cladocera. Recent works by Flössner (1964), Fryer (1968), Quade (1969), and Goulden (1971) have attempted to gain some insight into the relationships of Cladocera (Chydoridae) with their environment. It was the intent of this study to add more information to our incomplete knowledge of Cladocera. Copepoda were included because so little is known concerning their general ecology in littoral situations.

Distribution, community structure, qualitative and quantitative seasonal succession, plant and animal associations, and some behavioral aspects of littoral microcrustaceans were studied in Newfoundland waters. Only one previous study has been encountered that deals with littoral Cladocera from the island of Newfoundland (Smirnov and Davis, 1973). They reported 13 species or subspecies from six waters located on the Avalon Peninsula. Cushman (1908) reported on five samples from Labrador and one from Funk Island (approximately 59 km east of Newfoundland). Evidently there are no previous results dealing with littoral copepods in Newfoundland or Labrador. Any other reports of littoral microcrustaceans for Newfoundland are as tychoplankters, derived from plankton sampling (Frost, 1940; Megyeri, 1969; Davis, 1969a, 1972; Dadswell, 1970) There also has been very little study of littoral microcrustaceans anywhere in Canada. Here again, the species lists are mainly the results of their sporadic appearance in the plankton.

The littoral zone can be characterized as a heterogenous group of habitats which means the organisms are more than usually clumped. Difficulties are compounded because it is necessary to extract the animals from the other material one normally collects in a sample. This partially explains why there have been few studies dealing with the seasonal succession of littoral microcrustaceans. There appears to be no published studies that have dealt with the seasonal dynamics of littoral forms in Canada. Most of the previous quantitative work has been done in the United States (Ward, 1940; Pennak, 1966; Hall *et al.*, 1970; Gouldén, 1971; Keen, 1973), in England (Smyly, 1952, 1957), in Czechoslovakia (Straškraba, 1965), and in Russia (Smirnov, 1963a,b). Several of the above studies (Smyly, 1957; Hall *et al.*, 1970; Pennak, 1966; Straškraba, 1965) have included littoral copepods. In addition, Monakov (1968) dealt just with the dynamics of littoral copepods.

Much of the information concerning the substrates of littoral microcrustaceans can only be implied from the descriptions of sample localities (e.g., Bigelow, 1928; Sebestyén, 1948; Fryer, 1957a; Scourfield and Harding, 1958). However, several studies have investigated their relationships with particular substrates. Entz (1946) has studied the cladoceran fauna associated with the coatings of two plants, *Potamogeton perfoliatus* and *Myriophyllum spicatum*. Flössner (1964) sampled numerous substrates and found that many

Cladocera show preferences for particular plants or types of bottom. More recently, Quade (1969) has studied the affinities which some Cladocera show for particular plant-groupings in Minnesota lakes. Again, the data for littoral copepods is scarce. Much of the information must be taken from general descriptions of the animals' biology (Gurney, 1933; Rylov, 1948; Dussart, 1968). However, Lastochkin (1926) has studied the distribution of Cyclopoidae amongst various types of aquatic vegetation in several Russian lakes.

Some of the behavioral aspects (rate of defecation, food, mode of feeding) of chydorids (Cladocera) have been studied by Frey (1967) and Smirnov (1968, 1969a,b, 1971a). A recent paper by Fryer (1968) gives a thorough account of chydorid behavioral aspects and relates these to their mode of life and evolutionary development. Similar studies with Macrothricidae and Sididae are needed as there is little information available. Observations of feeding in several cyclopoid species have been made by Fryer (1957b,c) and Shcherbina (1970).

In view of the lack of information concerning littoral Cladocera and Copepoda in Newfoundland, this study represents an initial survey of their occurrence in various types of freshwater habitats. In addition, several localities in proximity to St. John's were chosen for more detailed studies to reveal some aspects of their ecology.

MATERIALS AND METHODS

Distribution

A total of 74 waters was sampled in order to describe the community structure and distribution of littoral microcrustaceans in the Province of Newfoundland and Labrador. The sampled waters included small pools, slow-moving streams, marshes, ponds, and lakes. The majority (59) were sampled only once in the period between July and September, 1972, and June and July, 1973. Three collections were made in July, 1971.[1] The remaining 12 waters, which were chosen to study seasonal succession, were sampled biweekly. The exact locations of the waters are described using the Canadian Topographic Maps,[2] which are based upon a grid system. Figure 1 shows the positions of the maps and Table 1 lists the number of waters sampled in the area depicted by each map. Each water also was assigned a number for future reference in this study (Table 1). Fifty of the waters were located on the Avalon Peninsula, 19 were from the West Coast of Newfoundland, four were from the central part of the island, and one was from Labrador.

Samples were collected with a small handnet (mesh aperture, 55μ; mouth diameter, 14 cm; net depth, 10 cm), while wading in the shallow waters of the study area. The net was dragged through a weedbed and the contents were preserved in 4-5% formaldehyde. In most instances, several samples were taken from each pond or pool,

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[1]Two samples (Table 1, No. 63 and 64) were collected by Dr. C. C. Davis and the other (Table 1, No. 74) by Dr. D. H. Steele.

[2]Produced by the Army Survey Establishment. Copies can be obtained from the Department of Mines and Technical Surveys, Ottawa.

Figure 1

Map of Newfoundland and Labrador showing the location of Canadian Topographic Maps in which samples were taken.

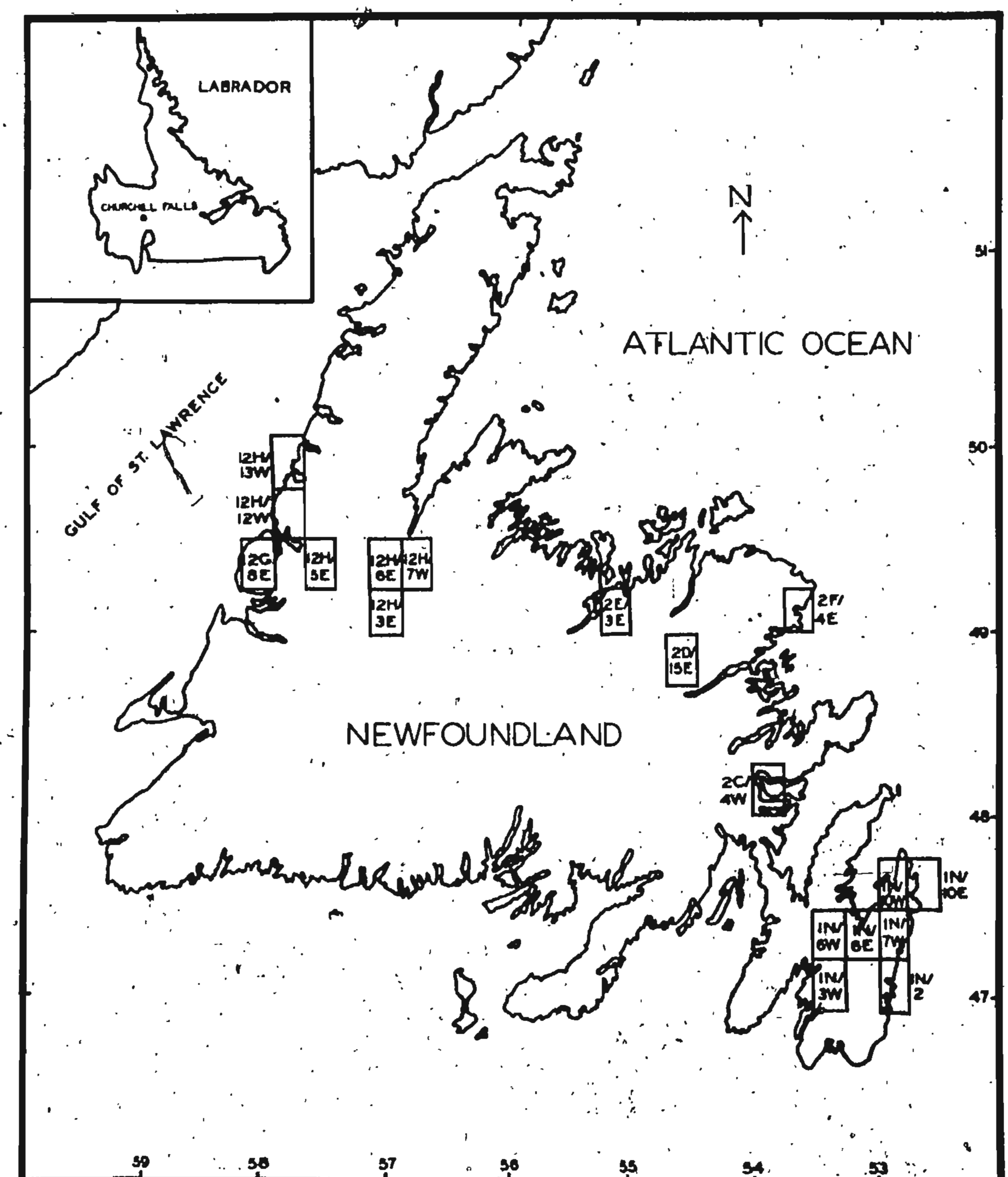
LABRADOR
CHURCHILL FALLS
N
ATLANTIC OCEAN
GULF OF ST. LAWRENCE
NEWFOUNDLAND
12H/ 13W
12H/ 12W
12G/ 8E
12H/ 5E
12H/ 6E
12H/ 7W
12H/ 3E
2E/ 3E
2D/ 15E
2F/ 4E
2C/ 4W
1N/ 10E
1N/ 6W
1N/ 6E
1N/ 7W
1N/ 3W
1N/ 2
51
50
49
48
47
59
58
57
56
55
54
53

TABLE 1

NUMBER DESIGNATION AND GRID LOCATION OF SAMPLED WATERS

– Name of water body not known

* Unofficial name of water body

Waters (Number Designation)	Name	Map Designation Easting x Northing
1	–	1N/2, 59.3 x 29.8
2	–	1N/2, 55.4 x 28.7
3	* La Manche Marsh	1N/2, 54.8 x 28.6
4	–	1N/2, 54.7 x 28.4
5	–	1N/3W, 25.2 x 34.6
6	–	1N/3W, 21.4 x 31.3
7	–	1N/6E, 30.7 x 42.6
8	–	1N/6E, 30.2 x 40.7
9	–	1N/6E, 46.7 x 49.4
10	–	1N/6E, 46.6 x 49.2
11	–	1N/6E, 46.6 x 49.1
12	–	1N/6E, 46.2 x 48.2
13	–	1N/6E, 47.9 x 48.2
14	–	1N/6E, 45.5 x 47.7
15	–	1N/6E, 35.9 x 54.0
16	–	1N/6E, 31.8 x 58.0
17	–	1N/6W, 29.3 x 40.0
18	–	1N/6W, 19.0 x 54.0
19	–	1N/6W, 16.2 x 54.8
20	–	1N/6W, 30.4 x 42.3
21	–	1N/6W, 14.8 x 54.6
22	–	1N/7W, 52.8 x 37.5
23	–	1N/7W, 53.3 x 37.5
24	–	1N/7W, 53.0 x 38.2
25	–	1N/7W, 52.8 x 37.9
26	–	1N/7W, 51.7 x 36.4

TABLE 1 (CONTINUED)

Waters (Number Designation)	Name	Map Designation, Easting x Northing
27	-	1N/7W, 62.8 x 41.0
28	-	1N/7W, 66.6 x 59.0
29	-	1N/7W, 61.8 x 39.9
30	-	1N/7W, 61.1 x 36.2
31	-	1N/7W, 59.8 x 42.8
32	Maggotty Pond	1N/7W, 62.1 x 40.1
33	-	1N/10E, 69.8 x 71.5
34	-	1N/10E, 71.4 x 72.6
35	-	1N/10E, 70.8 x 82.5
36	-	1N/10E, 70.9 x 82.6
37	-	1N/10E, 70.7 x 82.6
38	-	1N/10E, 71.1 x 82.9
39	Virginia Lake	1N/10E, 72.0 x 73.7
40	* Deadman's Pond	1N/10E, 74.4 x 75.3
41	Kenny's Pond	1N/10E, 70.9 x 72.0
42	Kent's Pond	1N/10E, 70.3 x 71.8
43	Long Pond (St. John's)	1N/10E, 69.5 x 70.5
44	* Larry's Bog	1N/10E, 70.0 x 71.3
45	Rocky Brook	1N/10W, 61.2 x 82.4
46	* Round Pond	1N/10W, 65.1 x 83.1
47	* Weiss Pond	1N/10W, 65.0 x 84.1
48	Bauline Long Pond	1N/10W, 63.5 x 70.6
49	Triangle Brook	1N/10W, 63.8 x 85.3
50	Round Pond	1N/10W, 63.3 x 74.0
51	-	2C/4W, 79.7 x 21.2
52	-	2D/15E, 67.9 x 26.0
53	-	2E/3E, 24.4 x 36.5
54	-	2F/4E, 17.5 x 55.7
55	-	12G/8E, 26.8 x 81.7

TABLE 1 (CONTINUED)

Waters (Number Designation)	Name	Map Designation, Easting x Northing
56	-	12G/8E, 26.8 x 81.6
57	-	12G/8E, 26.9 x 81.7
58	-	12H/3E, 86.7 x 48.0
59	-	12H/5E, 57.4 x 69.5
60	-	12H/5E, 52.8 x 70.2
61	Jack's Pond	12H/5E, 57.5 x 69.8
62	Bonne Bay Little Pond	12H/5E, 51.0 x 70.0
63	-	12H/6E, 99.7 x 68.0
64	-	12H/6E, 83.4 x 65.4
65	Sandy Lake	12H/7W, 5.4 x 59.8
66	-	12H/12W, 31.2 x 95.9
67	-	12H/12W, 32.4 x 8.9
68	Rocky Harbour Pond	12H/12W, 35.5 x 91.0
69	-	12H/13W, 38.4 x 19.9
70	-	12H/13W, 38.9 x 21.0
71	-	12H/13W, 40.2 x 22.2
72	-	12H/13W, 37.5 x 14.4
73	Western Brook River	12H/13W, 39.2 x 14.9
74	-	Churchill Falls, Labrador

especially if different plants were common, to increase the probability that most species present at that time had been collected. If the sample was unusually concentrated with mud or detritus, the smaller microcrustaceans were separated by a centrifugation technique described by Goulden (1971). A sucrose layer (density 1.2) was inserted below part of the concentrated sample in a 10 ml test tube and centrifuged for approximately 10 minutes. The upper water-formaldehyde mixture containing the animals was decanted off and examined under a dissecting microscope. The larger Cladocera were identified under a dissecting microscope. The smaller chydorid Cladocera and all Copepoda were identified under 100 and 400 magnification of a compound microscope. The entire sample was examined and the relative abundance of each species was estimated. Identification of and terminology for the Cladocera followed the keys of Brooks (1959) and Smirnov (1971c), except for the bosminids which were based on Deevey and Deevey (1971). In addition, Frey's (1959) description of head pores in the Family Chydoridae proved very useful. The identification of cyclopoid copepods followed the key of Yeatman (1959) while that of Yeatman and Wilson (1959) was used for the harpacticoids.

<u>Seasonal Succession - Qualitative</u>

The seasonal distributions of Cladocera and Copepoda were determined in 10 waters located on the Avalon Peninsula. Referring to Table 1, the number designations of the waters are 27, 29, 30, 33, 34, 40, 41, 43, 44, and 47. Samples were taken at two week intervals between May and November, 1972. The sampling procedure was similar to that described in the distribution study. The entire sample was examined and the relative abundance of each microcrustacean was recorded.

The results were given as follows: very abundant, +++; numerous, ++; low numbers, +; present but rare (+), or not present.

Seasonal Succession - Quantitative

Quantitative seasonal succession was studied in two waters, one a shallow bog pond (Round Pond) with weedy margins and the other a small marsh (La Manche Marsh), both located on the Avalon Peninsula. Samples were taken biweekly between May and November, 1972, once a month in December, 1972, through April, 1973, and twice in May, 1973.

Areas studied. Samples were taken in the eastern margins of Round Pond (Table 1, No. 46; Figs. 2, 3, and 4), a bog pond[1] located approximately 16 km northwest of St. John's and 4.8 km from the fishing village of Bauline. It is shown on Canadian National Topographic Map 1N/10W, grid reference:, easting 65.1, northing 83.1. Round Pond lies at an altitude of 156 m, and is oriented in a northwest-southeast direction, the long axis being approximately 162 m and the greatest width 95 m. It occupies a surface area of 2.1 ha. The 'weedy' area is quite extensive in July and August, when it covers approximately 1.0 ha. The plants are rather evenly mixed and include *Equisetum fluviatile* L., *Chara globularis* Thuill., *Drepanocladus revolvens* (SW.) Warnst, *Utricularia intermedia* Hayne, and *Potamogeton gramineus* L.

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[1]This terminology is based upon Welch (1952) who defined a "bog lake" as "An area of open water, commonly surrounded either wholly or in part, by true bog margin, possessing peat deposits about the margin, in the bottom, or both; usually with a false bottom composed largely of very finely divided, flocculent vegetable matter; containing considerable amounts of colloidal materials; and so constituted generally that in time it may become completely occupied by bog vegetation."

Figure 2

Aerial photograph showing Round Pond (B) in relation to Route 21 (A).

Figure 3

Map of Round Pond showing the general area sampled.

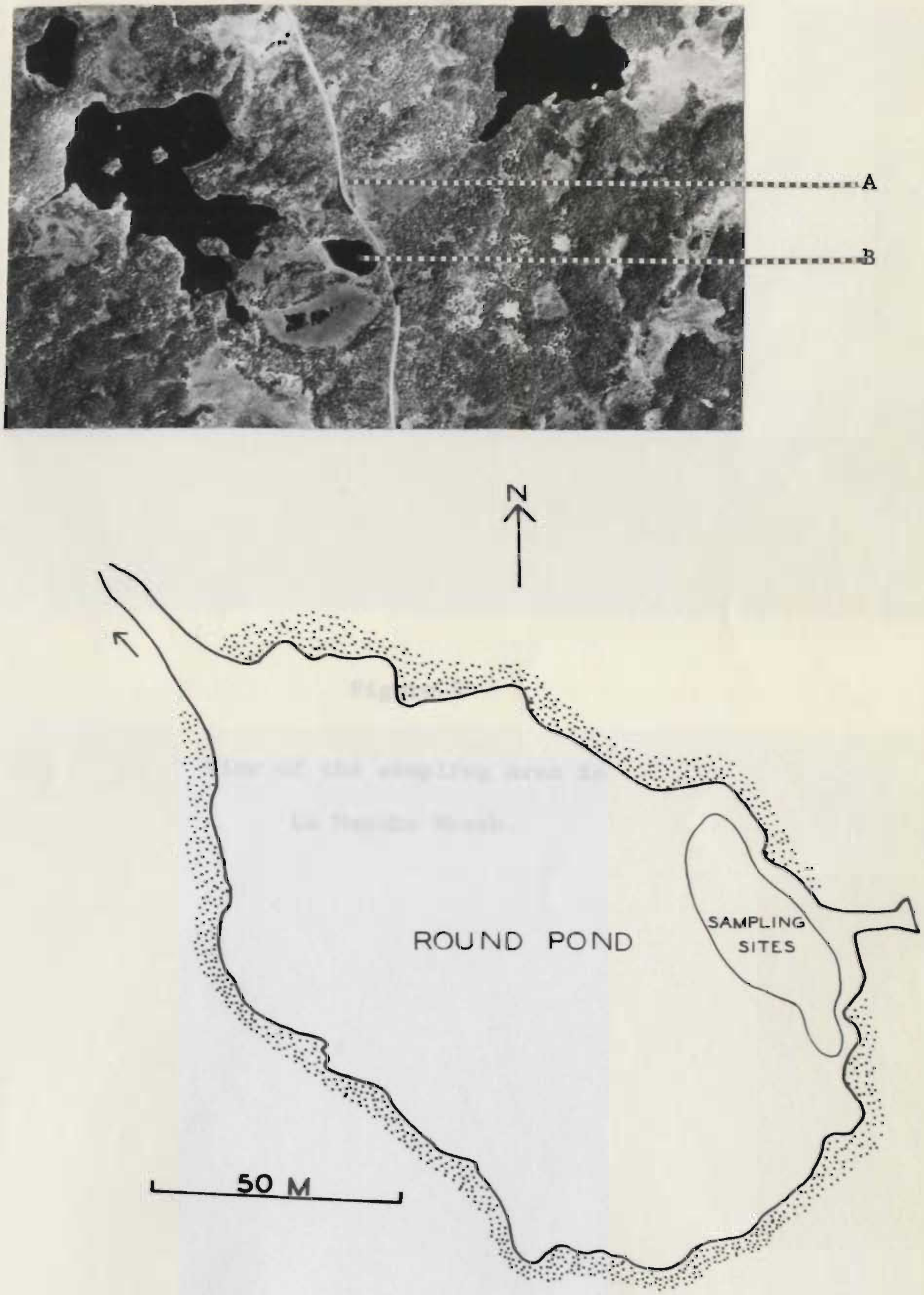
A
B
N
ROUND POND
SAMPLING SITES
50 M

Figure 4

View of the sampling area in Round Pond.

Figure 5

View of the sampling area in

La Manche Marsh.

In several sections on the northeast and west shores, *Menyanthes tripholiata* L. is dominant. The bottom is very soft and consists largely of organic material, high in peat content.

There appear to be no permanent streams which empty into Round Pond. Since much of the area adjacent to the west and south shores are bog, water is probably contributed by small springs (not permanent). An outlet at the northwestern end of the pond carries water to Bauline Rocky Pond.

The other study area was a small weedy marsh[1] located approximately 56 km south of St. John's and situated at an altitude of 45 m. It is not shown on the Canadian National Topographical Map series, but its location can be described on map 1N/2, grid reference 54.8 x 28.6 (Table 1, No. 3). It is difficult to demarcate the exact boundary of La Manche Marsh because of the thick *Carex* vegetation surrounding it. La Manche Marsh (Figs. 6 and 7) measures approximately 54 m north to south and 82 m east to west, and has a surface area of about 0.5 ha. Samples were taken along the east shore. Except for a small margin of open water which extends 0.5 to 3 m from the east shore and a small area near the middle of the marsh, the water is densely covered with vegetation (Fig. 5). The plants include *Nymphaea odorata* Ait., *Sphagnum majus* (Russow) C. Jens, *Potamogeton gramineus* L., *Utricularia intermedia* Hayne, and *Carex lasiocarpa* Ehrh. The bottom material consist

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[1]This terminology is based upon Damman's (1964) definition of a marsh (as reported by Pollett, 1968) "Rich sites covered with a high vegetation of sedges and grasses, a vegetation of periodically flooded alluvial soil or shore vegetation of nutrient rich ponds and lakes. This is a relatively rare habitat in Newfoundland."

Figure 6

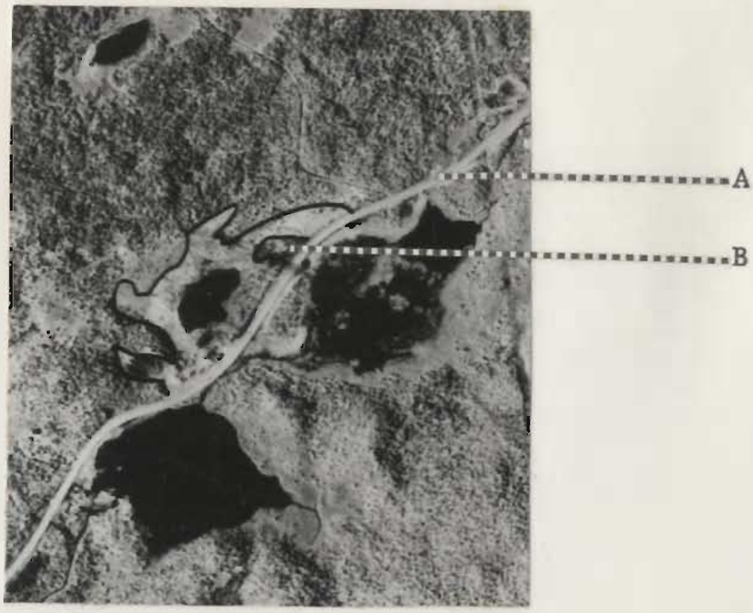
Aerial photograph showing La Manche Marsh (B)

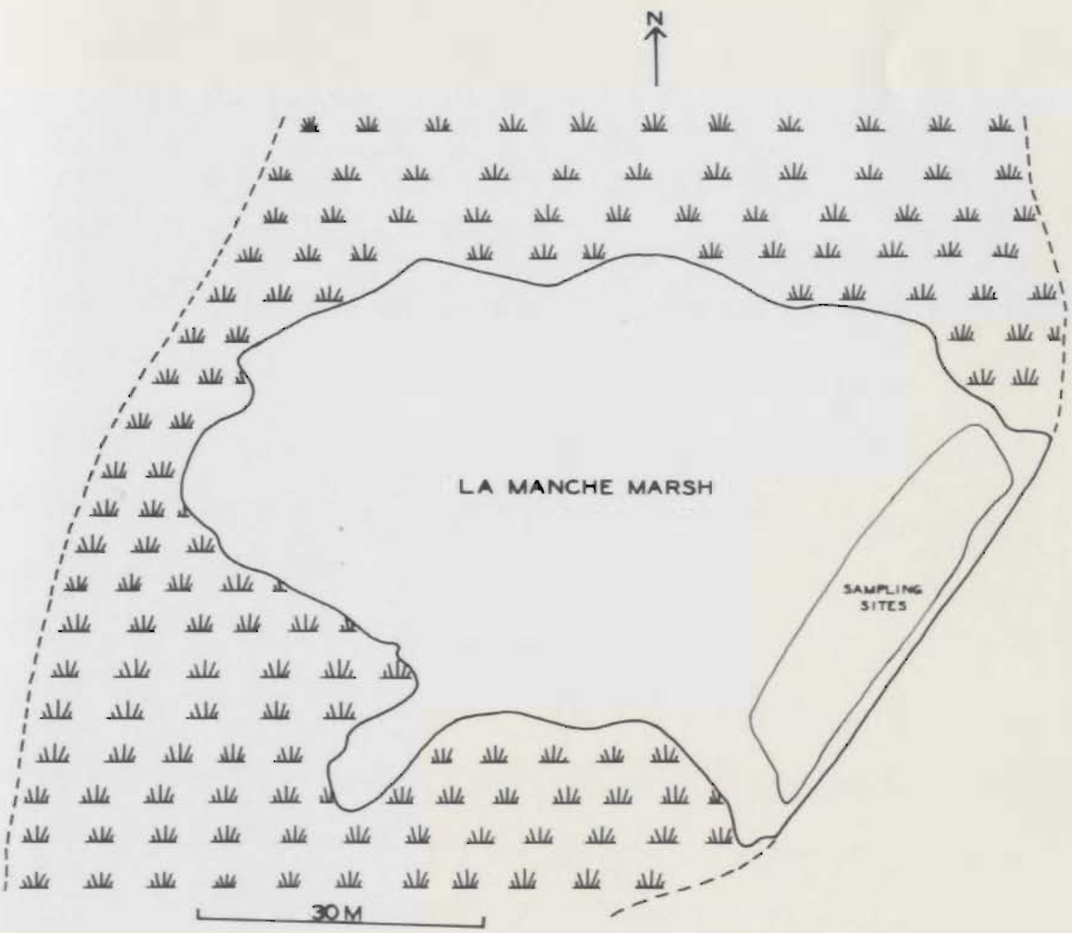
in relation to Route 5 (A).

Figure 7

Map of La Manche Marsh showing the

general area sampled.


A
B


N
LA MANCHE MARSH
SAMPLING SITES
30 M

of organic sediments (but no peat) and detritus. The bottom is soft, but there are a few rocks along the east shore.

The water table in La Manche Marsh is at or above the surface. It receives considerable drainage from the surrounding marsh area along the north, west, and south borders which comprise at least an additional 10 ha. The vegetation is much thicker in the surrounding area with no open water. There also is another large unnamed pond to the southwest which contributes water to the adjacent marsh area. The large weedy area to the east of La Manche Marsh (across Route 5) is a floating fen (F. Pollett, personal communication). It is probable that La Manche Marsh will eventually become a floating fen.

Sampling procedure. The method of quantitative sampling involved enclosing a 1/4 m^2 section of the littoral zone with a plexiglass container open at both ends (0.5 m x 0.5 m x 0.7 m). The enclosure was pushed several centimeters into the bottom mud at a random site in the weedy zone. Then, the water within the enclosure was swept with a handnet (mesh aperture, 55μ; mouth diameter, 25.5 cm; net depth, 21 cm). The contents were washed into collecting jars. This same procedure was repeated fifteen times to capture most of the animals within the enclosure. This mainly captured swimming species and plant-browsers, but inevitably some bottom forms were collected after they had been stirred up into the water column. Next, the plants within the enclosure were handpicked and placed in plastic bags. The contents of the bags and jars were immediately preserved in 4-5% formaldehyde.

The top two or three centimeters of bottom also were collected with a net. However, the frame of this net was a rectangle (26 cm x 14 cm). The net was dragged along the bottom. Then, a thin piece of metal was placed in front of the opening to contain the collected material. This material was placed in plastic bags and preserved. Later, the plants and bottom material were placed in a box with a 10 mm screen as its base. The contents were washed and some of the smaller particles and animals were caught by a 100μ mesh net which had been placed underneath the screen. In addition, the plants were separated by species and counted.

After the plants and bottom material had been removed from the enclosure, the water was swept at least five more times to capture any remaining animals. This meant that the enclosure was swept a total of 20 times for each site. This number was determined by taking 70 sweeps plus bottom samples for two sites in each water body. By counting the animals collected after every five sweeps, it was possible to determine the point at which almost all of the animals had been collected. Twenty sweeps captured a minimum of 88% and a maximum of 92%[1] of the animals that were captured after 70 sweeps. Considering the time it would require for 99% accuracy, the number 20 was chosen.

Collections were made in two 1/4 m^2 areas in each pond. The results were given as the average number of animals over one m^2 of bottom.

First, the preserved sample was poured into a large graduated

[1]Results of four sampling trials in early July, 1972.

cylinder and the volume was recorded. Then the sample was poured into a 1000 ml beaker and stirred thoroughly in an irregular pattern to achieve a random distribution. While stirring the sample, a 5 ml aliquot was removed with a calibrated pipette, whose tip had been cut off to make a 5 mm opening. The more abundant species were counted in 5 ml aliquots in a marked petri dish, until at least 20 ml had been examined. The number of individuals over one m^2 of bottom was found by the following procedure:

Subsample_A = Animals captured after 20 sweeps

Subsample_B = Animals from plant washings and bottom material

No. animals in $\text{Subsample}_{A \text{ or } B}$ =

$$\frac{\text{Total ml in subsample}}{\text{5 ml aliquot}} \times \frac{1}{\text{no. of aliquots}} \times \frac{1\ m^2}{0.25\ m^2}$$

No. animals over one m^2 = No. animals in Subsample_A + Subsample_B

The entire sample was examined for the less abundant and rare species. Since depths were taken, calculations of the numbers of individuals/m^3 were made for "swimming forms." "Swimming forms," as used here is in very broad terms, meaning plant or bottom browsers which can use the water column on occasion. The term only excludes those species which are confined to the bottom or plant surface (e.g. *Ilyocryptus spinifer* and *Chydorus piger*).

Several, chemical, physical, and biological parameters also were measured in the waters chosen for seasonal succession studies. Temperature, oxygen content, apparent color, and pH were measured on every sampling date. A Porto-Matic pH meter, model 175 was used to record the pH. Color units were obtained with a Hellige Aqua Tester

Colorimeter (APHA platinum-cobalt standard). Dissolved oxygen was determined by the Winkler Method. However, when the water was unusually high in suspended solids, the Alum-Flocculation step was added (American Public Health Association, 1971). In addition, depth, nature of the substratum, relative abundance of predators, and the common plants were recorded.

<u>Plant and Microcrustacean Associations</u>

Individual plant and animal relationships were studied to determine whether the microcrustaceans show affinities for particular aquatic macrophytes. Since a net usually fails to show such relationships (Quade, 1969), a plastic bag (34 cm x 32 cm x 56 cm) was carefully inverted over a single plant or stand. The relationship between plants and animals was shown by calculating percentage occurrence, which I defined as

$$\frac{\text{number of times an animal was collected on a plant species}}{\text{number of waters in which plant species occurred}} \times 100$$

This procedure involved 12 plant species or plant types (e.g. submerged grasses). The percentage occurrence of the animal on these plants was then compared. In addition, the relative abundance of microcrustaceans was noted. A large syringe was used to sample particular parts of a plant (upper or lower surface of leaves, upper or lower portion of the stem). The contents of the bags and the syringe were washed through a 55μ net. This material was examined under dissecting and compound microscopes. The relative abundance of species was recorded. Utilization of particular parts of a plant also was determined by observing live animals in a large Syracuse dish. Excessive illumination was avoided, and mud, detritus, and plant material were provided to meet the requirements of the animals.

Feeding Behavior and Important Predators

Observations were made concerning the feeding behavior and important predators of microcrustaceans. The animals were examined in a petri dish which was again provided with some mud, detritus, plant material and water from the animals' environment. Illumination was kept minimal. Gut contents of individual species were examined after dissecting an animal on a clean slide.

RESULTS

Species List

A total of 62 microcrustacean species was found in the 74 sampled waters. This included 47 species of Cladocera and 15 species of Copepoda. The species are shown in Table 2. One of the copepods, *Paracyclops yeatmani*, represents a new species. The description of this copepod is included at the end of the results. The common limnetic forms, *Daphnia catawba* Coker, *Diaptomus minutus* Lilljeborg, *Epischura nordenskiöldi* Lilljeborg, and *Eubosmina longispina* Leydig were included, since they were collected a number of times in the littoral zone of lakes or in small ponds. The bosminids presented some difficulties in their taxonomy. Most of the specimens seemed to compare closely with the characteristics listed for *E. longispina* by Deevey and Deevey (1971). However, few collections contained males, which are necessary for distinguishing species in *Eubosmina*. Specimens from several localities have been sent to Dr. V. Kořínek[1] to determine whether more than one species occurred in the sampled waters. Tentatively, all specimens were named as *Eubosmina longispina*.

Representatives of *Simocephalus*, *Scapholeberis*, and *Diaphanosoma* were keyed out according to the criteria given in Brooks (1959). However, it is recognized that these genera are presently being revised (Smirnov and Davis, 1973; Brandlova *et al.*, 1972).

The chydorid (Cladocera) listed as *Eurycercus* sp. (formerly *lamellatus*) is apparently the same species that occurs in New England

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[1]Charles University, Prague, Czechoslovakia.

TABLE 2

LITTORAL MICROCRUSTACEANS FOUND IN THE PROVINCE OF NEWFOUNDLAND AND LABRADOR

CLADOCERA (47 species)

Bosminidae:

Eubosmina longispina Leydig 1860

Chydoridae:

Acroperus alonoides Hudendorff 1876
A. (= Alonopsis elongata) elongatus (Sars) 1862
A. harpae Baird 1843
**Alona costata* Sars 1862
A. guttata Sars 1862
**A. quadrangularis* (O. F. Müller) 1785
**A. rustica* Scott 1895
**Alonella excisa* (Fischer) 1854
A. exigua (Lilljeborg) 1853
**A. nana* (Baird) 1850
**Biapertura affinis* (Leydig) 1860
**B. intermedia* Sars 1862
Camptocercus rectirostris Schoedler 1862
**Chydorus bicornutus* Doolittle 1909
**C. faviformis* Birge 1894
**C. ovalis* Kurz 1874
C. piger Sars 1862
C. sphaericus (O. F. Müller) 1785
Disparalona acutirostris (Birge) 1878
Eurycercus glacialis Lilljeborg 1887
**E.* sp. (formerly *lamellatus*)
Graptoleberis testudinaria (Fischer) 1848
**Kurzia latissima* (Kurz) 1874
**Pleuroxus denticulatus* Birge 1878
P. laevis Sars 1862

TABLE 2 (Continued)

Pleuroxus procurvus Birge 1878
P. trigonellus (O. F. Müller) 1785
Rhynchotalona falcata (Sars) 1861

Daphnidae:

**Ceriodaphnia quadrangula* (O. F. Müller) 1785
C. reticulata (Jurine) 1820
Daphnia catawba Coker 1926
**Scapholeberis aurita* (Fischer) 1849
**S. kingi* Sars 1903
Simocephalus serrulatus (Koch) 1841
**S. vetulus* O. F. Müller

Macrothricidae:

Acantholeberis curvirostris (O. F. Müller)
**Ilyocryptus spinifer* Herrick 1884
**Lathonura rectirostris* (O. F. Müller) 1785
Ophryoxus gracilis Sars 1861
**Parophryoxus tubulatus* Doolittle 1909
Streblocercus serricaudatus (Fischer) 1849

Polyphemidae:

Polyphemus pediculus (Linné) 1761

Sididae:

Diaphanosoma brachyurum (Liévin) 1848
**D. leuchtenbergianum* Fischer 1850
Latona setifera (O. F. Müller) 1785
Sida crystallina (O. F. Müller) 1785

TABLE 2 (Continued)

COPEPODA (15 species)

Calanoida:

Diaptomus minutus Lilljeborg 1889
Epischura nordenskiöldi Lilljeborg 1889

Cyclopoida:

**Cyclops nanus* Sars 1863
**C. varicans rubellus* Lilljeborg 1901
**C. venustoides pilosus* Kiefer 1934
**C. vernalis* Fischer 1853
**Eucyclops agilis* (Koch) 1838
**Macrocyclops albidus* (Jurine) 1820
M. ater (Herrick) 1882
**M. fuscus* (Jurine) 1820
**Orthocyclops modestus* (Herrick) 1883
**Paracyclops yeatmani* n. sp.
**Tropocyclops prasinus* (Fischer) 1860

Harpacticoida:

**Bryocamptus arcticus* (Lilljeborg) 1902
**Canthocamptus vagus* Coker and Morgan 1940

*New record for the Province of Newfoundland and Labrador.

and Indiana--not yet described (D. G. Frey, personal communication). Frey has found that the former species, *Eurycercus lamellatus*, comprises at least six different species and possibly more (personal communication). Problems also exist in the taxonomy of other Cladocera, especially Chydoridae. Most of the difficulty has resulted because there have not been adequate comparisons between North American and European specimens of the same species. Frey (1971a) stated that the "names proposed originally for populations occurring in Europe have often been applied rather carelessly to morphologically similar populations without the necessary documentation to show that they do in fact belong to the same morphospecies."

All of the cladoceran species were verified by Dr. D. G. Frey except *Alona guttata*, *Camptocercus rectirostris*, *Ceriodaphnia reticulata*, *Daphnia catawba*, *Diaphanosoma brachyurum*, *Eubosmina* spp., *Kurzia latissima*, *Polyphemus pediculus*, *Scapholeberis aurita*, *Sida crystallina* and *Simocephalus* spp. Representative specimens of the copepod species were verified by Dr. H. C. Yeatman except *Diaptomus minutus*, *Epischura nordenskiöldi*, *Macrocyclops ater*, and *Tropocyclops prasinus*.

Distribution and Community Structure

The occurrence of microcrustaceans, from the results of sampling 73 waters from various parts of the island, is shown in Table 3. In addition, one sample was examined from Churchill Falls, Labrador. General information describing the sampled waters is given in Appendix A. The mean microcrustacean community consisted of 8.5 species of Cladocera and 2.8 species of Copepoda. There were

TABLE 3

DISTRIBUTION OF LITTORAL MICROCRUSTACEANS IN 74 WATERS IN THE PROVINCE OF NEWFOUNDLAND AND LABRADOR

	MICROCRUSTACEA \ WATERS	1	2	**3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CLADOCERA	*Acantholeberis curvirostris*		+	+	+			+	+	+		+	+				+	+		+	
	Acroperus alonoides				+	+			+	+	+	+		+		+	+				
	A. elongatus																				
	A. harpae																				
	Alona costata		+		+									+	+						
	A. guttata					+			+	+				+							
	A. quadrangularis	+		+		+								+	+					+	
	A. rustica				+								+						+		
	Alonella excisa					+				+							+				
	A. exigua																			+	
	A. nana															+				+	
	Biapertura affinis			+							+	+		+					+	+	
	B. intermedia		+	+	+	+				+	+						+	+	+	+	
	Camptocercus rectirostris																				
	Ceriodaphnia quadrangula			+	+					+											
	C. reticulata															+	+				
	Chydorus bicornutus			+	+																
	C. faviformis														+						
	C. ovalis													+							
	C. piger			+				+													
	C. sphaericus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Daphnia catawba																				
	Diaphanosoma brachyurum			+	+					+				+				+			
	D. leuchtenbergianum															+	+				
	Disparalona acutirostris		+	+	+			+				+			+						
	Eubosmina longispina								+	+				+		+					
	Eurycercus glacialis										+				+						
	E. sp.								+	+								+	+		
	Graptoleberis testudinaria															+					
	Ilyocryptus spinifer			+	+											+	+	+			
	Kurzia latissima																				
	Lathonura rectirostris																				
	Latona setifera			+	+											+	+				
	Ophryoxus gracilis	+	+	+	+	+			+	+	+		+	+					+	+	
	Parophryoxus tubulatus																				
	Pleuroxus denticulatus																				
	P. laevis		+	+	+	+			+	+											
	P. procurvus													+		+			+		
	P. trigonellus								+												
	Polyphemus pediculus			+						+	+	+				+	+		+		
	Rhynchotalona falcata																				
	Scapholeberis aurita																				
	S. kingi			+	+	+		+													
	Sida crystallina	+							+											+	
	Simocephalus serrulatus	+				+		+	+												
	S. vetulus		+					+		+											
	Streblocercus serricaudatus			+	+								+					+		+	
COPEPODA	*Bryocamptus arcticus*			+																	
	Canthocamptus vagus																				
	Cyclops nanus				+																
	C. varicans rubellus		+	+	+									+	+						
	C. venustoides pilosus																				
	C. vernalis	+		+			+	+	+		+	+							+		
	Diaptomus minutus																			+	
	Epischura nordenskiöldi																+				
	Eucyclops agilis	+	+	+	+	+	+	+	+	+			+		+	+	+	+	+	+	
	Macrocyclops albidus	+		+	+				+	+		+	+	+		+	+	+	+	+	+
	M. ater																				
	M. fuscus			+											+	+					
	Orthocyclops modestus	+		+																	
	Paracyclops yeatmani n. sp.																				
	Tropocyclops prasinus																				

TABLE 3 (Continued)

Group	WATERS / MICROCRUSTACEA	21	22	23	24	25	26	*27	28	*29	*30	31	32	*33	*34	35	36	37	38	39	*40
CLADOCERA	*Acantholeberis curvirostris*	+	+	+	+			+	+	+					+			+			+
	Acroperus alonoides	+	+	+	+	+			+		(+)	+	+				+		+	+	(+)
	A. elongatus											+									
	A. harpae																				
	Alona costata					+															
	A. guttata										+	+	+			+					
	A. quadrangularis									+											+
	A. rustica					+				(+)		+		+						+	+
	Alonella excisa	+		+								+									
	A. exigua																				
	A. nana								+					+							
	Biapertura affinis	+	+	+	+	+		+				+		+	+			+	+		
	B. intermedia		+	+		+		+			+		+					+	+		
	Camptocercus rectirostris																				
	Ceriodaphnia quadrangula		+	+		+			+					+			+		+		+
	C. reticulata																				
	Chydorus bicornutus																				
	C. faviformis																				
	C. ovalis									+											+
	C. piger		+	+							+						+				
	C. sphaericus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Daphnia catawba			+																	
	Diaphanosoma brachyurum														+	+	+		+		
	D. leuchtenbergianum					+															
	Disparalona acutirostris	+		+				+		+	+				+					+	+
	Eubosmina longispina		+	+	+	+										+	+		+		
	Eurycercus glacialis												+								
	E. sp.								+				+								
	Graptoleberis testudinaria										+										
	Ilyocryptus spinifer						+	+								+		+			+
	Kurzia latissima																				
	Lathonura rectirostris																				
	Latona setifera				+												+				
	Ophryoxus gracilis		+	+	+	+		+		+	+	+	+	+			+		+	+	
	Parophryoxus tubulatus																				
	Pleuroxus denticulatus																				
	P. laevis		+							+	+	+							+		
	P. procurvus													(+)	(+)						
	P. trigonellus																				
	Polyphemus pediculus	+	+	+		+		+		+	+	+	+			+	+		+	+	+
	Rhynchotalona falcata																				
	Scapholeberis aurita										+										
	S. kingi								+					+	+			+			+
	Sida crystallina					+	+	+							+				+		
	Simocephalus serrulatus													(+)	(+)		+	+			(+)
	S. vetulus																+	+			
	Streblocercus serricaudatus			+				+		+								+			
COPEPODA	*Bryocamptus arcticus*		+							+											
	Canthocamptus vagus																			+	
	Cyclops nanus									+											
	C. varicans rubellus								+				+					+			
	C. venustoides pilosus									+											
	C. vernalis	+			+		+			+		+		+	+	+		+	+		+
	Diaptomus minutus	+			+												+			+	
	Epischura nordenskiöldi			+													+				
	Eucyclops agilis	+			+	+		+			+		+	+	+	+	+		+		+
	Macrocyclops albidus	+		+	+	+		+	+	+	+	+	+	+	+		+	+	+	+	+
	M. ater																				
	M. fuscus								+			+			+						
	Orthocyclops modestus																				+
	Paracyclops yeatmani n. sp.		+	+						+											
	Tropocyclops prasinus												+								

TABLE 3 (Continued)

	MICROCRUSTACEA \ WATERS	*41	42	*43	*44	45	**46	*47	48	49	50	51	52	53	54	55	56	57	58	59	60
CLADOCERA	*Acantholeberis curvirostris*				⊕								+		+						
	Acroperus alonoides	+		+		+	+	+	+	+	+			+							
	A. elongatus										+										
	A. harpae																+	+			+
	Alona costata							+													
	A. guttata	+		+					+												
	A. quadrangularis	+		+	+		+		+	+			+								
	A. rustica	⊕				+	+	+	+					+	+	+		+			+
	Alonella excisa						+														+
	A. exigua							+					+								
	A. nana	+			+		+									+		+			+
	Biapertura affinis		+	+	+	+	+		+	+	+	+	+	+						+	
	B. intermedia			+			+						+	+						+	
	Camptocercus rectirostris										+										
	Ceriodaphnia quadrangula	+		+			+														
	C. reticulata							+													
	Chydorus bicornutus																				
	C. faviformis																				
	C. ovalis																				
	C. piger						+	+												+	
	C. sphaericus	+	+	+	+		+	+	+	+	+	+	+		+	+	+	+	+	+	+
	Daphnia catawba					+		+	+		+										
	Diaphanosoma brachyurum																				
	D. leuchtenbergianum																				
	Disparalona acutirostris	⊕																		+	
	Eubosmina longispina			+			+	+	+												
	Eurycercus glacialis			+				+	+												
	E. sp.	+	+		+																+
	Graptoleberis testudinaria		+	+	⊕		+			+											
	Ilyocryptus spinifer						+								+					+	
	Kurzia latissima																				
	Lathonura rectirostris																				+
	Latona setifera							+									+				
	Ophryoxus gracilis			+			+		+	+	+			+							
	Parophryoxus tubulatus						+													+	
	Pleuroxus denticulatus																				+
	P. laevis			+					+	+											
	P. procurvus	⊕		⊕	⊕		+														+
	P. trigonellus						+														
	Polyphemus pediculus							+	+	+							+				
	Rhynchotalona falcata																				
	Scapholeberis aurita																				
	S. kingi			+			+														+
	Sida crystallina						+		+		+	+	+								
	Simocephalus serrulatus	⊕	+	+	+		+	+				+	+							+	+
	S. vetulus						+						+	+						+	
	Streblocercus serricaudatus							+													
COPEPODA	*Bryocamptus arcticus*																				+
	Canthocamptus vagus	+		+	+																
	Cyclops nanus														+						
	C. varicans rubellus									+			+		+						+
	C. venustoides pilosus																				
	C. vernalis	+		+	+						+					+		+			+
	Diaptomus minutus						+			+											
	Epischura nordenskiöldi						+				+										
	Eucyclops agilis	+	+	+	+		+	+	+	+	+		+	+			+			+	+
	Macrocyclops albidus	+	+	+	+		+	+	+	+		+	+				+		+	+	+
	M. ater				+		+														+
	M. fuscus							+													+
	Orthocyclops modestus																			+	
	Paracyclops yeatmani n. sp.																				
	Tropocyclops prasinus																				

TABLE 3 (Continued)

	MICROCRUSTACEA \ WATERS	61	62	63	64	65	66	67	68	69	70	71	72	73	74	Σ
CLADOCERA	*Acantholeberis curvirostris*				+					+			+			27
	Acroperus alonoides															31
	A. elongatus					+								+		4
	A. harpae					+			+	+		+	+	+	+	10
	Alona costata															6
	A. guttata															11
	A. quadrangularis		+						+	+	+			+		20
	A. rustica	+		+		+							+	+		24
	Alonella excisa	+					+									10
	A. exigua					+							+			5
	A. nana	+	+													12
	Biapertura affinis						+			+	+					32
	B. intermedia						+									24
	Camptocercus rectirostris															1
	Ceriodaphnia quadrangula							+								15
	C. reticulata						+		+	+		+				7
	Chydorus bicornutus														+	3
	C. faviformis															1
	C. ovalis				+											4
	C. piger									+						10
	C. sphaericus	+	+	+	+			+	+	+	+	+	+	+	+	70
	Daphnia catawba	+		+							+	+			+	10
	Diaphanosoma brachyurum			+											+	11
	D. leuchtenbergianum													+		4
	Disparalona acutirostris			+	+	+				+						20
	Eubosmina longispina		+							+	+				+	19
	Eurycercus glacialis															6
	E. sp.			+		+						+				13
	Graptoleberis testudinaria	+	+											+	+	11
	Ilyocryptus spinifer			+												14
	Kurzia latissima					+										1
	Lathonura rectirostris															1
	Latona setifera				+											9
	Ophryoxus gracilis			+		+				+		+			+	36
	Parophryoxus tubulatus					+				+						4
	Pleuroxus denticulatus		+						+	+				+		5
	P. laevis															14
	P. procurvus		+													11
	P. trigonellus															2
	Polyphemus pediculus			+						+			+			28
	Rhynchotalona falcata												+	+		2
	Scapholeberis aurita															1
	S. kingi				+			+								14
	Sida crystallina	+	+	+		+							+	+		19
	Simocephalus serrulatus							+				+				21
	S. vetulus	+								+		+				12
	Streblocercus serricaudatus															10
COPEPODA	*Bryocamptus arcticus*												+	+		6
	Canthocamptus vagus															4
	Cyclops nanus															3
	C. varicans rubellus	+					+									14
	C. venustoides pilosus															1
	C. vernalis				+		+	+			+	+		+		32
	Diaptomus minutus	+	+	+		+			+	+	+		+		+	16
	Epischura nordenskiöldi															5
	Eucyclops agilis	+	+	+	+	+			+	+		+		+		51
	Macrocyclops albidus	+	+	+		+		+		+		+		+	+	54
	M. ater					+										4
	M. fuscus			+	+											10
	Orthocyclops modestus						+								+	6
	Paracyclops yeatmani n. sp.															3
	Tropocyclops prasinus															1

Σ = The total number of waters inhabited by a given species.
*Qualitative study localities; **Quantitative study localities;
⊕ Seasonal distribution was different than pattern(s) described for quantitative study localities.

more species of Cladocera than of Copepoda in 96% of the sampled waters. The largest community was found in Round Pond (No. 46) and it consisted of 21 Cladocera and five Copepoda. The smallest community occurred in Pond 20 and Pool 58, each of which included only one species of Cladocera and one species of Copepoda.

The most common cladoceran was *Chydorus sphaericus* (O. F. Müller) occurring in 95% of the sampled waters. *Ophryoxus gracilis* Sars, *Biapertura affinis* (Leydig), *Polyphemus pediculus* (Linné), *Acantholeberis curvirostris* (O. F. Müller), *Alona rustica* Scott, and *Biapertura intermedia* Sars were also common and widespread, as they were found in 48%, 44%, 38%, 37%, 34%, and 33% of the waters, respectively. The most common Copepoda were *Macrocyclops albidus* (Jurine), *Eucyclops agilis* (Koch), and *Cyclops vernalis* Fischer. They occurred in 73%, 70%, and 43% of the sampled waters, respectively.

Several species showed a more restricted range of occurrence. The following species were found only in West Coast localities:

Acroperus harpae Baird
Kurzia latissima Kurz
Lathonura rectirostris (O. F. Müller)
Pleuroxus denticulatus Birge
Rhynchotalona falcata (Sars)

No copepods seemed to be restricted to the western portion of the island. The following microcrustaceans were not collected on the West Coast:

Cladocera:

Acroperus alonoides Hudendorff
Alona costata Sars
A. guttata Sars
Camptocercus rectirostris Schoedler

Chydorus bicornutus[1] Doolittle
C. faviformis Birge
Eurycercus glacialis Lilljeborg
Pleuroxus laevis Sars
P. trigonellus (O. F. Müller)
Scapholeberis aurita (Fischer)

Copepoda:

Canthocamptus vagus Coker and Morgan
Cyclops nanus Sars
C. venustoides pilosus Kiefer
Paracyclops yeatmani n. sp.
Tropocyclops prasinus Fischer

However, some of the above species were only collected in one or two waters; namely, *Camptocercus rectirostris*, *Chydorus bicornutus*, *C. faviformis*, *Cyclops venustoides pilosus*, *Kurzia latissima*, *Lathonura rectirostris*, *Pleuroxus trigonellus*, and *Tropocyclops prasinus*.

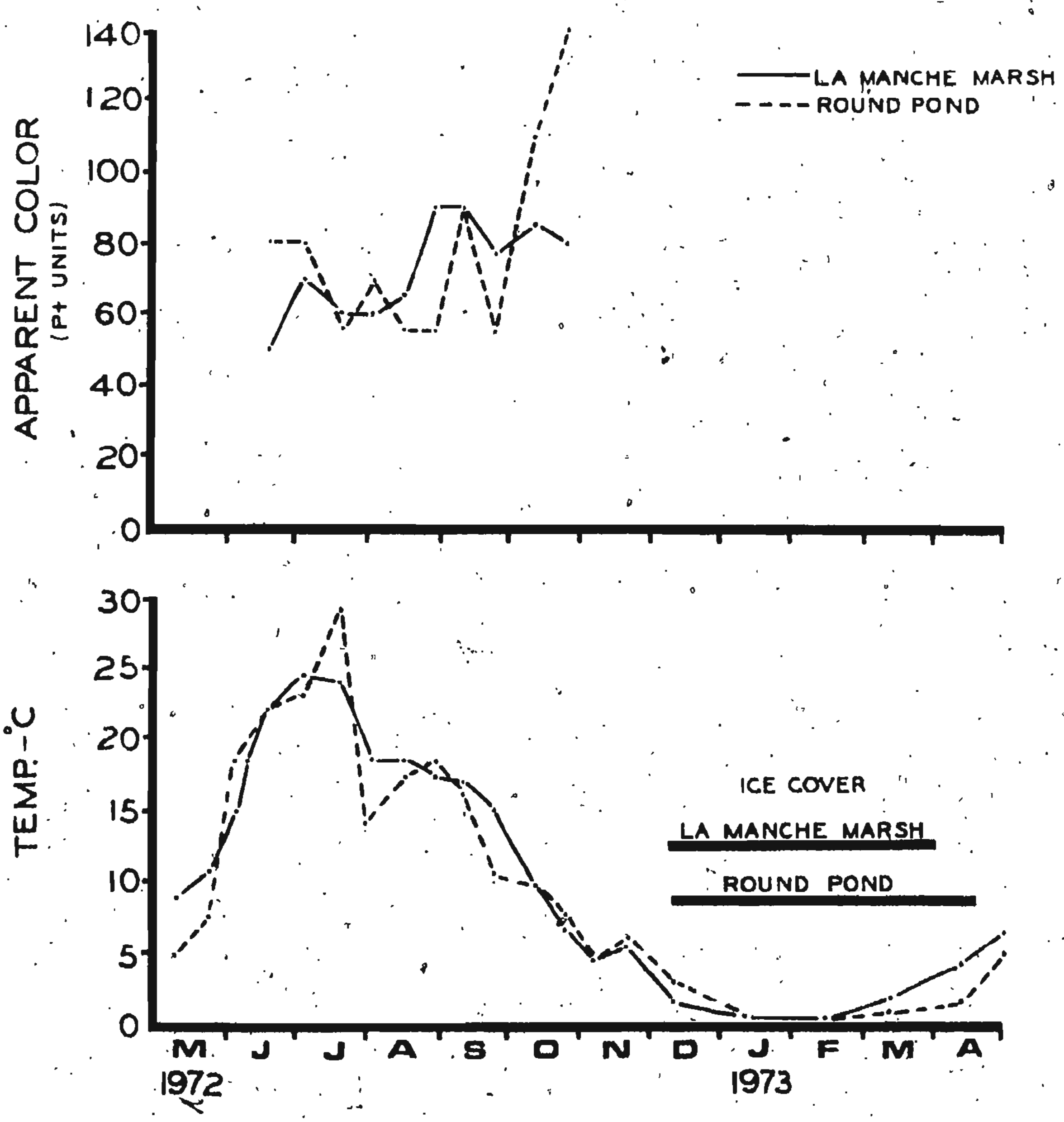
Temperature and Apparent Color in La Manche Marsh and Round Pond

Surface temperatures for La Manche Marsh and Round Pond are shown in Figure 8. The highest temperatures were attained in July and early August. Samples were taken in less than 1 meter of water and there seemed to be no significant difference between surface and bottom temperatures. Ice cover was from December 10, 1972 to April 7, 1973 in La Manche Marsh and from December 10, 1972 to April 20, 1973 in Round Pond. In the previous winter the ice cover lasted longer, the ice disappearing approximately two weeks later in Round Pond and one week later in La Manche Marsh. The maximum

[1]This species was found in the sample from Labrador, which might indicate that this cladoceran occurs on the western portion of the island. The Labrador location represents a marked northern extension of the range for this species (Frey, personal communication).

Figure 8

Temperature and apparent color in Round Pond and La Manche Marsh.


140
120
100
80
60
40
20
0
APPARENT COLOR
(Pt UNITS)
LA MANCHE MARSH
ROUND POND
30
25
20
15
10
5
0
TEMP.-°C
ICE COVER
LA MANCHE MARSH
ROUND POND
M J J A S O N D J F M A
1972
1973

thickness of ice encountered in 1972-1973 was 36 cm in La Manche Marsh and 52 cm in Round Pond. The ice cover in La Manche Marsh had very little snow cover except for the sample taken in January. This is probably the result of the strong winds and the lack of a surrounding forest that would act as a windbreak. In contrast, the surface of Round Pond was always covered with at least several centimeters of packed snow. Conditions did not seem to become stagnant as the mud was brown and did not smell of H_2S. There were plants present under the ice in both localities. *Sphagnum majus* was present in La Manche Marsh while *Drepanocladus revolvens* was present in Round Pond. It is doubtful that they would contribute significant amounts of oxygen under such conditions (G. Brassard, personal communication).

Both La Manche Marsh and Round Pond are highly colored waters. Apparent color (Pt units) is also shown in Figure 8. Maximum color was attained in Round Pond in late October (140 units). The highest values in La Manche Marsh occurred in August and September (90 units). The lowest values for La Manche Marsh occurred in early June, while the lowest units for Round Pond occurred in mid-July, mid-August, and mid-September.

Quantitative Seasonal Succession

A total of 17 species of Cladocera and 7 species of Copepoda were found in La Manche Marsh, while 21 species of Cladocera and 5 species of Copepoda were collected in Round Pond. Twelve were common to both La Manche Marsh and Round Pond, so that in the two localities together there was a total of 38 species. In most instances, the dominant and codominant microcrustaceans were different in the two localities.

In both La Manche Marsh and Round Pond, the largest total numbers of microcrustaceans occurred in August and September (Tables 4 and 5; Appendix C, Table 1). The maximum standing crops appeared to be similar in the two waters, which were 53,680 individuals over one m^2 in Round Pond and 48,180 individuals over one m^2 in La Manche Marsh. The standing crops in the spring were about 2 to 4 times higher in La Manche Marsh, mainly due to the numbers of *Chydorus sphaericus*.

Cladocera

Tables 4 and 5 give a summary of the seasonal patterns of Cladocera in La Manche Marsh and Round Pond. Several Cladocera (*Acantholeberis curvirostris*, *Biapertura intermedia*, and *Chydorus sphaericus*) appeared as early as April in La Manche Marsh. In contrast, Cladocera did not appear in Round Pond until late May, 1972 and early May, 1973. Cladoceran populations reproduced parthenogenetically through the spring and summer. In the fall resting eggs were produced gamogenetically. Most of the Cladocera passed the winter as resting eggs but a few parthenogenetic females of *Chydorus piger* and *Ilyocryptus spinifer* were found throughout the winter in La Manche Marsh. In Round Pond, *C. piger* was collected in the winter but *I. spinifer* was absent. Since limited sampling was done in the winter, it is possible that animals were missed. The following section describes the seasonal dynamics of individual cladoceran species for the two localities.

TABLE 4

SEASONAL PATTERNS OF CLADOCERA IN LA MANCHE MARSH

Species	Appearance of Juveniles	Population Maximum	Sexual Cycle*	Disappearance of Population
Acantholeberis curvirostris	IV	IX	XI-XII	II
Alona quadrangularis	V	VIII	XI	XII
Biapertura affinis	VI	VIII	IX-XII	II
B. intermedia	IV	VIII	X-XII	II
Ceriodaphnia quadrangula	VI	VII	VII-IX	IX
Chydorus bicornutus	V	VIII	IX-X	I
C. piger	IV	VII, X	X	–
C. sphaericus	IV	VI-VII	X-XII	II
Diaphanosoma brachyurum	V	IX	IX-X	X
Disparalona acutirostris	V	X	X-XII	II
Ilyocryptus spinifer	V	IX	XI	–
Latona setifera	V	IX	X-XI	I
Ophryoxus gracilis	V	IX	X-XI	XII
Pleuroxus laevis	VI	IX	*	XII
Polyphemus pediculus	VI	VIII-IX	IX	IX

*Sexual cycle not observed.

TABLE 5

SEASONAL PATTERNS OF CLADOCERA IN ROUND POND

Species	Appearance of Juveniles	Population Maximum	Sexual Cycle*	Disappearance of Population
Acroperus alonoides	V	VII, X	X-XII	II
Alona quadrangularis	VI	VIII	X	XII
A. rustica	VII	IX	XI	XII
Alonella excisa	VI	IX	XI	I
A. nana	V	VII, X	X-XI	II
Biapertura affinis	VI	VIII	X-XI	I
B. intermedia	V	VIII	X-XI	I
Ceriodaphnia quadrangula	VI	VIII	IX	XI
Chydorus piger	V	VIII, X	XI	-
C. sphaericus	V	VI	X-XI	II
Graptoleberis testudinaria	VI	VIII	*	X
Ilyocryptus spinifer	VI	VIII	*	I
Ophryoxus gracilis	V	VIII-IX	IX-XI	XII
Parophryoxus tubulatus	VII	IX	*	XI
Pleuroxus trigonellus	VII	VIII	X	X
Sida crystallina	V	VIII	IX-X	XI

*Sexual cycle not observed.

La Manche Marsh. *Acantholeberis curvirostris* was a common species which was most abundant in the fall. It attained a maximum of 9,300 individuals over one m^2 in September, when it was codominant with *Ilyocryptus spinifer* (Fig. 9). Juveniles were present when the first sample was taken in early May and remained until November. In the following spring, juveniles first appeared in mid-April. Parthenogenetic females were dominant between June and October. Ephippial females and males dominated the population in late November and early December.

Alona quadrangularis is a bottom form which was never abundant. It reached a peak in late July (2,300 over one m^2) (Fig. 10). Juveniles first appeared in May and disappeared in September. No ephippial females were observed. Males were collected in minimal numbers in November.

Biapertura affinis showed a seasonal distribution similar to *Alona quadrangularis*. It occurred regularly between early June and January (Fig. 10). The maximum was attained in late August (4,200 over one m^2). The numbers were low during the other months in which it was present. Juveniles occurred between June and September. Ephippial females and males dominated the population in September through November.

Biapertura intermedia was more numerous than the preceding species. It attained 9,980 individuals over one m^2 in late August (Fig. 11), when it was the dominant microcrustacean. In general, it was not abundant in the other months. Juveniles were present in the May 10, 1972, sample and disappeared in early October. They first appeared in April of the following year. Ephippial females dominated the December sample. Males were scarce, but low numbers occurred in

October and November.

Ceriodaphnia quadrangula was found in minimal numbers except in mid-July, when it reached 3,900 over one m^2 (Fig. 11). Juveniles first appeared in June and were present until August. Adult females were collected until September. Several ephippial females were collected as early as July, but were more abundant in August and September, when they comprised 70% of the population. No males were observed.

Chydorus bicornutus was a common species between May and December. The peak was reached in late August (5,460 over one m^2) (Fig. 12). Juveniles were present on May 10, 1972, and others were found regularly until October. They were first collected on May 2 in the following spring. Minimal numbers of ephippial females were present in the December sample. Males comprised approximately 40% of the November population.

Chydorus piger was a common species which was present throughout the year in La Manche Marsh. Maximum numbers were attained in July (6,420 over one m^2) and in October (3,780 over one m^2) (Fig. 13). The numbers remained relatively low during the rest of the year. Juveniles appeared between May and August. No ephippial females were observed. Few females found in the winter contained eggs or embryos. Males were scarce, as only a few were collected in October.

Chydorus sphaericus was the most abundant cladoceran in La Manche Marsh, dominating the microcrustaceans from May to July. It attained a maximum of 27,000 individuals over one m^2 in early July (Fig. 14). After July 3, the numbers decreased and remained low until the species disappeared in February. Juveniles and parthenogenetic females were present in the first sample taken in May. Juveniles first appeared in April in the following year. Ephippial females were present only in December. Males occurred in October and November, making up a large portion of the population.

Diaphanosoma brachyurum was never an abundant species. It was collected regularly between May and mid-October. The highest numbers occurred in September (1,880 over one m^2) (Fig. 12). Juveniles were found between May and September, but always in low numbers. Males and ephippial females dominated the population in late September and October, prior to the disappearance of the species.

Disparalona acutirostris was found between May and January, but always in low numbers (Fig. 15). The highest counts were in October (1,180 over one m^2). Ephippial females were collected in late November and December. Males dominated the October population.

Ilyocryptus spinifer is a benthic species which was present throughout the year, but the numbers were low from January to March. The maximum was attained in early September (8,400 over one m^2) (Fig. 15). Minimal numbers of males were present in November. However, no ephippial females were observed.

Latona setifera also is a bottom form which was common between May and September (Fig. 16). The peak occurred in September (2,750 over one m^2), but the numbers were low in the other months. Juveniles first appeared in May and remained until September. In the following year, juveniles first appeared on May 2, and the numbers were considerably higher. Ephippial females and males dominated the population in October and November.

Ophryoxus gracilis was collected regularly between May and November (Fig. 16). The highest numbers were attained in late September (3,680 over one m^2). The numbers were low between May and August and in late October and November. Juveniles dominated the numbers from May until August. Males dominated the numbers in October, while ephippial females were abundant in November.

Pleuroxus laevis was one of the least abundant cladocerans in La Manche Marsh. It was collected consistently between June and November (Fig. 17). The highest count occurred in September (1,050 over one m^2). Juveniles were present between June and October. No males or ephippial females were observed.

Polyphemus pediculus showed a short seasonal distribution. Juveniles first appeared in June and were still present in the last collection, prior to the species' disappearance in late September. The peak abundance occurred in August (4,080 over one m^2) and September (3,550 over one m^2) (Fig. 17). *P. pediculus* reached its peak and disappeared very abruptly. No ephippial females were observed. Males appeared in minimal numbers in September.

Scapholeberis kingi was collected on three occasions in August and September. It always occurred in low numbers. Except for a few juveniles which were present on August 1, the specimens were adult females.

Streblocercus serricaudatus also showed a rather sporadic occurrence. It was encountered on six occasions between August and

November, 1972. The numbers were always low and consisted entirely of adult females. However, juveniles were numerous in the following spring. On May 2, 1973, there were 1,270 juveniles over one m^2.

<u>Round Pond</u>. *Acroperus alonoides* was collected consistently between May and January (Fig. 18). The maximum number of individuals was attained in July (7,300 over one m^2), when this species was the dominant microcrustacean. The numbers were low in August and September, but increased again in October (5,480 over one m^2). Ephippial females were collected in late November and early December. Males were numerous in October and November.

The seasonal distribution of *Alona quadrangularis* (Fig. 19) and *Biapertura affinis* (Fig. 22) in Round Pond were similar to the pattern described for these species in La Manche Marsh. In both instances, the maximum occurred in August; namely, 1,850 for *A. quadrangularis* and 2,900 for *B. affinis*. The numbers were low during the other months. *A. quadrangularis* males were collected in early October, while males of *B. affinis* dominated in late October and November. Minimal numbers of ephippial females were collected in November for both species.

Alona rustica was an abundant species, but it showed a rather restricted seasonal distribution. Juveniles were collected between mid-July and October (Fig. 19). The maximum was attained in early September (11,820 over one m^2), when it shared dominance with *Alonella excisa* and *Sida crystallina*. The numbers were relatively low in October and November. Ephippial females were dominant in November, but no males were observed.

Alonella excisa also was more abundant in the fall. Juveniles were first collected in early June and remained until October (Fig. 20). The maximum (mostly juveniles) was reached in early September (7,880 over one m^2). Adult females were not abundant, occurring from late July until December. No ephippial females were collected. Males occurred in minimal numbers in November.

Alonella nana was a common species collected regularly between May and January (Fig. 21). It appeared to have two maxima, one in July (5,860 over one m^2) and another in October (4,800 over one m^2). The numbers were relatively low at the other times that it was present. Juveniles occurred from May until October, and comprised 50% of the July maximum. A few ephippial females were collected in the November 20 sample. Males dominated the numbers in October, just after the fall maximum.

Biapertura intermedia was a common species collected between late May and December (Fig. 22). The numbers were much lower than the population in La Manche Marsh. The maximum was observed in late August (3,860 over one m^2), but the numbers were minimal in the other months. Juveniles were found from June until October, 1972. However, they first appeared in late May in the following year. Males occurred in late October and November, when they dominated the population. Ephippial females were numerous in late November.

The benthic form, *Chydorus piger*, was collected in every month except March (Fig. 23). The numbers were lower than in La Manche Marsh. The species exhibited two maxima which occurred in July (3,800 over one m^2) and October (4,340 over one m^2). Juveniles were collected from May to November, 1972 and April and May, 1973. Ephippial females occurred in minimal numbers in late November. No males were observed.

Chydorus sphaericus was more common in late spring or early summer, (Fig. 23) but the numbers were considerably lower than in La Manche Marsh. The maximum was attained in early June (9,400 over one m^2), when it was the dominant microcrustacean. Juveniles were present in the first sample taken in May, 1972, and remained until November. They reappeared in early May in the following year but the numbers were approximately three times higher. Adult females were found in every month except February and March. Males occurred in low numbers in October and early November. Ephippial females dominated the population in late November and December.

Ceriodaphnia quadrangula showed a restricted seasonal distribution and it was not an abundant species. It was found regularly between June and early October (Fig. 24). The maximum was reached in August (2,920 over one m^2). Juveniles occurred from June until September. Ephippial females dominated the population in early September. No males were identified.

Eubosmina longispina was collected in minimal numbers on one occasion in July.

Disparalona acutirostris was not collected in 1972, but it was one of the cladocerans in the May, 1973, samples.

Graptoleberis testudinaria occidentalis was frequently encountered. The highest count was observed in July (850 over one m^2) (Fig. 24). Juveniles were collected from early June until August. Adult females were found in July through September. Several ephippial females were collected in the September 25 sample. No males were observed.

Ilyocryptus spinifer usually occurred in minimal numbers. Contrary to its constant occurrence in La Manche Marsh, it was lacking in Round Pond from December, 1972 to May, 1973, but it was collected from June until December, 1972 (Fig. 24). The highest numbers were attained in late August (1,700 over one m^2). Juveniles were found from June until October. No ephippial females or males were identified.

Ophryoxus gracilis was a common and abundant species in Round Pond. It was found between late May and November (Fig. 25). Greatest numbers encountered were 7,650 over one m^2 in August, of which 4,900 were in the adult female stage. Males first appeared in September, and constituted the majority of the population in October. Ephippial females occurred in low numbers in October and early November.

Parophryoxus tubulatus was only collected from July to October (Fig. 25). The greatest numbers were observed in September (1,800 over one m^2), 1,280 of which were adult females. Juveniles were collected from July until October. No ephippial females or males were identified.

Pleuroxus procurvus was observed on two occasions in August. The numbers were minimal and consisted entirely of parthenogenetic females.

Pleuroxus trigonellus was found only in the warmer months, occurring from July until October (Fig. 26). The maximum (mostly juveniles) was attained in late August (2,050 over one m^2). No males were observed in the samples. However, a few ephippial females appeared in October before the species disappeared.

Scapholeberis kingi was encountered, but only on two occasions and in minimal numbers. The sporadic appearance seems to be common of this species, since a similar occurrence was observed in La Manche Marsh and several of the qualitative localities. Adult females were collected in late July and late August. No other stages were found.

Sida crystallina was common between May and October, and was dominant or codominant in August and September (Fig. 26). The greatest numbers were attained in late August (15,100 over one m^2) when it was the dominant cladoceran. Juveniles were found from June until October, and attained maximum numbers in August (5,800 over one m^2). Males first appeared in mid-September and constituted the majority of individuals in late September and early October. Ephippial females were also present in September and October, but were not as abundant as the males.

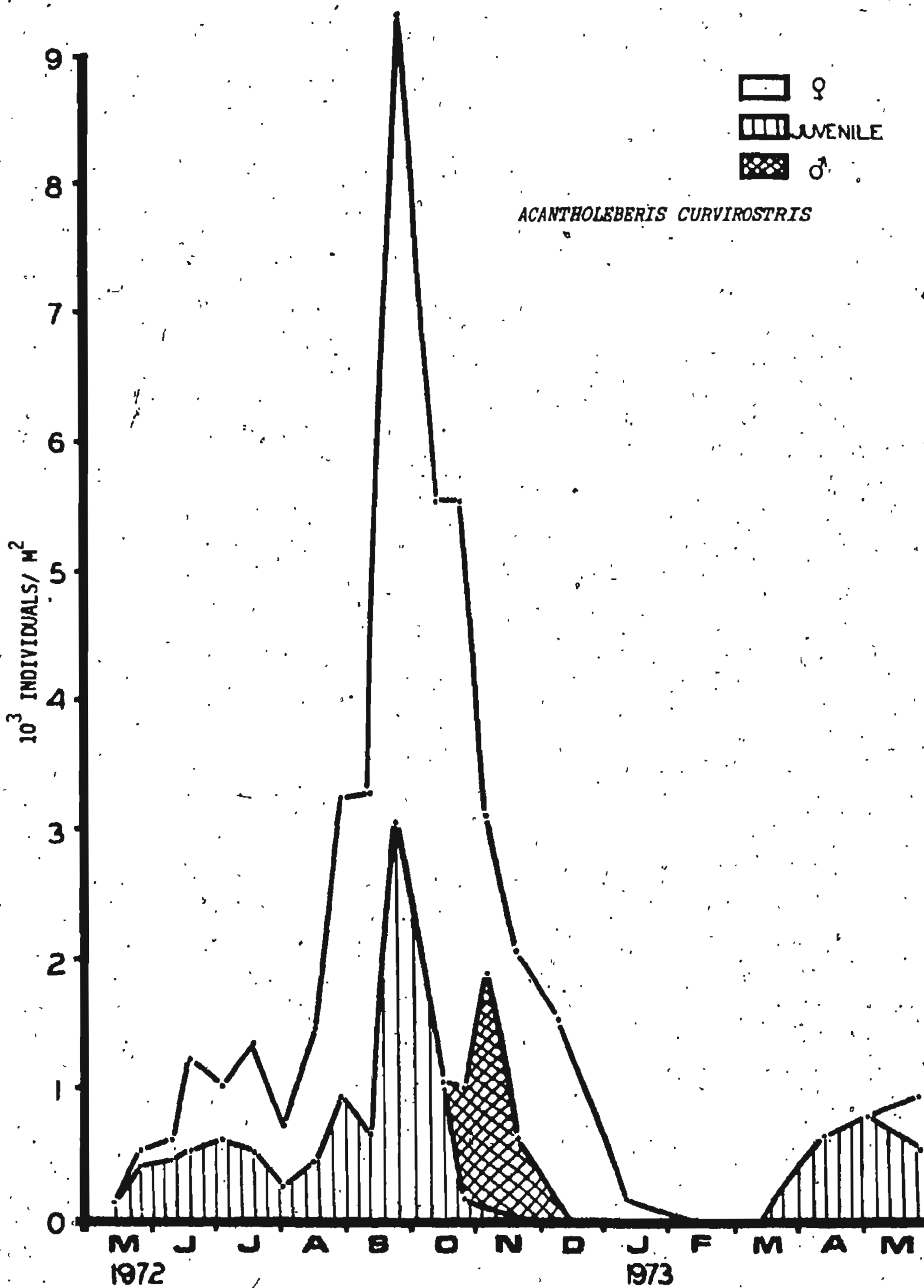
Simocephalus serrulatus and *S. vetulus* were found occasionally in July and August. The highest numbers were observed in the August 14 sample (2,100 over one m^2). Juveniles and adult females were present in each of the samples.

Copepoda

Copepoda were always present and common in La Manche Marsh and Round Pond but they dominated the microcrustaceans only in the winter and early spring. The most significant difference between the two localities was that La Manche Marsh contained seven littoral species, while Round Pond supported three. The seasonal distributions

Figures 9-17

Seasonal distributions of individual cladoceran species in La Manche Marsh.



♀
JUVENILE
♂
ACANTHOLEBERIS CURVIROSTRIS
10^3 INDIVIDUALS/ M^2
9
8
7
6
5
4
3
2
1
0
M J J A S O N D J F M A M
1972
1973

FIGURE 9

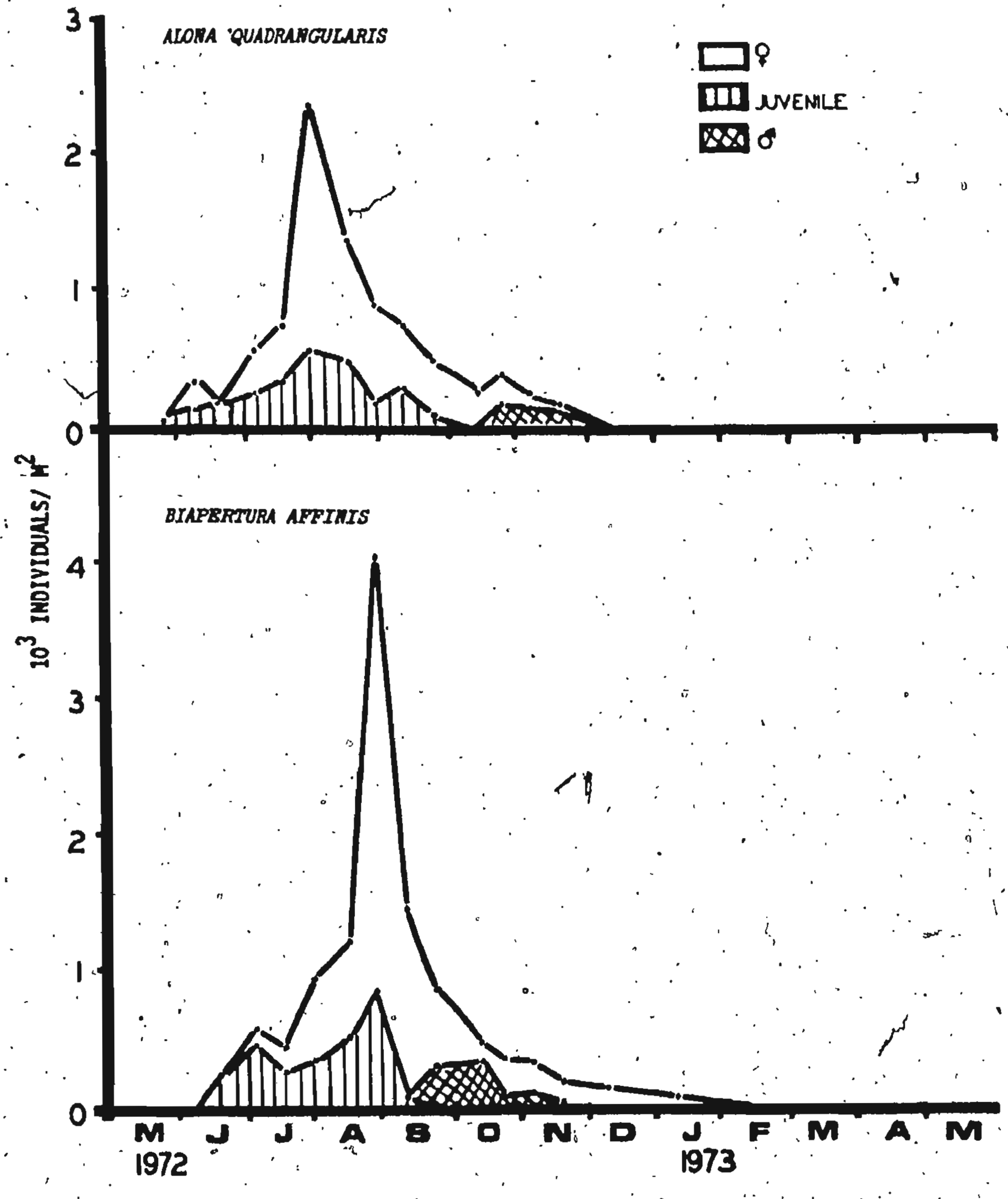

ALONA QUADRANGULARIS
♀
JUVENILE
♂
BIAPERTURA AFFINIS
10^3 INDIVIDUALS/ M^2
3
2
1
0
4
3
2
1
0
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 10

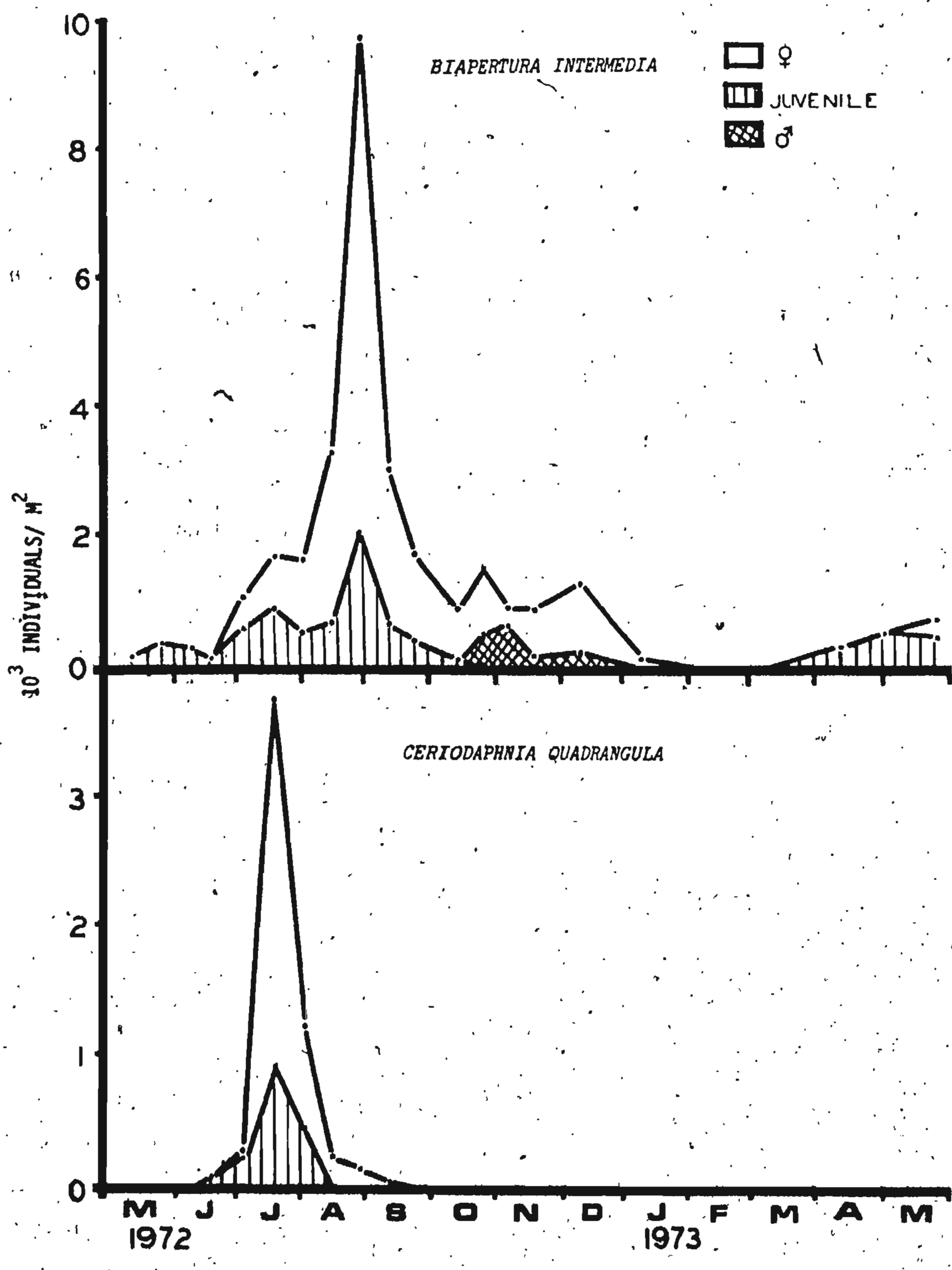

BIAPERTURA INTERMEDIA
♀
JUVENILE
♂
CERIODAPHNIA QUADRANGULA
10^3 INDIVIDUALS/ M^2
10
8
6
4
2
0
3
2
1
0
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 11

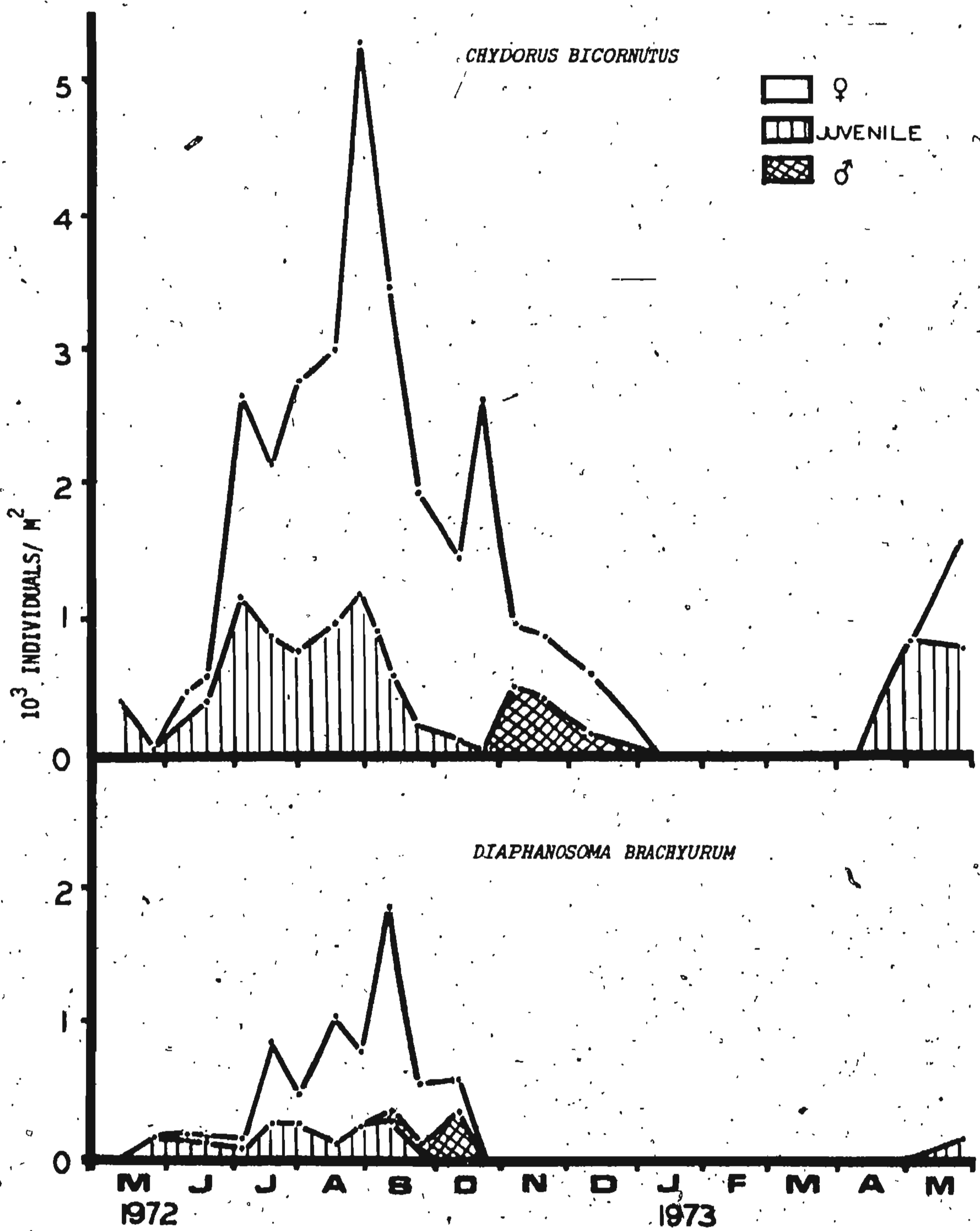

CHYDORUS BICORNUTUS
♀
JUVENILE
♂
10³ INDIVIDUALS/ M²
5
4
3
2
1
0
DIAPHANOSOMA BRACHYURUM
2
1
0
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 12

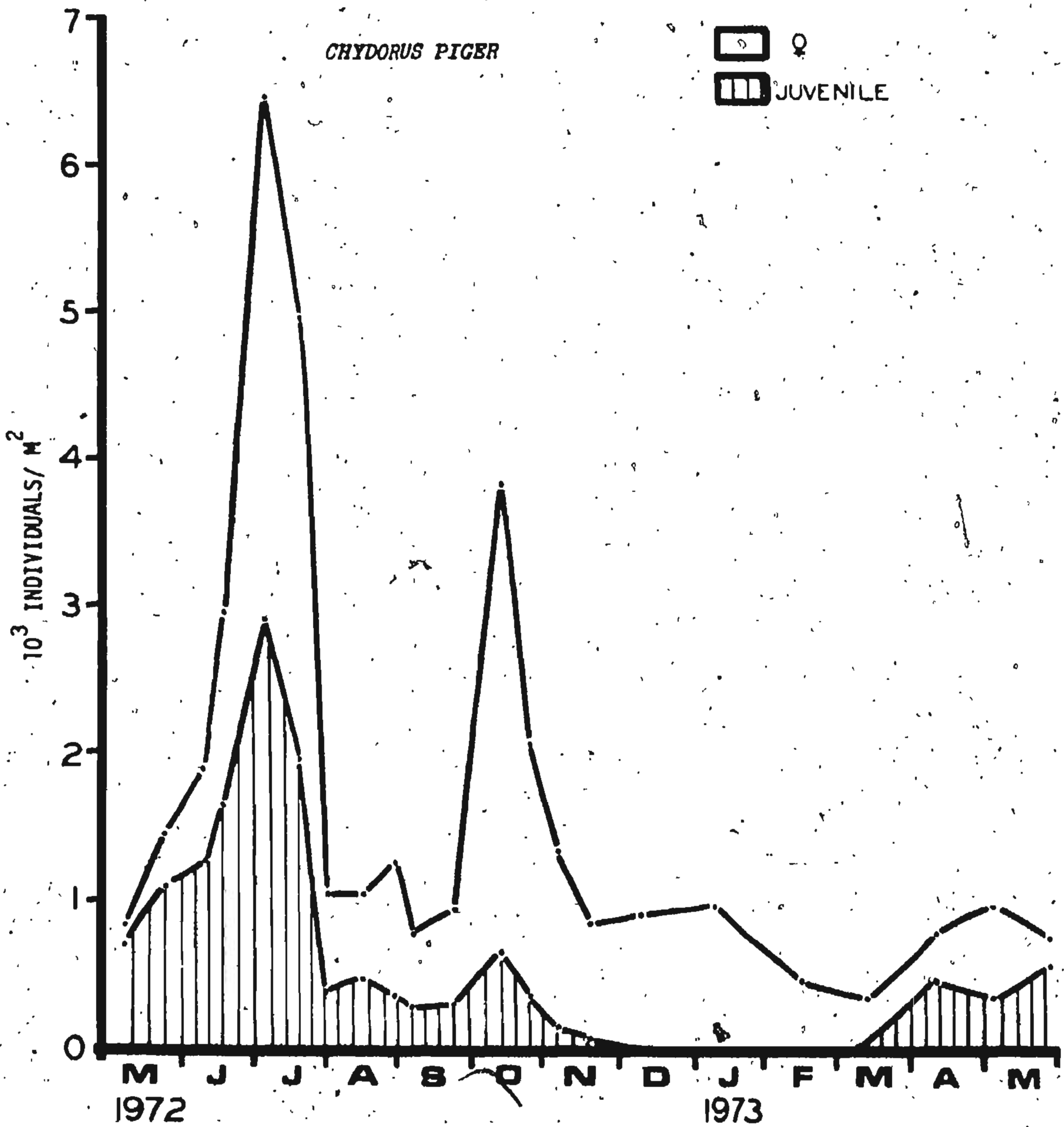

CHYDORUS PIGER
♀
JUVENILE
10^3 INDIVIDUALS/ M^2
0
1
2
3
4
5
6
7
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 13

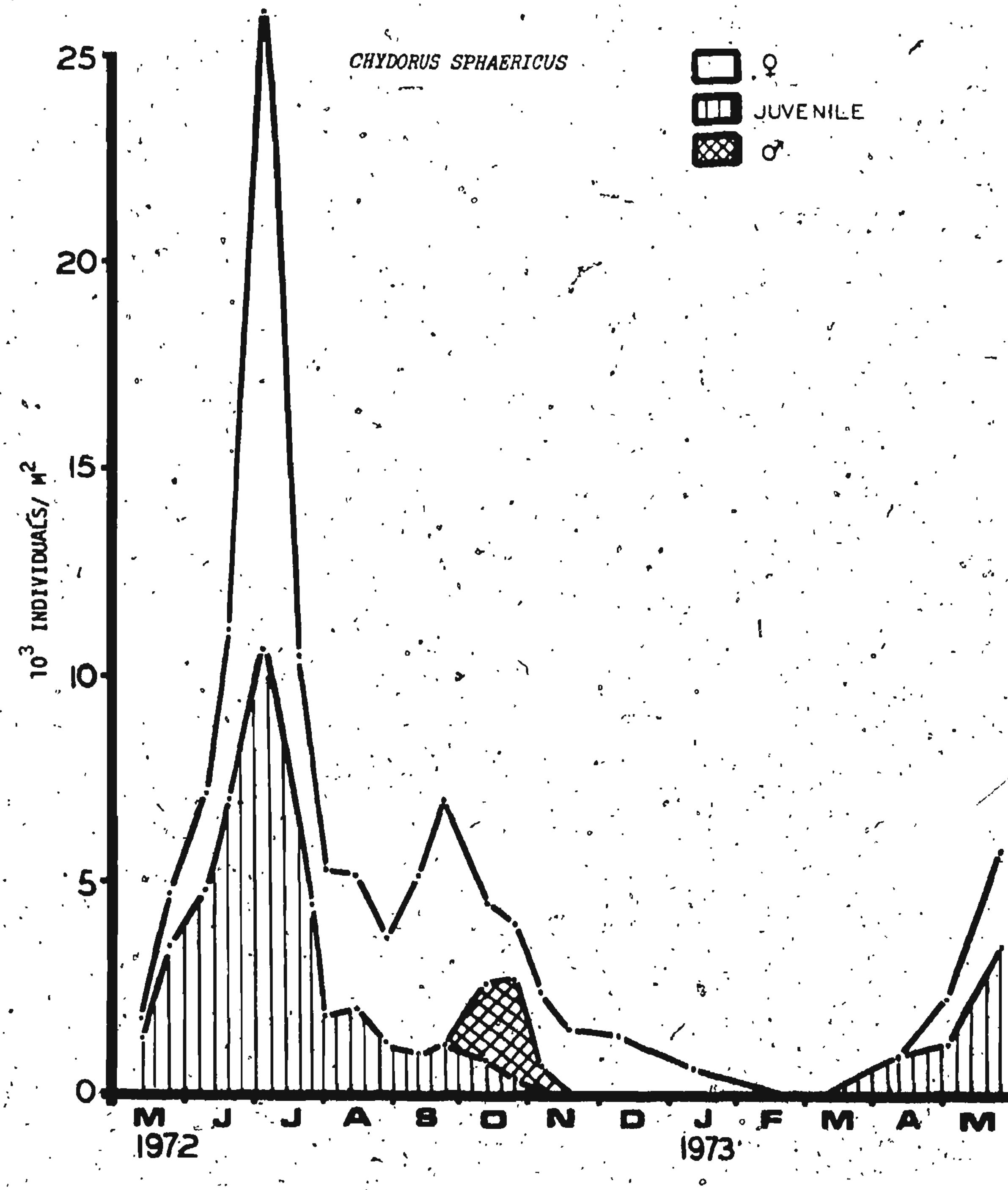
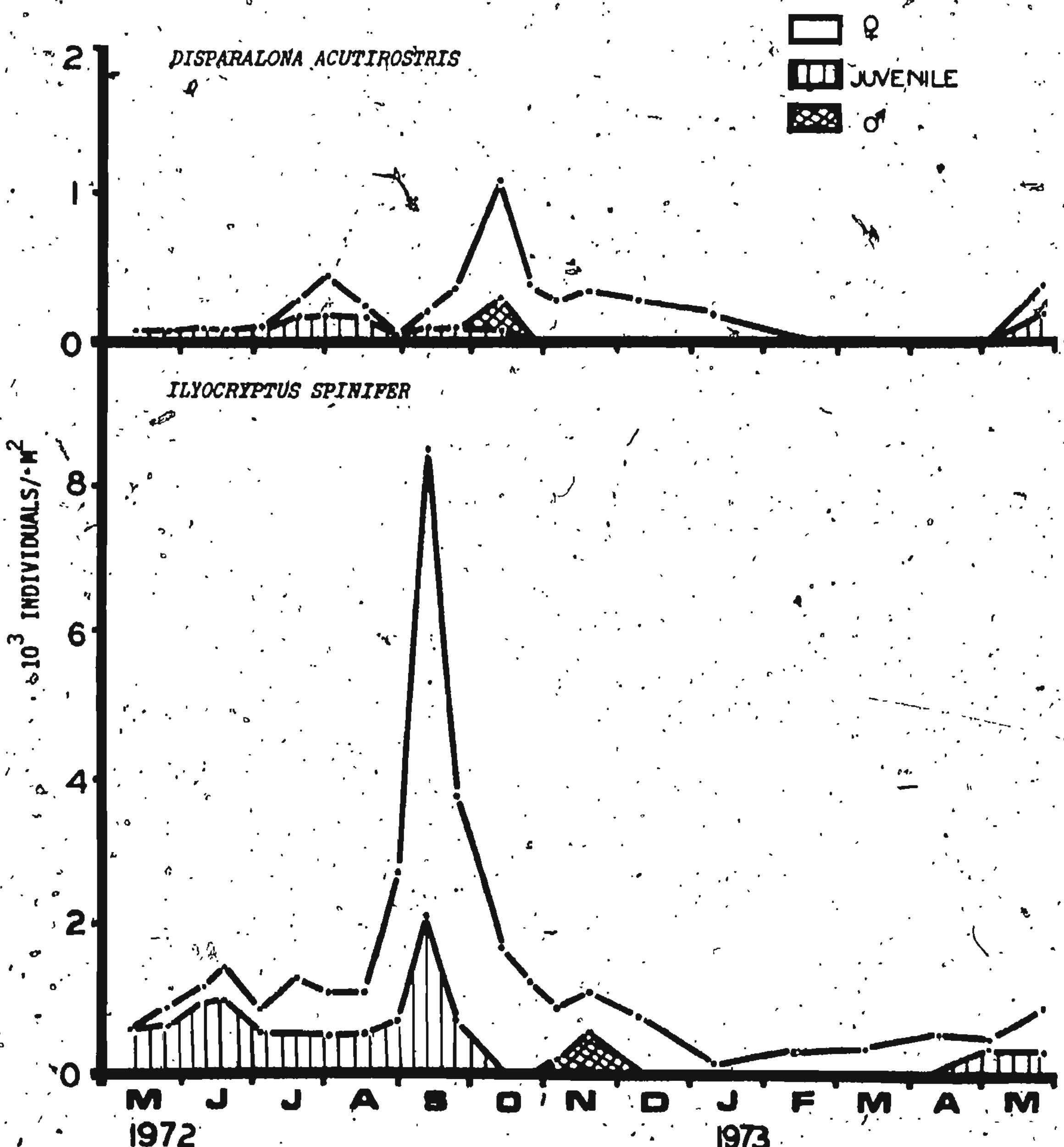

CHYDORUS SPHAERICUS
♀
JUVENILE
♂
25
20
15
10
5
0
10^3 INDIVIDUALS/ M^2
M J J A S O N D J F M A M
1972
1973

FIGURE 14



DISPARALONA ACUTIROSTRIS
ILYOCRYPTUS SPINIFER
♀
JUVENILE
♂
10^3 INDIVIDUALS/·M^2
0
1
2
4
6
8
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 15

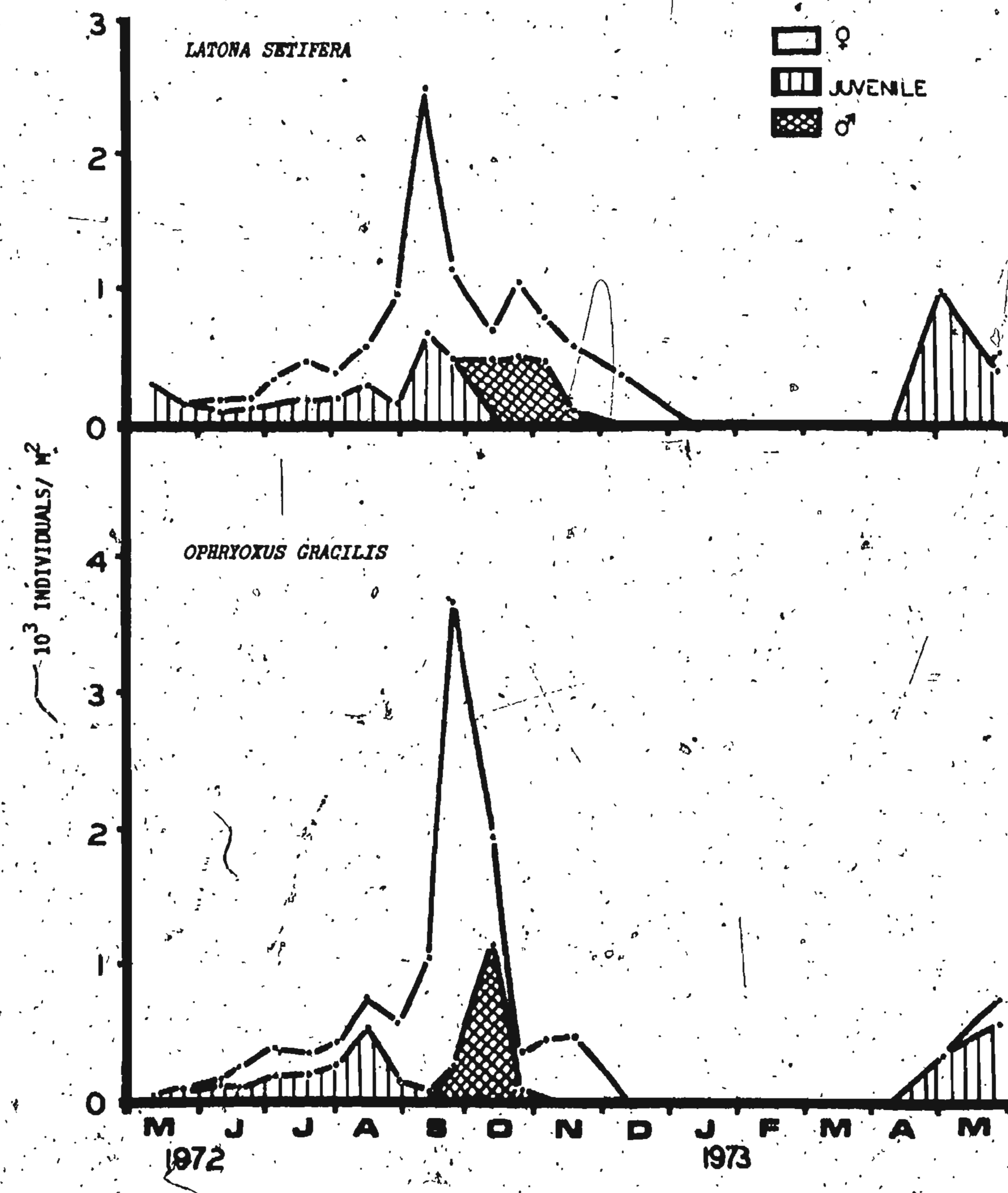
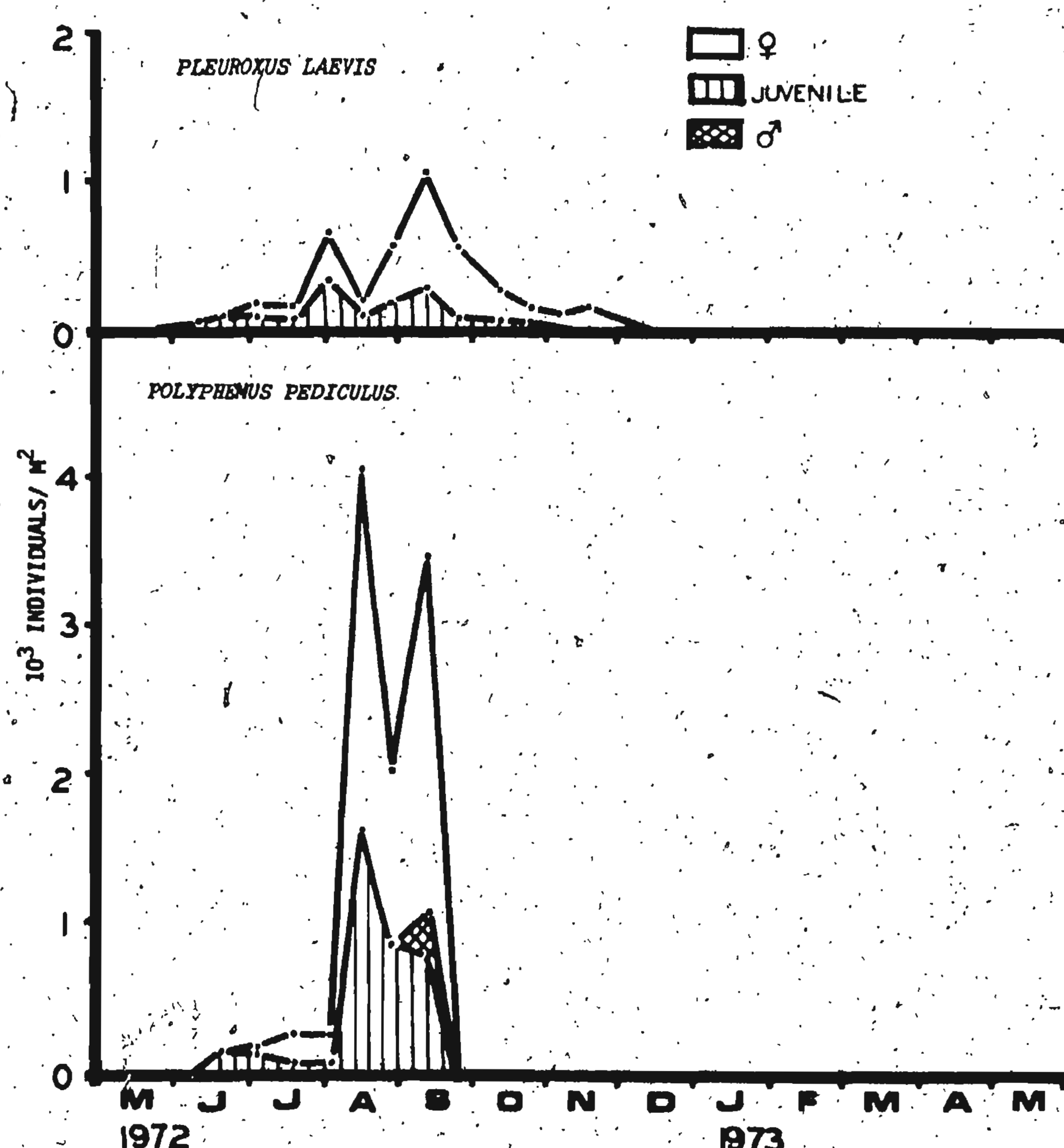

LATONA SETIFERA
♀
JUVENILE
♂
OPHRYOXUS GRACILIS
10^3 INDIVIDUALS/ M^2
3
2
1
0
4
3
2
1
0
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 16



PLEUROXUS LAEVIS
♀
JUVENILE
♂
POLYPHEMUS PEDICULUS
10^3 INDIVIDUALS/ M^2
0
1
2
3
4
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 17

Figures 18-26

Seasonal distributions of individual cladoceran species in Round Pond.

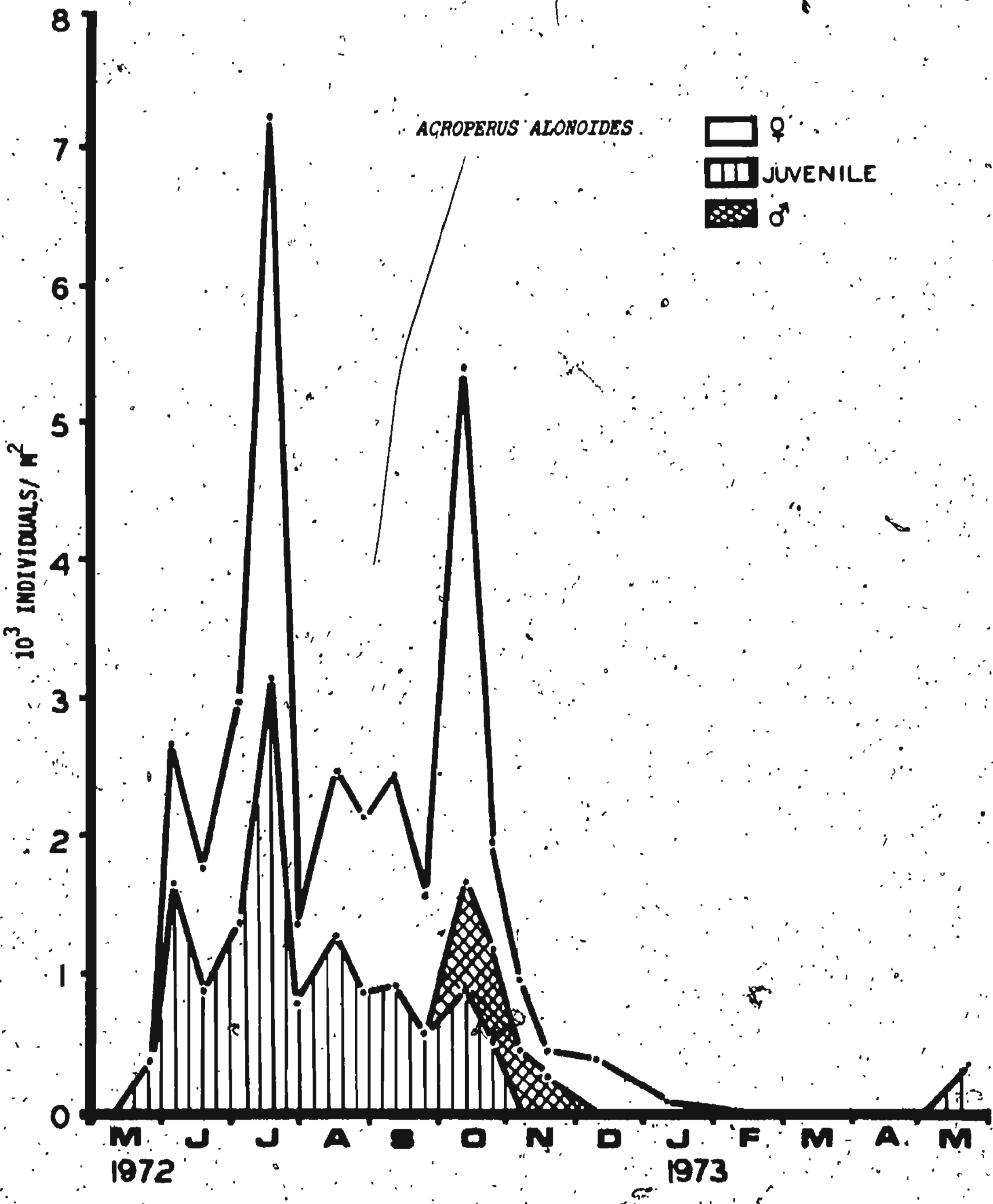

ACROPERUS ALONOIDES
♀
JUVENILE
♂
10^3 INDIVIDUALS/ M^2
8
7
6
5
4
3
2
1
0
M J J A S O N D J F M A M
1972
1973

FIGURE 18

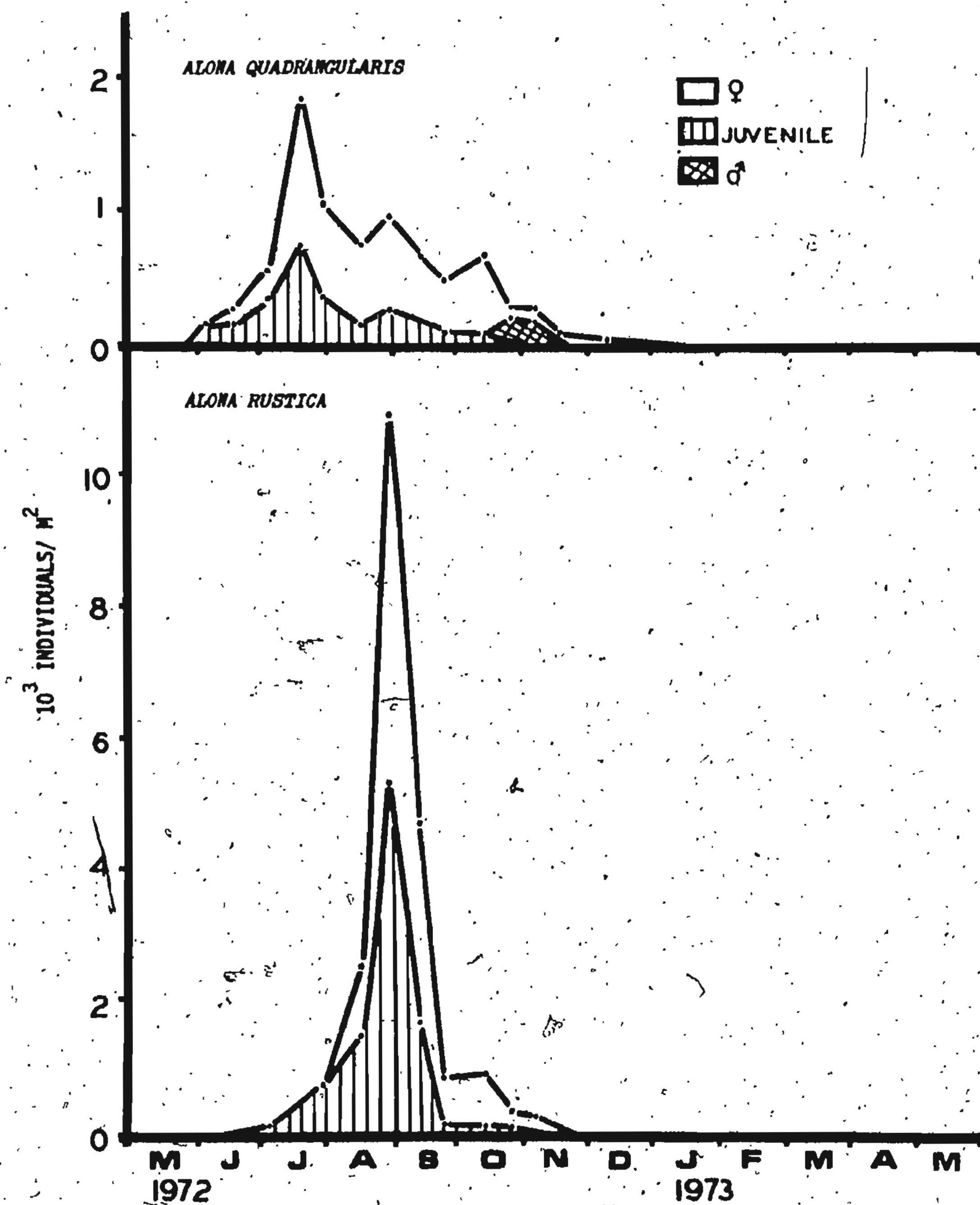

ALONA QUADRANGULARIS
♀
JUVENILE
♂
ALONA RUSTICA
10³ INDIVIDUALS/ M²
0
1
2
4
6
8
10
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 19

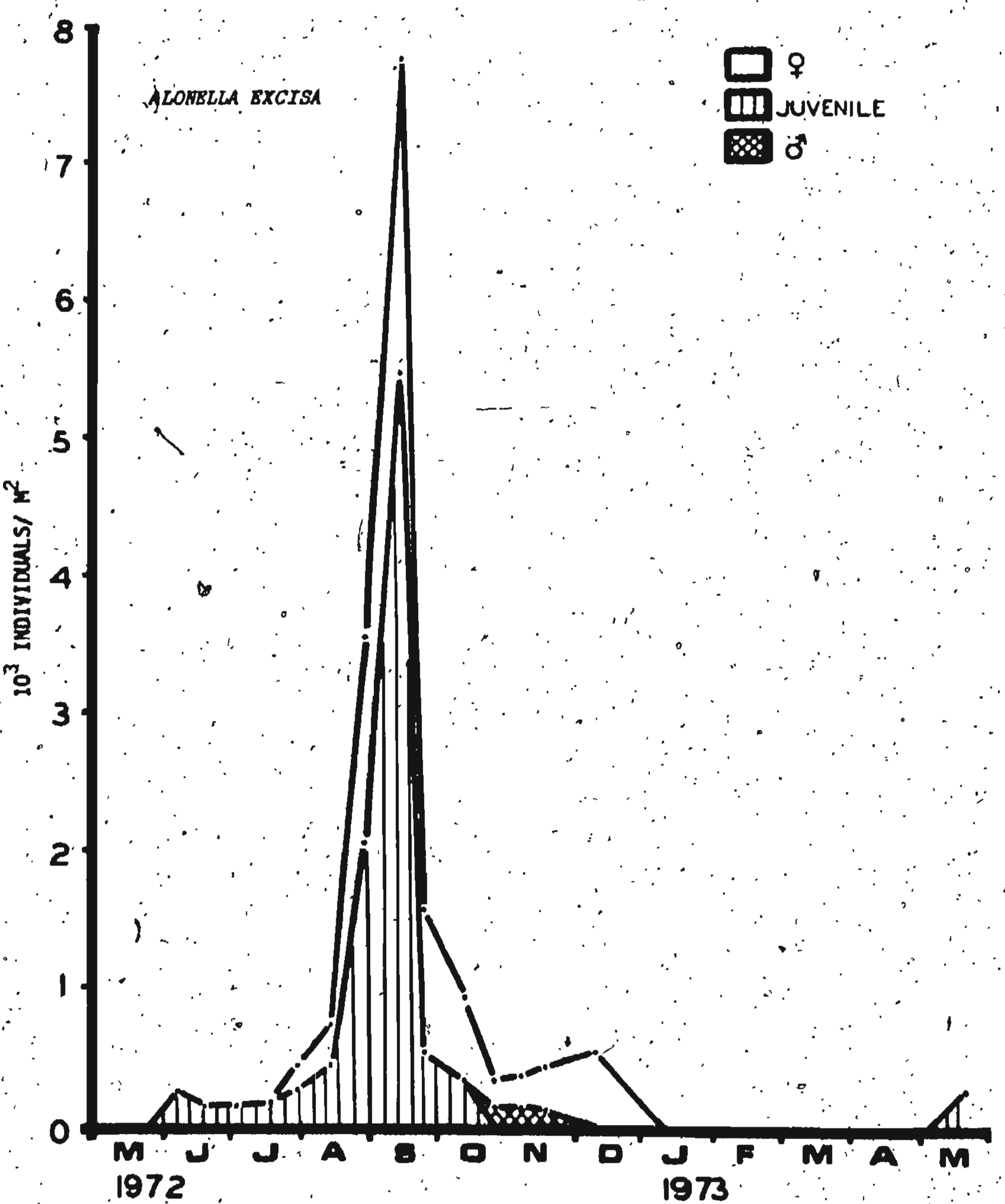
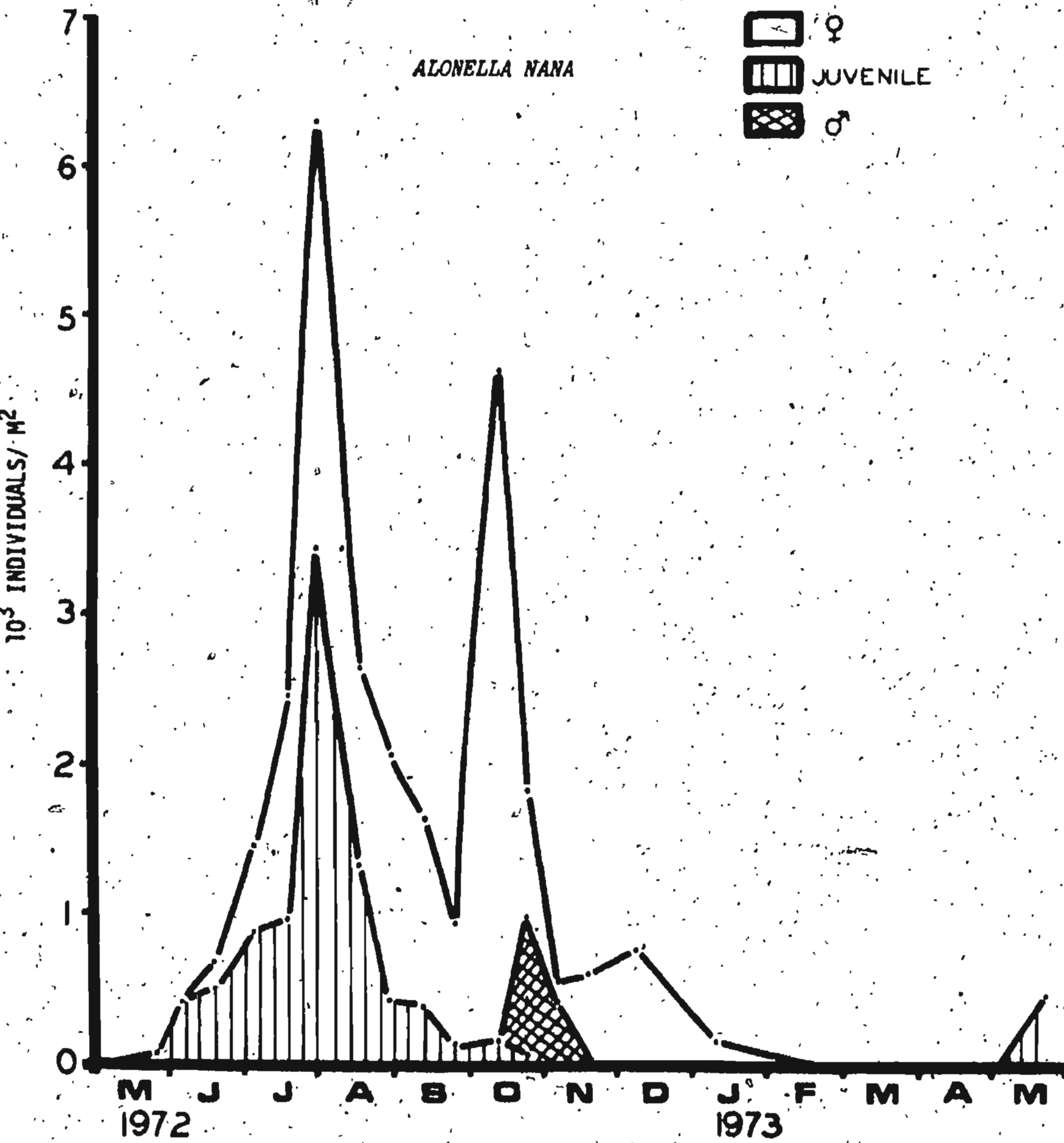

ALONELLA EXCISA
♀
JUVENILE
♂
10^3 INDIVIDUALS/ M²
8
7
6
5
4
3
2
1
0
M J J A S O N D J F M A M
1972
1973

FIGURE 20



ALONELLA NANA
♀
JUVENILE
♂
10^3 INDIVIDUALS/ M^2
0
1
2
3
4
5
6
7
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 21

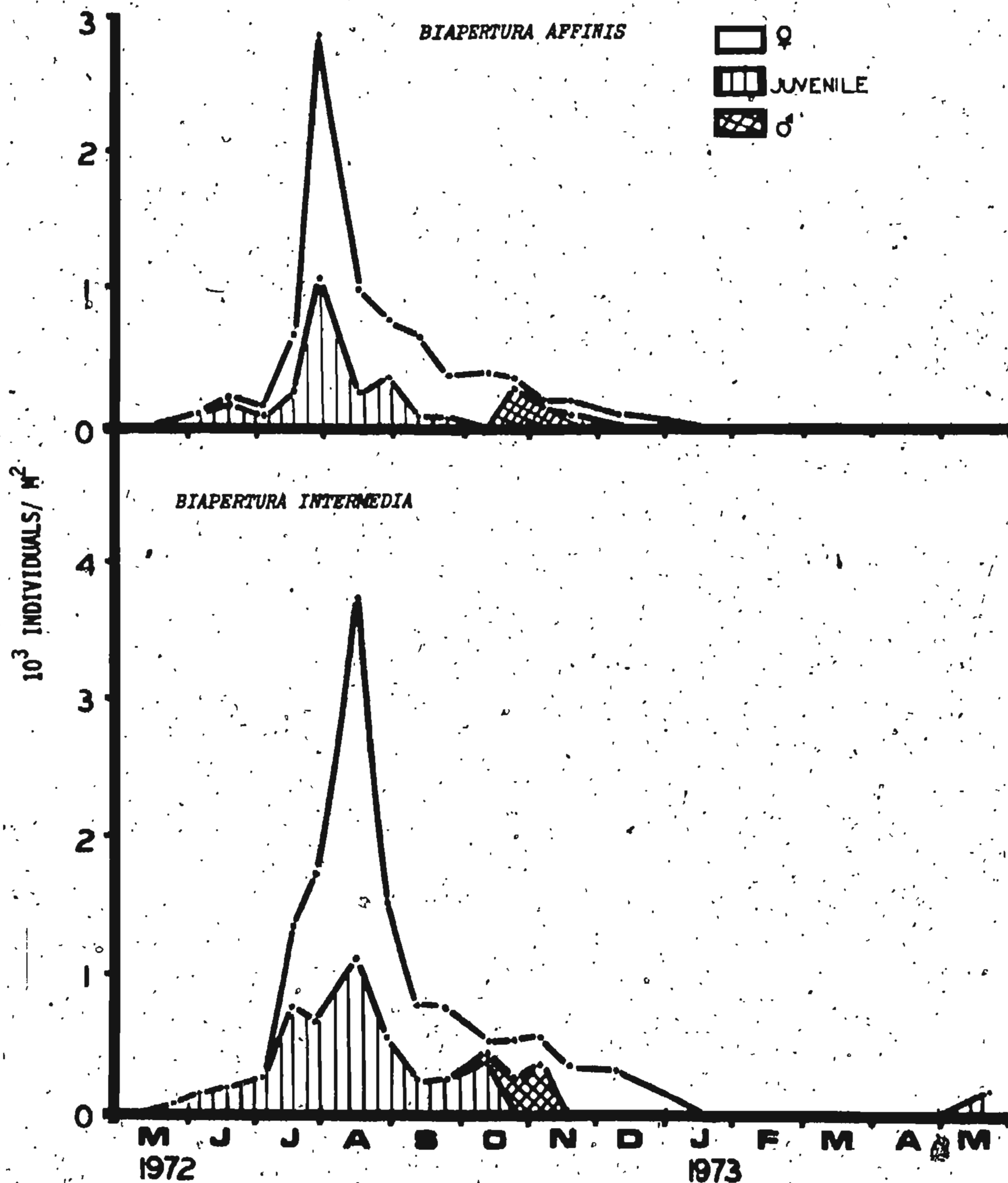
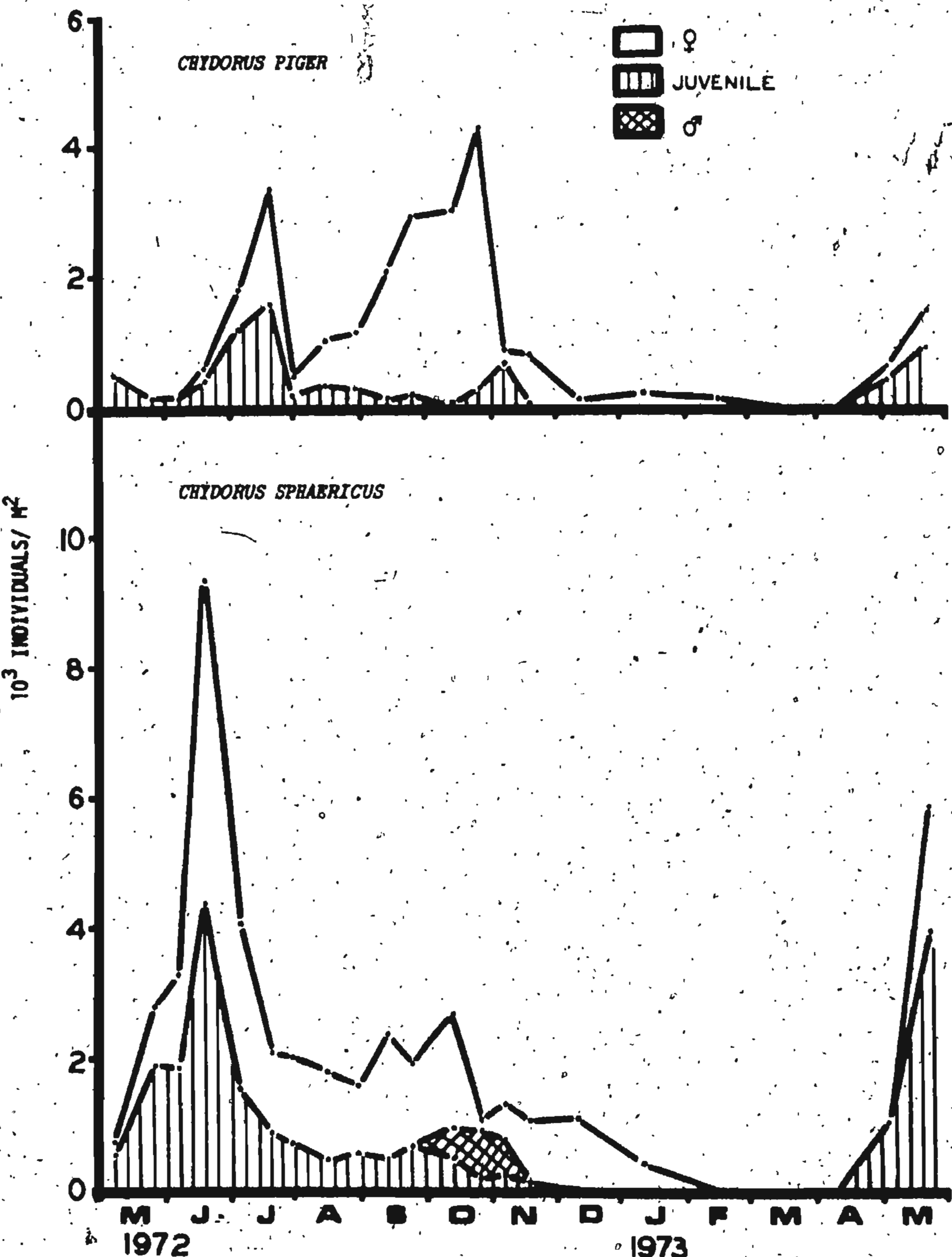

BIAPERTURA AFFINIS
♀
JUVENILE
♂
BIAPERTURA INTERMEDIA
10^3 INDIVIDUALS/ M²
3
2
1
0
4
3
2
1
0
M J J A S O N D J F M A M
1972
1973

FIGURE 22



CHYDORUS PIGER
♀
JUVENILE
♂
CHYDORUS SPHAERICUS
10^3 INDIVIDUALS/ M^2
0
2
4
6
8
10
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 23

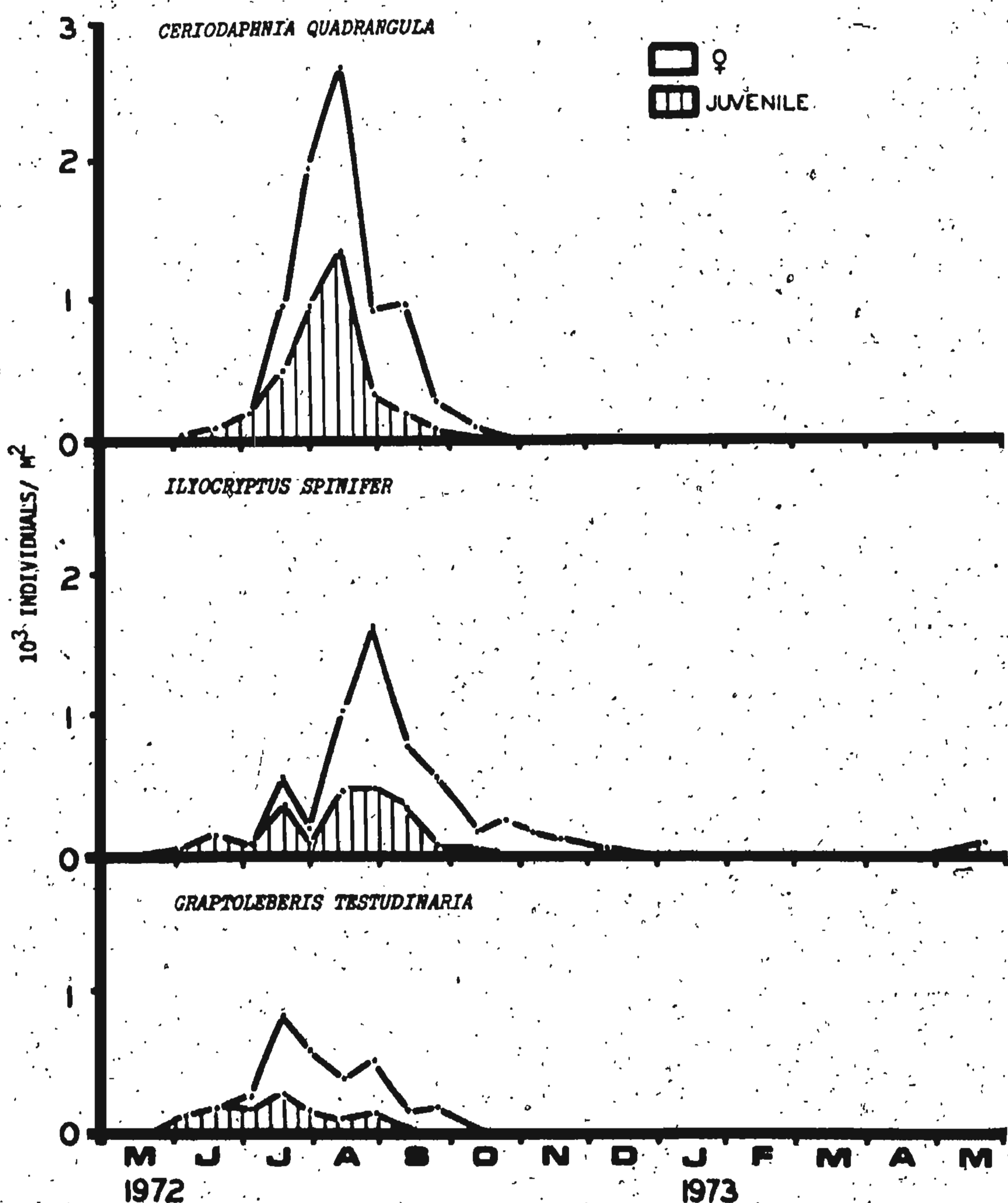

CERIODAPHNIA QUADRANGULA
♀
JUVENILE
ILYOCRYPTUS SPINIFER
GRAPTOLEBERIS TESTUDINARIA
10^3 INDIVIDUALS/ M^2
3
2
1
0
2
1
0
1
0
M J J A S O N D J F M A M
1972
1973

FIGURE 24

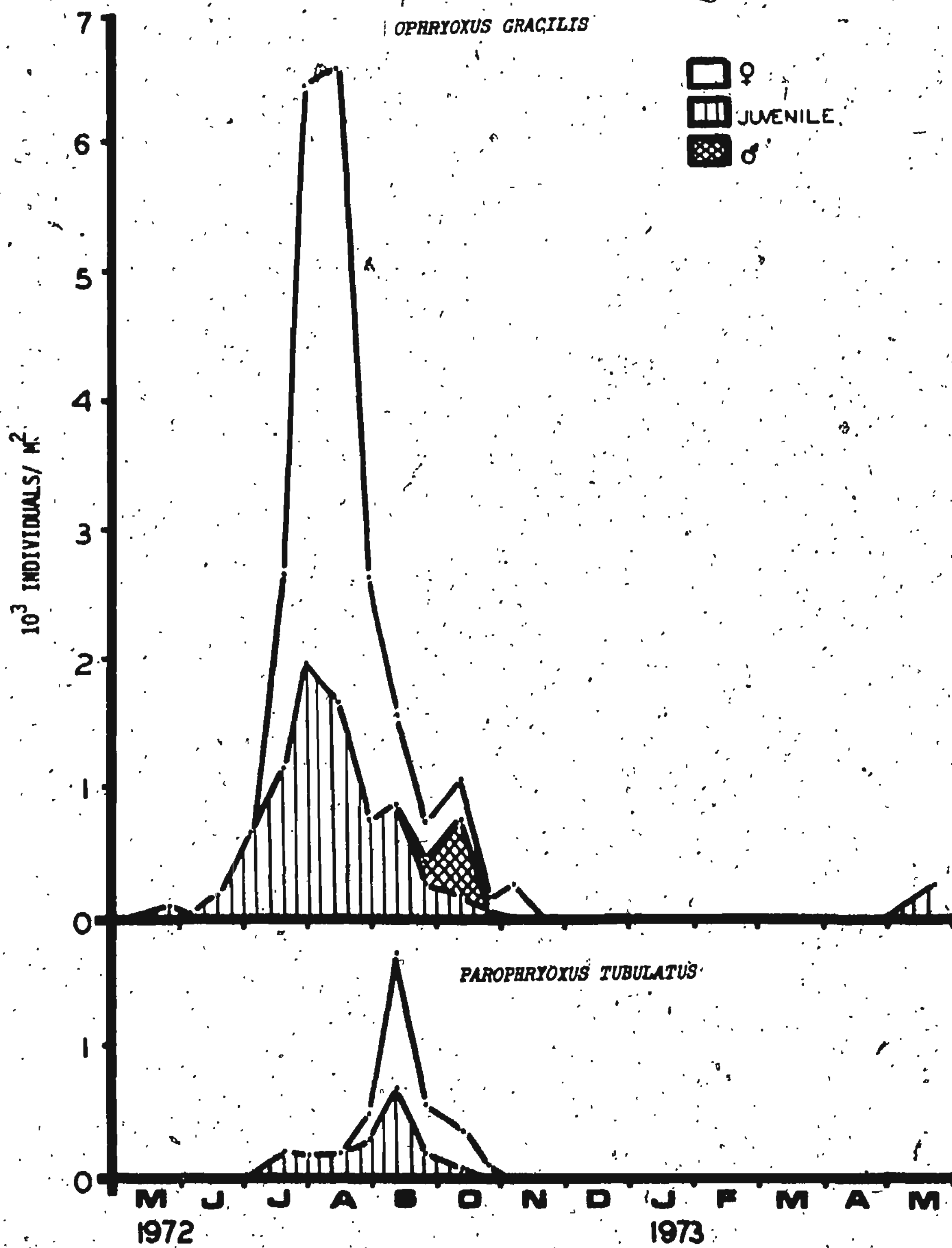

OPHRYOXUS GRACILIS
♀
JUVENILE
♂
10^3 INDIVIDUALS/ M^2
7
6
5
4
3
2
1
0
PAROPHRYOXUS TUBULATUS
1
0
M J J A S O N D J F M A M
1972
1973

FIGURE 25

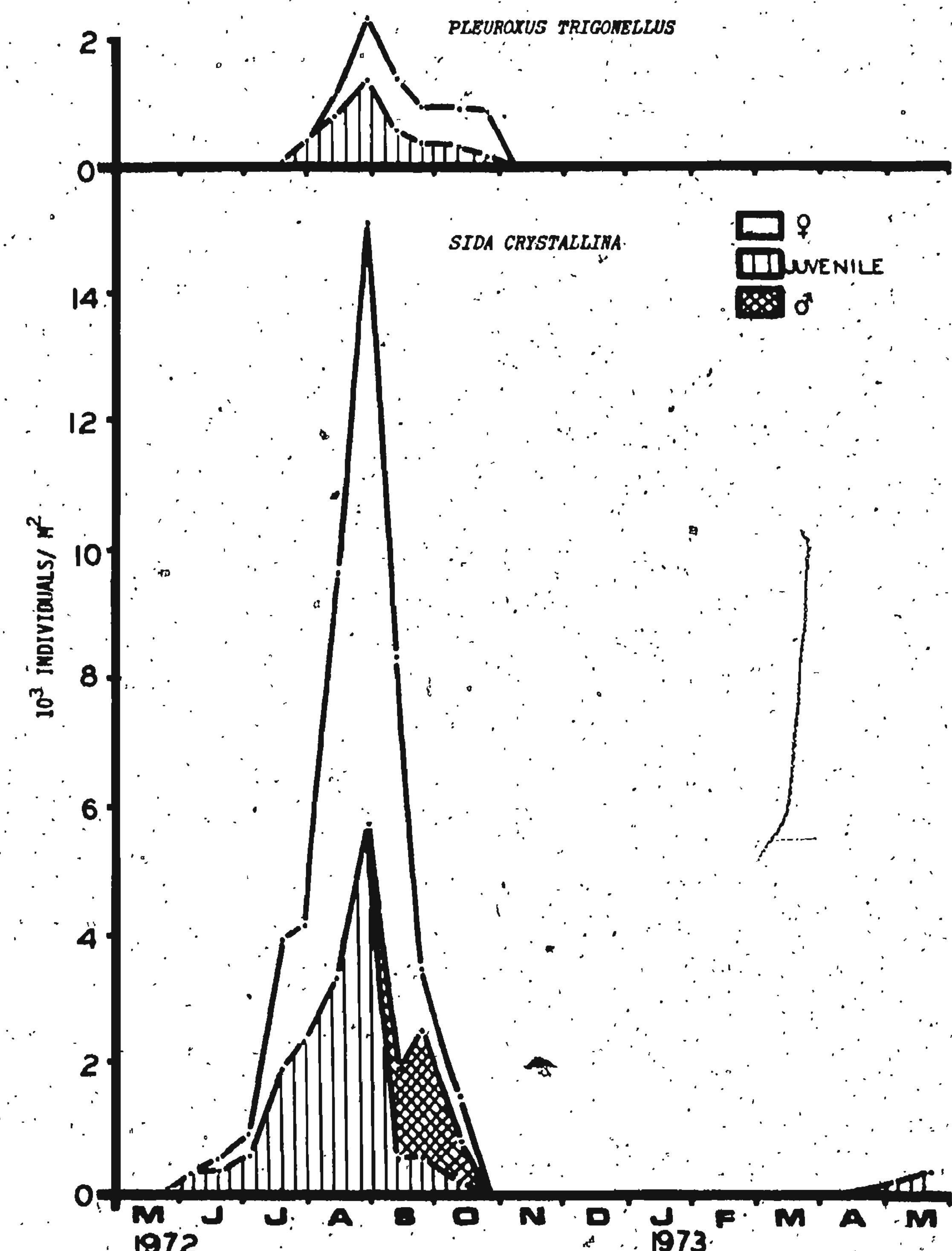

PLEUROXUS TRIGONELLUS
SIDA CRYSTALLINA
♀
JUVENILE
♂
10^3 INDIVIDUALS/ M^2
2
0
14
12
10
8
6
4
2
0
M J J A S O N D J F M A M
1972
1973

FIGURE 26

of the copepod species were quite variable. Three species were present all year, while five were restricted to the warmer months. The following results describe their seasonal dynamics.

La Manche Marsh. *Bryocamptus arcticus* occurred for a brief period in the spring and early summer (Fig. 27). There was one generation per year with adults occurring between May and early July. The maximum observed in 1972 was 1,150 over one m^2 and 1,300 over one m^2 in May, 1973. Adult females dominated the population in 1972. Ovigerous females and males occurred in minimal numbers in May, 1972. In the following year, late stage copepodids and adults were present on May 2. Ovigerous females were more numerous than the previous year. Males were not found in the samples, but several females had spermatophores attached. The disappearance of this species in the warmer months probably represents a resting stage. No copepodids were collected after June, which suggests that the resting stage is either an egg or nauplius. Resting eggs are common in harpacticoids (Fryer and Smyly, 1954).

Cyclops varicans rubellus was common except during the winter when it was absent (Fig. 27). There were two generations per year, with adults occurring between March and November. There were two maxima of adults, which occurred in April, 1973 (2,020 over one m^2) and September, 1972 (2,250 over one m^2). Males were never more numerous than females. They also occurred from March until November. Nauplii and copepodid stages were not counted but the presence of copepodids was noted. Stages I and II were seen in late May and June. Stage III appeared in June. Stages IV and V appeared in July and early August. Breeding activity occurred again in September as females were carrying spermatophores. Immature stages reappeared in late September and remained until December. No late stage copepodids or adults were found in the mud during the winter. However, more winter collections would be required to determine the overwintering stage. Adult females were the first specimens to be collected in the spring. Gurney (1933) assumed that *C. varicans* undergoes resting stages as adults. Chaston (1969) also has shown that adult *C. varicans* can withstand anaerobic conditions longer than immature stages.

Cyclops vernalis adults were collected in every month except March and April (Fig. 28). Maximum numbers of adults occurred in August (3,500 over one m^2). Ovigerous females were observed in June through September with maximum egg production in August. Males were collected between June and December. During August and September, a number of males were observed containing spermatophores. Copepodids first appeared in July, 1972, and remained until December, 1972. The relative abundance of copepodids was quite uniform during their period of occurrence. Except for July, most of the stages were present in the collections. Late stage copepodids occurred in low numbers during March and April, 1973, but were absent in May. Since the numbers of immatures were quite uniform, the number of generations per year was not definitely established. If the July copepodids became adults and produced another fall generation, then there were two generations per year. Since there was no reproductive activity observed in the winter or spring, the copepodids which appeared in March, 1973, were probably overwintering forms, though not necessarily in the stage collected. Rylov (1948) stated that "this crustacean probably withstands drying in the advanced stages of metamorphosis, but not in the resting-egg stage."

Eucyclops agilis adults were common throughout the period of study. There was a minimum in May, 1972 (300 over one m^2) and maximum in October (2,800 over one m^2) and January (2,300 over one m^2) (Fig. 28). Breeding activity occurred between August and January. Extremely active copulatory activity occurred in January. Most of the males seen were containing spermatophores in their fifth thoracic segments, and the females had spermatophores attached. Subsequently, the males died off in late January. The females overwintered as active adults. Egg production occurred in the spring (March-May). Hatching commenced in April, since nauplii were present in mid-April. Stage I and II copepodids were numerous in May. Stage III appeared in late May. Stages IV and V were common in June and early July. By late July, late stage copepodids had disappeared, but they reappeared in late October. This would indicate that there are two generations of *E. agilis* per year.

Macrocyclops albidus was the most abundant copepod in La Manche Marsh. The seasonal distribution is similar to that of *E. agilis*, but the winter maximum was more pronounced. Adult females were present throughout the year, but the numbers were low in May and June, 1972 (Fig. 29). The maximum was observed in February, 1973, under 36 cm of ice (5,700 over one m^2). Ovigerous females were found from May until October, 1972, and they first appeared in March in the following year. Breeding activity occurred between August and January.

Copulatory activity was most evident in late August and January. In January, most of the males contained spermatophores and females had one to four spermatophores attached to the genital segment. The females must have retained the sperm acquired in December or January to fertilize the eggs in the following spring. There were two generations per year. Hatching began in mid-April, and the first copepodids appeared in late May. Late stage copepodids were abundant in June and early July, which resulted in a summer generation of adults in July and August. Nauplii of the summer generation were abundant in September. Subsequently, copepodid stages were produced which eventually reached maturity in December.

Macrocyclops fuscus was the least frequently encountered cyclopoid copepod in La Manche Marsh. It was collected almost entirely in the summer and fall (Fig. 29). It exhibited one generation per year, with adult females occurring from July until November. It showed a short reproductive period, with ovigerous females and males present in late August and September. No nauplius stages could be distinguished. Several immature copepodids were observed prior to the appearance of adults in July. In January, one stage IV or V copepodid was found in a mud sample. This suggests that *M. fuscus* may be capable of overwintering in its late copepodid stages.

Orthocyclops modestus also was confined to the summer and fall (Fig. 27). There was just one generation per year, with adults present between June and November. The maximum was observed in early August (2,950 over one m^2). Ovigerous females occurred in July and August, while males were collected from July until November.

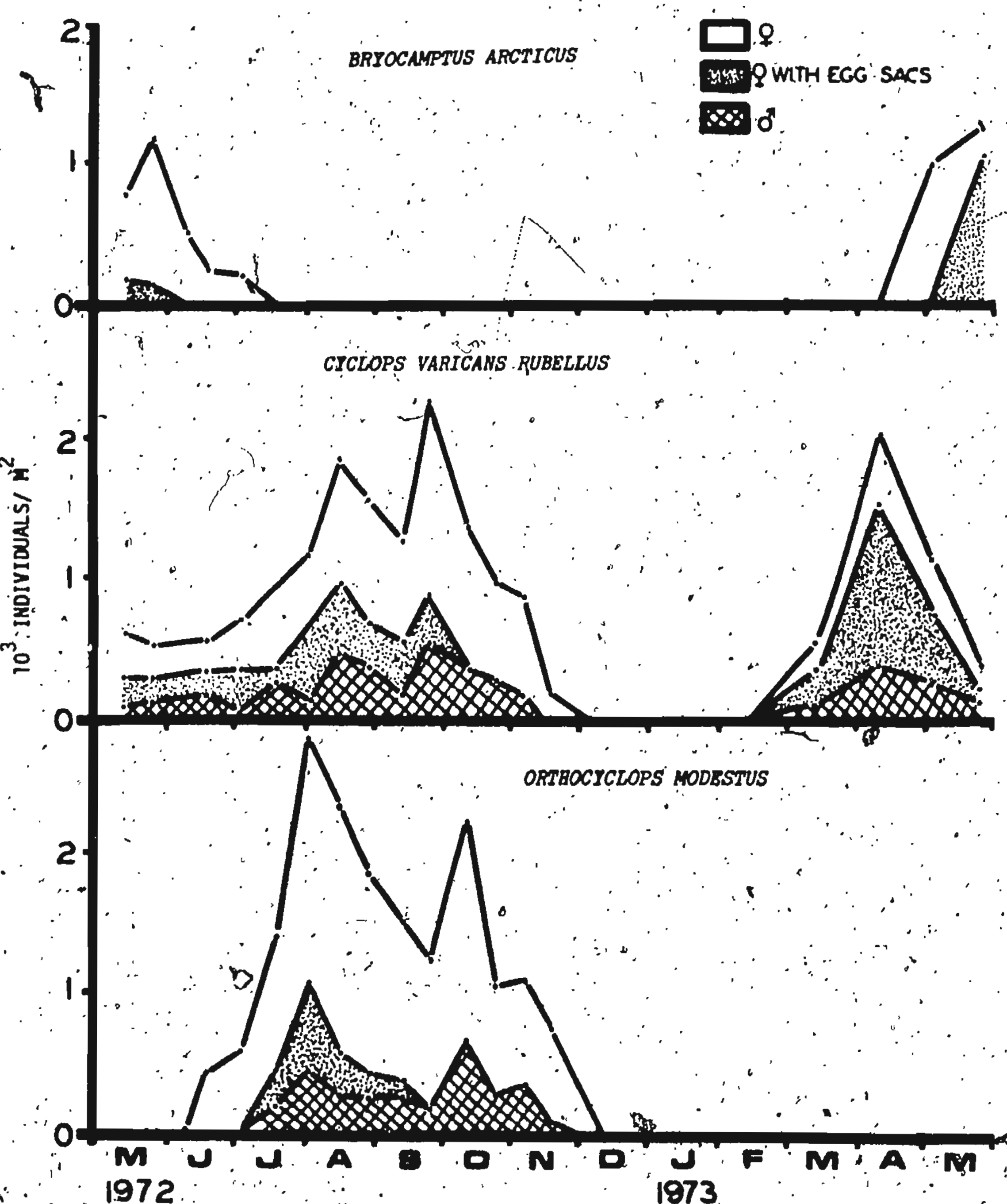
Nauplius stages could not be distinguished. However, late stage copepodids were observed in late May and June. Immatures decreased after June, but they reappeared in late October and November. Mud samples were examined in the winter but no immatures were found.

Round Pond. *Eucyclops agilis* was a common species found throughout the year, but there were low numbers in May and June, 1972, and from January to April, 1973 (Fig. 30). The maximum observed was 3,100 over one m^2 in mid-August. There were two generations per year, with adult females always dominating the population. As in La Manche Marsh, copepodid stages occurred from May to July and in September through November. The winter generation of adults did not increase as they did in La Manche Marsh, which could have been the result of predation.

Macrocyclops albidus was the most abundant copepod in Round Pond. It also exhibited two generations per year, with adults occurring throughout the year (Fig. 30). The summer maximum was similar to that found in La Manche Marsh (3,700 over one m^2), but there was no pronounced winter maximum. The numbers were relatively low from May through July and in November and December, 1972. The development of copepodid stages was similar to that described in La Manche Marsh. Copepodid stages were collected from May until July, and again in the fall (late September until November). Breeding activity was evident from August through January. Since no males appeared until July, the winter generation of females probably retained sperm acquired in December and January, which was used to fertilize the spring production of eggs.

Figures 27-29

Seasonal distributions of individual copepod species (adults) in La Manche Marsh.



♀
♀ WITH EGG SACS
♂
BRYOCAMPTUS ARCTICUS
CYCLOPS VARICANS RUBELLUS
ORTHOCYCLOPS MODESTUS
10^3 INDIVIDUALS/ M²
0
1
2
M J J A S O N D J F M A M
1972
1973

FIGURE 27

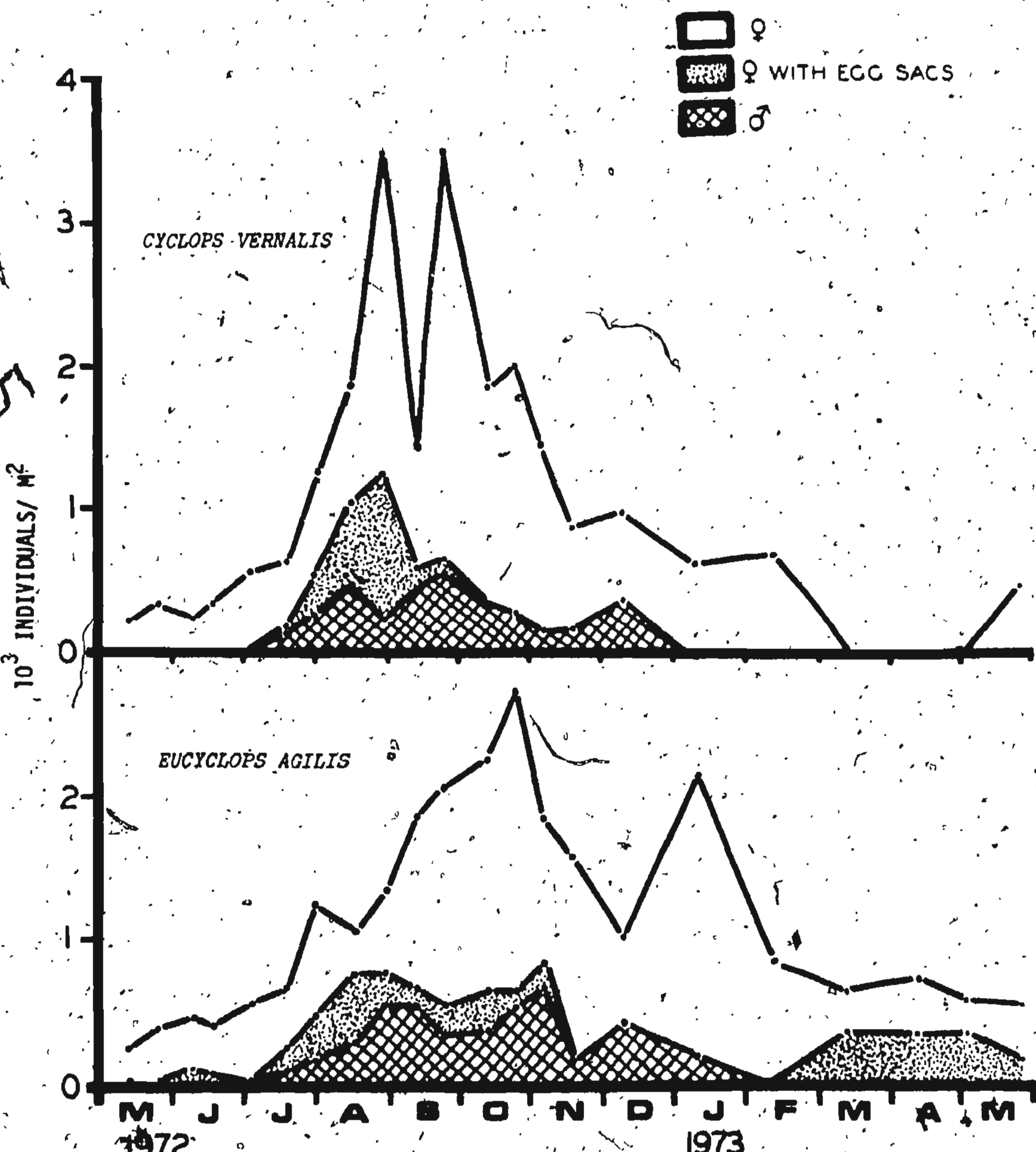
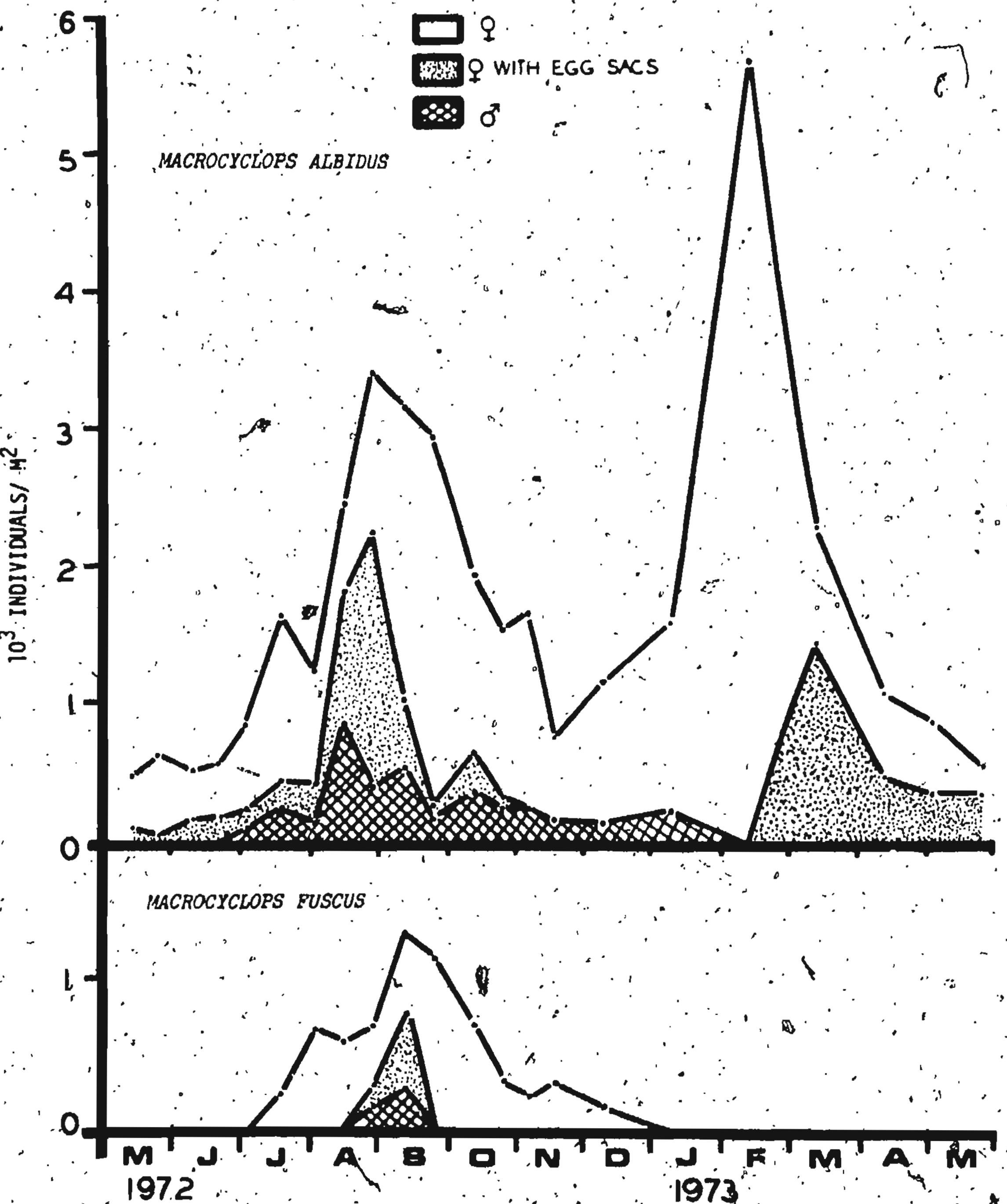

♀
♀ WITH EGG SACS
♂
4
3
2
1
0
2
1
0
CYCLOPS VERNALIS
EUCYCLOPS AGILIS
10^3 INDIVIDUALS/ M^2
M J J A S O N D J F M A M
1972
1973

FIGURE 28



♀
♀ WITH EGG SACS
♂
MACROCYCLOPS ALBIDUS
MACROCYCLOPS FUSCUS
10^3 INDIVIDUALS/ M^2
6
5
4
3
2
1
0
1
0
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 29

Figure 30

Seasonal distributions of individual copepod species (adults) in Round Pond.

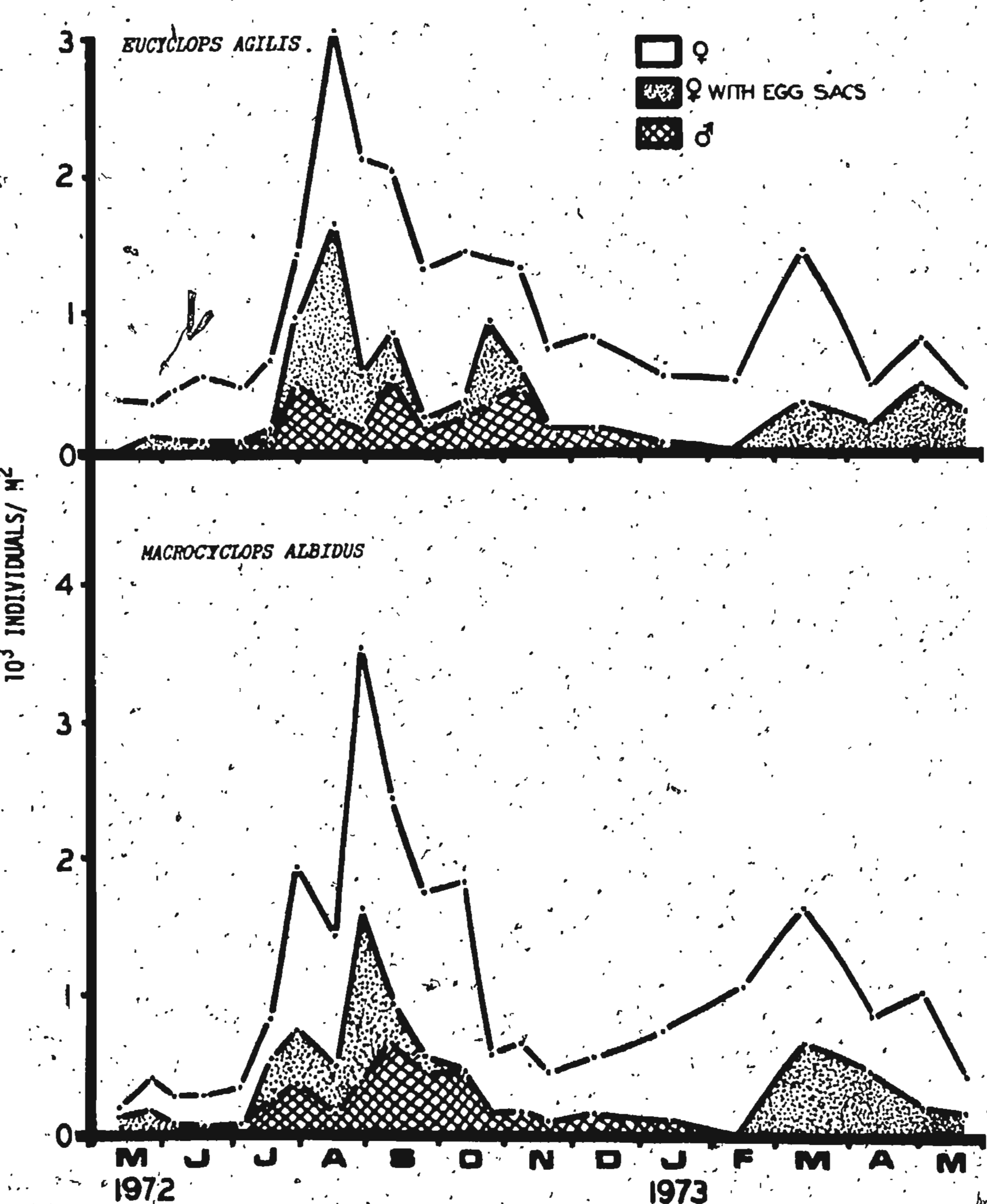

EUCYCLOPS AGILIS
♀
♀ WITH EGG SACS
♂
3
2
1
0
MACROCYCLOPS ALBIDUS
4
3
2
1
0
10^3 INDIVIDUALS/ M^2
M
J
J
A
S
O
N
D
J
F
M
A
M
1972
1973

FIGURE 30

Macrocyclops ater was collected on several occasions, but the numbers were always insignificant. The species occurred in August and November. No ovigerous females were found.

Diaptomus minutus and *Epischura nordenskioldi* were collected on three occasions in minimal numbers in July and August. These species are limnetic forms and are not usually encountered in the littoral area.

Qualitative Seasonal Succession

Qualitative seasonal succession was studied in 10 waters on the Avalon Peninsula. Lists of species and the relative abundances between May and September, 1972, are shown in Appendix B. Additional information describing the areas is given in Appendix A. Temperature, dissolved oxygen, and color measurements are given in Appendix D.

Twenty-eight species which occurred in La Manche Marsh and Round Pond also were found in the qualitative study areas (Table 3). The qualitative studies showed that the seasonal patterns of some microcrustaceans can vary, as shown in Table 3 and Appendix B--*Acantholeberis curvirostris* (Pond 44), *Acroperus alonoides* (Stream 30 and Pond 40), *Alona rustica* (Stream 29 and Pond 41), *Disparalona acutirostris* (Pond 41), *Graptoleberis testudinaria* (Pond 44), *Pleuroxus procurvus* (Pool 33, Pool 34, Pond 41, Pond 43, and Pond 44), and *Simocephalus serrulatus* (Pool 33, Pool 34, Pool 40, and Pond 41). The seasonal succession studies also showed that sampling on any one date seldom revealed all species known for a particular locality (Appendix B, Table 6).

The seasonal distributions of 10 microcrustacean species, which were not found in La Manche Marsh or Round Pond, are described below.

Cladocera

Alona costata was collected only in Pond 47. Parthenogenetic females first appeared in mid-June and remained until the end of October. The largest numbers (mostly adult females) seemed to occur in mid-August. No ephippial females or males were observed.

Alona guttata was collected in two of the study areas; namely, Stream 30 and Pond 43. This species was found in low numbers and showed a rather sporadic appearance. In Pond 43 it was collected once in June and on four occasions between late September and mid-November. A similar distribution was observed in Stream 30, where it occurred in May and between September and mid-November. Several ephippial females were collected in mid-October in Stream 30. No males were found.

Alonella exigua was found only in Pond 47. Juveniles and a few adult females were collected in June. Ephippial and parthenogenetic females were still present in late November when the last sample was taken. The population seemed to be largest in August. Minimal numbers of males were observed in early November.

Ceriodaphnia reticulata was collected only in Pond 47. Adult females first appeared in late June, when they shared dominance with *Latona setifera* and *Chydorus sphaericus*. They were not found during most of July, but reappeared in mid-August and remained until the end of September. Ephippial females were numerous in early September.

Chydorus ovalis was found only in Stream 29. It was most abundant in late May and early June, when it was dominant or codominant with *Disparalona acutirostris*. It first appeared in late May and remained until November. A few ephippial females were observed in the October 25 sample. One male was found in the November 6 sample.

Eurycercus glacialis was present in Pond 43 and Pond 47. Parthenogenetic females occurred from May until November in Pond 47, and from June until October in Pond 43. Maximum numbers occurred in August and September in both localities. Unfortunately, no males or ephippial females were collected in either of the localities.

Eurycercus sp. occurred in Pond 41 and Pond 44. Parthenogenetic females were found from May until November in both localities, but usually in low numbers. Males were observed in October and early November, while ephippial females were present in November.

Copepoda

Canthocamptus vagus was present in Pond 41, Pond 44, and Pond 43. Adult females were present in the first samples taken in early May in each of the ponds. In the first two ponds females occurred from early May to late June, while in Pond 43, females were present until mid-July. Only two ovigerous females were observed in early May in Pond 41. Males were collected in May in Pond 43.

Cyclops venustoides pilosus was found only in Stream 29. A few immatures were found in May. Adult females occurred between June and late November. The population seemed to reach its peak in

September. Ovigerous females were never abundant but did occur between early July and early September. Males were numerous in September and October, comprising approximately 40% of the population.

Paracyclops yeatmani n. sp. also was collected only in Stream 29. Adult females were present when the first sample was taken in May, 1972, and were still present in low numbers in the winter. Maximum numbers occurred from April through June when ovigerous females dominated the population. Males were very scarce, but several specimens were found in October and November.

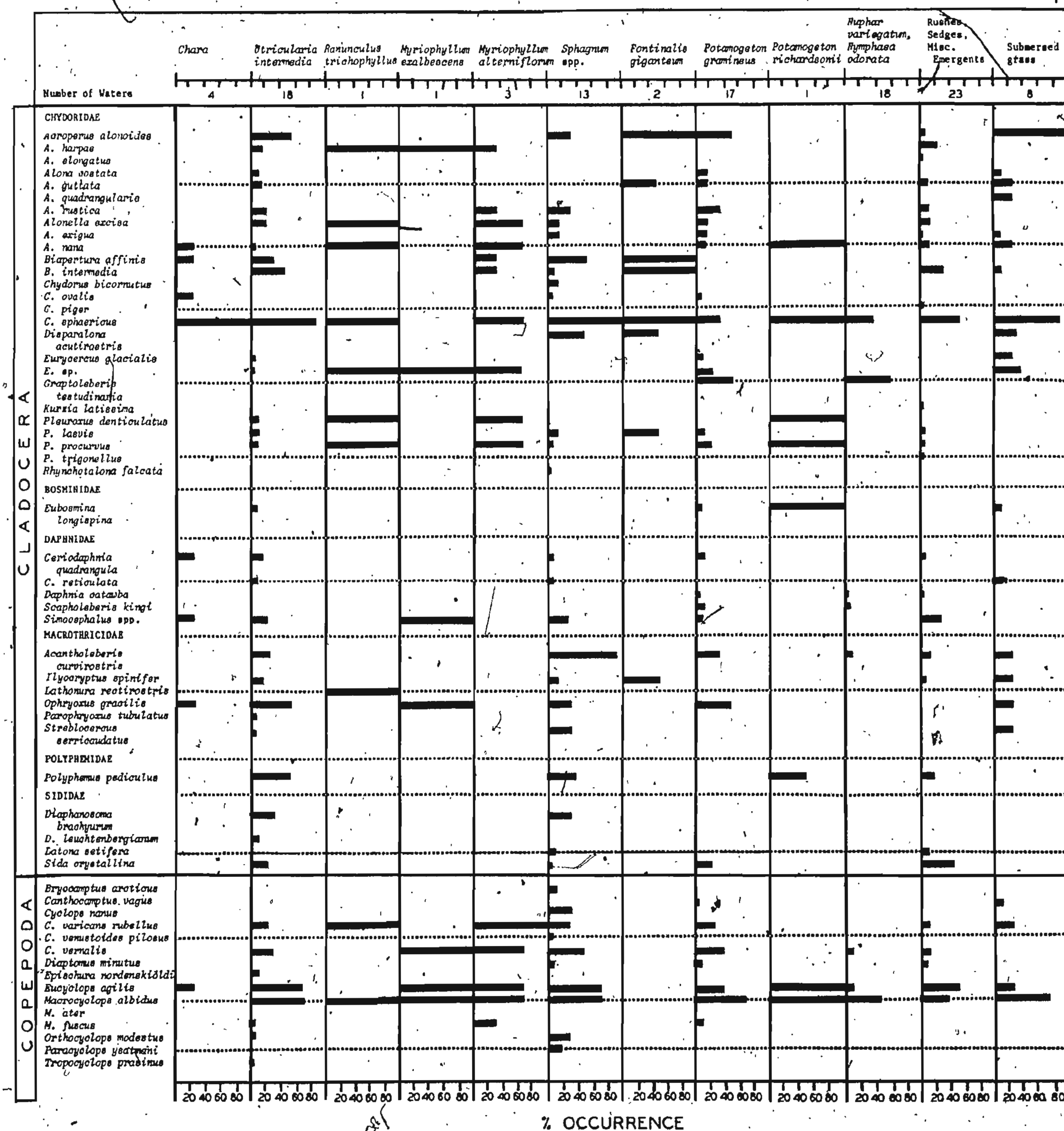
Plant and Animal Associations

The relationship between the occurrence of plants and microcrustaceans is shown in Figure 31. There are several limitations in attempting to show plant and animal associations in this way, and these should be kept in mind. Actual numbers were not determined and so the results do not show the quantitative importance of each microcrustacean. Secondly, animals which are not found on the plant surface also were collected. The relationship between swimming forms, benthic forms, and forms on particular plants does not necessarily represent ecological preference. Finally, several plants were only found in one water and were only sampled at one time during the year. The percentages given for each plant (or plant-type) did not distinguish between frequently sampled plants and those sampled on one or two occasions. It should be realized that the percentages of microcrustaceans associated with the less frequently sampled plants are not as significant.

After all collections from each plant species were examined,

Figure 31

Plant and microcrustacean associations.


Chara
Utricularia intermedia
Ranunculus trichophyllus
Myriophyllum exalbescens
Myriophyllum alterniflorum
Sphagnum spp.
Fontinalis giganteum
Potamogeton gramineus
Potamogeton richardsonii
Nuphar variegatum, Nymphaea odorata
Rushes, Sedges, Misc. Emergents
Submersed grass
Number of Waters
4
18
1
1
3
13
2
17
1
18
23
8
CLADOCERA
CHYDORIDAE
Acroperus alonoides
A. harpae
A. elongatus
Alona costata
A. guttata
A. quadrangularis
A. rustica
Alonella excisa
A. exigua
A. nana
Biapertura affinis
B. intermedia
Chydorus bicornutus
C. ovalis
C. piger
C. sphaericus
Disparalona acutirostris
Eurycercus glacialis
E. sp.
Graptoleberis testudinaria
Kurzia latissima
Pleuroxus denticulatus
P. laevis
P. procurvus
P. trigonellus
Rhynchotalona falcata
BOSMINIDAE
Eubosmina longispina
DAPHNIDAE
Ceriodaphnia quadrangula
C. reticulata
Daphnia catawba
Scapholeberis kingi
Simocephalus spp.
MACROTHRICIDAE
Acantholeberis curvirostris
Ilyocryptus spinifer
Lathonura rectirostris
Ophryoxus gracilis
Parophryoxus tubulatus
Streblocercus serricaudatus
POLYPHEMIDAE
Polyphemus pediculus
SIDIDAE
Diaphanosoma brachyurum
D. leuchtenbergianum
Latona setifera
Sida crystallina
COPEPODA
Bryocamptus arcticus
Canthocamptus vagus
Cyclops nanus
C. varicans rubellus
C. venustoides pilosus
C. vernalis
Diaptomus minutus
Epischura nordenskiöldi
Eucyclops agilis
Macrocyclops albidus
M. ater
M. fuscus
Orthocyclops modestus
Paracyclops yeatmani
Tropocyclops prasinus
20 40 60 80
% OCCURRENCE

some differences were evident.

Chara globularis Thuill. was found in four waters, two from the West Coast and two from the Avalon Peninsula. It occurred on firm, sandy bottoms on the West Coast and soft, mud bottoms on the Avalon Peninsula. There were few species in the collections taken amongst *Chara* beds. *Chydorus sphaericus* was the only species which was found in all the samples. It also was the most abundant species in every collection. The following species were found in one pond and in low numbers: *Alonella nana*, *Biapertura affinis*, *Ophryoxus gracilis*, *Simocephalus serrulatus*, and the copepod, *Eucyclops agilis*.

<u>Broad-leaved submersed plants</u>. *Potamogeton gramineus* L. inhabits a wide range of bottom types and water chemistry, as it was common on the West Coast, the central part of the island, and the Avalon Peninsula. *Potamogeton gramineus* was a popular plant-substrate as there was a total of 28 species found in the 17 collections. The collections most often included *Graptoleberis testudinaria*, which occurred in 58% of the total samples, *Sida crystallina* (52% of the samples), and the copepod, *Macrocyclops albidus* (52% of the samples). Of these, *Sida crystallina* seemed to be the most consistently abundant species. The other two species varied from very low numbers to abundant in some collections. The other common and abundant species included *Acroperus alonoides* (48%), *Ophryoxus gracilis* (48%), *Cyclops vernalis* (40%), and *Eucyclops agilis* (40%). *Potamogeton richardsonii* Benn (Rydb.), which was sampled once in Bonne Bay Little Pond on the West Coast, was dominated by *Graptoleberis testudinaria* and *Alonella nana*. In addition, *Pleuroxus denticulatus*, *P. procurvus*, and

Sida crystallina were collected in low numbers. *Potamogeton alpinus* also was found in just one pond on the West Coast (Pond 61). However, no littoral forms were found in the sample.

Submersed Bryophytes. Thirteen collections were taken amongst *Sphagnum* spp., one from the West Coast (Pool 71), eleven from the Avalon Peninsula, and one from Labrador. The waters were characteristically small, shallow, and with a low pH. The collections revealed that *Chydorus sphaericus* (100%) and *Acantholeberis curvirostris* (91%) were the most common cladocerans, while *Macrocyclops albidus* (82%) was the most frequent copepod. The two cladocerans were the dominant or co-dominant forms in eight of the collections. Other common micro-crustaceans included *Polyphemus pediculus* (44%), *Disparalona acutirostris* (44%), *Eucyclops agilis* (44%), and *Cyclops vernalis* (38%). The moss, *Fontinalis giganteum,* occurred in two waters, one from the West Coast (Pool 59) and the other from a stream on the Avalon Peninsula (Stream 30). The most common and abundant associated microcrustacean species were *Acroperus alonoides, A. harpae, Biapertura intermedia,* and *B. affinis*. *Acroperus harpae* was the dominant form in Pool 59, while *A. alonoides* dominated in Stream 30. *Chydorus sphaericus* also was found in both samples, but the numbers were low. No copepods were collected. The other bryophyte, *Drepanocladus revolvens* (SW.) Warnst, was sampled in four ponds from the Avalon Peninsula (Pond 43, Lake 39, Pond 41, and Pond 46). In the first three localities, the plants were found overlying a rocky bottom. However, in Pond 46 the plants inhabited a soft, mud bottom. *Acroperus alonoides* also was the most frequent and dominant cladoceran associated with this plant.

Other Cladocera which were abundant but found only in three of the waters included *Pleuroxus procurvus*, *Ophryoxus gracilis*, and *Biapertura intermedia*.

Fine-leaved submersed plants. *Ranunculus trichophyllus* Chaix was found in Pool 60. The bottom was sandy and firm. *Acroperus harpae*, *Pleuroxus procurvus*, *Chydorus sphaericus*, and *Lathonura rectirostris* were associated with this plant. *Pleuroxus procurvus* was the dominant microcrustacean. Three collections were taken among *Myriophyllum alterniflorum* DC. stands, two from Pool 60 and one from Pool 66. *Cyclops varicans rubellus* was present in all three collections, but the numbers were low. *Alonella nana*, *A. excisa*, and *Pleuroxus denticulatus* were found in two collections and represented the most abundant species. *Myriophyllum exalbescens* Fernald was sampled in Pool 71. *Acroperus harpae* was the dominant species. Other less numerous species included *Eurycercus* sp., *Ophryoxus gracilis*, *Simocephalus serrulatus*, and *Macrocyclops albidus*. The other fine-leaved macrophyte, *Utricularia intermedia* Hayne, was common on the West Coast, the central part of the island, and the Avalon Peninsula, inhabiting a total of 18 waters. *Chydorus sphaericus* (82%) and *Macrocyclops albidus* (82%) were the species which were found most often in the collections. They were abundant but seldom were they the dominant microcrustaceans. *Acroperus alonoides*, *Biapertura intermedia*, *Ophryoxus gracilis*, *Polyphemus pediculus*, and *Eucyclops agilis* were found in 58%, 48%, 48%, 48%, and 68% of the samples, respectively. *Ophryoxus gracilis* and *Biapertura intermedia* were usually the dominant forms when present. Submersed grasses also were sampled in eight waters, all of which were located on the Avalon Peninsula. The most frequent species were similar to those associated with *Utricularia intermedia*. The following microcrustaceans were associated with submersed grasses: *Acroperus alonoides* (100%), *Chydorus sphaericus* (87%), *Eurycercus glacialis* (50%), *Alona quadrangularis* (37%), and *Alonella nana* (37%). All of the species were abundant but *Chydorus sphaericus* usually dominated, or shared dominance with *Acroperus alonoides* or *Alona quadrangularis*.

Broad-leaved, floating plants. The water lilies, *Nuphar variegatum* Engelm, and *Nymphaea odorata* Ait. were sampled in 18 waters, two from the West Coast and the remaining localities were on the Avalon Peninsula. *Graptoleberis testudinaria* (62%), *Polyphemus pediculus* (48%), and *Macrocyclops albidus* (48%) were the species most frequently associated with these plants. However, the numbers were always low. Few other microcrustaceans were collected. A plant with very small floating-leaves, *Callitriche* sp., was sampled in Pond 44. The only species collected were *Graptoleberis testudinaria* and *Alonella nana*. Again the numbers were low.

Rushes, sedges, and other emergents. A total of six macrophytes were included in this group: *Eleocharis palustris* (L.) R & S., *Sparganium* spp., *Juncus effusus* L., *Equisetum fluviatile* L., *Eriocaulon septangulare* With., and *Carex* spp. They occurred in 23 waters on the West Coast and the Avalon Peninsula. It is difficult to interpret any preference of microcrustaceans for these plants because in most cases few animals were collected. Also, few animals showed high per cent occurrences on any of the plants. Only *Chydorus sphaericus* (50%), *Sida crystallina* (43%), *Macrocyclops albidus* (50%), and *Eucyclops agilis* (43%) were found in a significant portion of the 23 samples. The other 13 species which were collected were found in less than 25% of the collections.

Observations on Microdistribution of Some Cladocera

Five plant species were studied to determine if Cladocera showed preferences for particular parts of a plant (i.e. upper or lower leaves, upper or lower surface of leaves, or different portions of the stem). Ten collections for particular parts of the plants were made on two occasions (July 6 and August 9). The plants that were sampled inhabited Pool 27, Stream 31, Pond 43, Pond 44, or Pond 46. The results of the 20 collections are shown in Table 6.

Potamogeton gramineus. A total of seven species were associated with this plant in Pond 43. *Graptoleberis testudinaria* was found on the upper surface of submersed leaves in 17 of the collections. *Simocephalus serrulatus* and *Sida crystallina* were found on all portions of the stem. However, *S. serrulatus* was more common on the lower portion of the stem. *Alonella excisa* and *Ophryoxus gracilis* were the dominant species collected on the submersed leaves. The ubiquitous forms, *Chydorus sphaericus* and *Alonella nana*, were found on all parts of the plant. However, *A. nana* was absent from the July collections. Observations of live animals showed that *Chydorus sphaericus* and *Alonella nana* most often used algal filaments (periphyton) as their substrate.

TABLE 6

MICRODISTRIBUTION OF CLADOCERA ON SEVERAL PLANTS

PLANTS	*Potamogeton gramineus*								*Nuphar variegatum*								*Callitriche* sp.							
CLADOCERA	a_1	b_1	c_1	d_1	a_2	b_2	c_2	d_2	a_1	b_1	c_1	d_1	a_2	b_2	c_2	d_2	a_1	b_1	c_1	d_1	a_2	b_2	c_2	d_2
Alonella excisa	5	1	–	–	9	–	–	–																
A. nana	–	–	–	–	3	2	4	4																
Chydorus sphaericus	5	2	4	3	4	–	5	1	4	–	2	1	–	–	3	1	4	–	2	3	3	–	1	1
Graptoleberis testudinaria	7	–	–	–	10	–	–	–	8	–	–	–	2	–	–	–	1	–	–	–	5	–	–	–
Ophryoxus gracilis	4	–	–	–	7	1	–	2																
Pleuroxus procurvus									5	–	1	–	4	–	–	–								
Sida crystallina	–	2	6	7	–	–	6	6																
Simocephalus serrulatus	–	1	4	9	1	–	3	9	1	–	–	4	–	–	1	6	1	–	2	7	–	–	4	9

TABLE 6 (Continued)

CLADOCERA \ PLANTS	*Utricularia intermedia*								*Fontinalis giganteum*							
	a_1	b_1	c_1	d_1	a_2	b_2	c_2	d_2	a_1	b_1	c_1	d_1	a_2	b_2	c_2	d_2
Acroperus alonoides	7	–	–	–	4	–	–	–	8	–	1	–	8	–	–	2
Chydorus sphaericus	8	3	6	4	2	–	–	–	9	2	1	2	4	–	1	1
Eurycercus sp.	7	–	1	–	9	–	–	–								
Ophryoxus gracilis	2	–	1	1	1	–	2	–	5	–	2	–	4	–	2	1
Pleuroxus procurvus	4	–	–	–	3	–	–	–								
P. laevis	3	–	–	–	2	–	–	–	3	–	–	–	1	–	–	–
Sida crystallina	2	–	–	2	2	–	–	7								
Simocephalus serrulatus	2	–	1	4	1	–	–	3								

Explanation: a = upper surface of leaves, b = lower surface of leaves, c = upper stem, d = lower stem $a_1b_1c_1d_1$ (July 6 sample), $a_2b_2c_2d_2$ (August 9 sample). Values given for each habitat represent the number of collections in which the species was numerous (greater than 10% of total Cladocera present in a sample).

Nuphar variegatum (in Pond 43). Collections taken amongst leaves which were floating revealed no animals. Even though floating leaves are more characteristic of this plant, some submersed leaves were observed. This situation probably resulted from excessive crowding or young plants which had not yet reached the surface. The results represent samples from slightly submersed leaves. *Graptoleberis testudinaria* was the most abundant species. In July, *G. testudinaria* occurred in 8 samples but in August it was present in only 2 collections. It was found on the upper surface of the submersed leaves. In addition, *Chydorus sphaericus* and *Pleuroxus procurvus* were present in low numbers in the July and August samples. *Simocephalus serrulatus* was the only cladoceran associated with the stem.

Callitriche sp. (in Pond 44). *Simocephalus serrulatus* was collected in 16 samples taken from the lower portion of the stem. The only other cladocerans inhabiting the plants were *Chydorus sphaericus* and *Graptoleberis testudinaria* which were collected on the upper surface of the leaves (if slightly submersed).

Utricularia intermedia (in Pool 27 and Pond 46). Eight species were associated with this plant. *Chydorus sphaericus* was the most common and abundant cladoceran in the July collection, occurring on all parts of the plant. However, it was found in only two samples in August. In addition, *Eurycercus* sp. and *Acroperus alonoides* occurred in July and August samples taken from the leaves. *Sida crystallina* was collected more consistently on the lower stem. It was present in low numbers in July in 4 samples, 2 from the stem area and 2 from the branches. In August, it reached high numbers in the lower-stem portion (7 collections), and low numbers in two leaf collections. Bladders also were examined and the animals found included *Acroperus alonoides*, *Chydorus sphaericus*, *Pleuroxus procurvus*, and *P. laevis*.

Fontinalis giganteum (in Stream 30). *Chydorus sphaericus* and *Acroperus alonoides* were present in high numbers in July, occurring in 9 and 8 collections, respectively. However, in August *C. sphaericus* was collected in only 4 samples. *A. alonoides* was still quite frequent, occurring in 8 samples. No particular part of the plant could be sampled with the pipette. Observing live animals in a large Syracuse dish showed that *C. sphaericus* was able to rest on the very margins of the leaves and also go down into the leaf. *A. alonoides* seems to rest where the leaves are attached to the stem. *Ophryoxus gracilis* was observed grasping the stem with its first pair of legs.

Feeding Behavior

Cladocera

There is considerable diversity in the types of food and food-collecting mechanisms in littoral microcrustaceans. Several species of Cladocera were studied in an attempt to elucidate their feeding behavior. In most cases, animals were collected from just one locality.

Eurycercus glacialis is a bottom and plant scraper (Frey, 1971b) showing similar habits, as has already been described for *E. lamellatus* (Fryer, 1963). The most important food seemed to be algae, as it comprised from 50%-90% of the stomach contents. Naviculoid diatoms, *Tabellaria*, and unicellular Chlorophyta were the forms most often encountered. Detritus also was collected by the animal, usually light brown in color, but it only seemed to be the major food item in the late fall. Inorganic material never seemed to be found in large quantity. The filamentous algae such as *Oscillatoria* were only found as a small broken piece. Even though scraping is not considered a "selective" feeding mechanism, the shape of some algae did not permit their collection.

Pleuroxus laevis also is a bottom and plant scraper. However, algae seemed to play a minor role as a food constituent. The majority of the gut contents (70-95%) were light brown organic material. The average particle size of the material was approximately 2μ, and rather uniform. Relatively few diatoms were collected. The food seemed to remain consistent throughout the summer and fall.

The gut contents of *Biapertura intermedia* were similar to the preceding species. Organic material constituted a large amount of the food (70-80%). However, much of this material had small green circles (1-5μ) scattered amongst it. It is possible that these were algal material which had been broken up and partly digested. There were bits of coarse inorganic material which comprised from 5-10% of the stomach contents. No algal cells could be identified in the material.

Disparalona acutirostris was recently transferred from *Alonella* to *Disparalona* by Fryer (1971a). It is essentially a bottom form, which stirs up particles as it moves along the bottom, sweeping them into the food groove. The stomach contents were always dominated by organic material, usually of small size (2-8μ). The flocculent matter also contained some inorganic material but never in significant quantities. The only plant material consisted of an occasional naviculoid diatom or unicellular Chlorophyta. The stomach contents again seemed to remain quite consistent throughout the warmer months.

Acantholeberis curvirostris showed a marked variation in the relative amounts of different food during its period of occurrence. Organic material sometimes dominated the stomach contents, but no pattern could be established. Animals in the same sample often showed algae as the largest constituent. The color of the organic material also differed throughout the year. In Stream 29, the material was light brown in the spring and summer. However, in September and October the material was dark black in appearance. The algae, which were usually unicellular Chlorophyta, were more common in the spring and summer.

Ophryoxus gracilis showed similar feeding habits to *Acantholeberis curvirostris*. Eriksson (1934) and Sergeev (1973) have stated that *Ophryoxus* utilizes two methods of food collection, which include scraping up particles and collection of suspended material. On numerous occasions, this macrothricid was observed resting on a clump of detritus, maneuvering it with the first two pairs of legs. This undoubtedly broke off small particles, which were then filtered into the filter chamber. It also scraped some of the material into its food groove. The gut contents contained varying amounts of algae and organic detritus. The color varied from a light yellow to dark brown. As in *Acantholeberis*, *Ophryoxus* seemed to feed upon black organic material with small amounts of inorganic particles during the fall in Pool 27 and Pond 41.

Simocephalus serrulatus is a suspension feeder. It usually filters material as it rests on a leaf surface, or bottom detritus. An interesting swimming behavior was observed in relation to its feeding. Adult females were observed swimming in circles quite vigorously amongst detritus for 10 to 30 seconds. Then they stopped and filtered various sized organic particles and unicellular algae. This same swimming behavior was repeated several times. This is most likely a means of stirring up larger particles which are not normally suspended in the water. Unicellular green algae and naviculoid diatoms were important food constituents, in some cases comprising up to 50% of the stomach material. Organic detritus also was an important food item, which was always present in the stomach. The mean rate of defecation in *Simocephalus* was once every two minutes. This would indicate that the animal needs a large quantity of food to extract the necessary nutritive material. Smirnov (1969a) has estimated that the relative daily consumption of the chydorid (Cladocera), *Acroperus harpae*, feeding on detritus is approximately 250% of its live body weight.

Sida crystallina also is a suspension feeder. It usually attaches to the stem of various plants by means of a labral gland (Scourfield and Harding, 1958). It then filters detritus and algal material from the water. It also was observed filtering material stirred up from the bottom, while attached to a plant leaf. The gut contents usually consisted of from 10 to 30% unicellular algae.

However, the bulk of material was detritus. The particle size of the stomach contents varied from 2 to 20μ.

Copepoda

Feeding mechanisms in copepods are quite different as was evident from this study. The cyclopoid copepods have mandibles which enable them to rip or tear at material. This "ripping" behavior is utilized in slightly different methods by the various species studied.

Macrocyclops albidus was observed feeding on a variety of material. Adult females fed quite extensively on *Eucyclops agilis*, immature *Cyclops vernalis*, copepod eggs, nauplii, and various rotifers. On several occasions, adult females were observed seizing *Ceriodaphnia quadrangula* and *Polyphemus pediculus*. The gut contents were usually reddish-brown in color, with few cell structures present. However, empty diatom shells, broken pieces of algal filaments, and shells of the cladoceran, *Chydorus sphaericus*, were often found in the material. As previously pointed out by Fryer (1957b), it is difficult to determine whether the algal fragments were indiscriminately picked up by the copepod, or obtained in the algal-feeding copepods on which *Macrocyclops* feeds. Fryer felt that the latter was the reason for their presence in the stomach material.

According to Fryer (1957b), the feeding habits of *M. albidus* and *M. ater* are similar. Very little was identified in the stomach analyses of *M. ater*. The gut contents were reddish-brown in color with an average particle size of 4μ. No algal cells or fragments were evident in the material. However, an ovigerous female was observed seizing an immature copepodid *M. albidus* and an adult *Eucyclops agilis*.

Eucyclops agilis seems to depend largely upon algae. In the spring, stomachs of some adult females were filled with unicellular green algae. In the summer and late fall, it was more difficult to identify any of the stomach contents. It consisted almost entirely of light brown material with a small particle size (2μ). Since there were small green circles (approximately 2μ) included in the material, they were probably still feeding on algae. *E. agilis* was often seen feeding on unicellular green algae on the surface film. It would use its first antennae to suspend itself from the surface and seize the algae with its mouthparts. Shcherbina (1970) has observed that *E. serrulatus* behaves polyphagously, feeding on algae, egg sacs of other copepods, dead microcrustaceans, and bacterial films.

Orthocyclops modestus also seemed to feed largely on algae. However, some detritus was also observed in the stomach. Large masses of detritus (approximately 72μ) were consistently found in the gut. Unicellular green algae and nacivuloid diatoms were also found in rather large quantities, especially in early summer. Numerous green circles (about 2.5μ diameter) were always plentiful; these possibly represent partially digested plant material or oils.

Observations on Important Predators of Microcrustaceans

Observations were made on bottom material, plants, etc., to determine what predators were feeding on the microcrustaceans. The microcrustacean species and their relative importance as a source of food also was noted. The insects seemed to be one of the most important predators in terms of the amount of microcrustaceans that they consumed. Tanypodine midges occurred in large numbers in July and August and always had various Cladocera in their gut. The most common prey seemed to be the smaller chydorids, i.e. *Chydorus sphaericus*, *Pleuroxus procurvus*, *Alonella nana*, *Chydorus piger*, *Biapertura intermedia*, *Alonella excisa*, and *Disparalona acutirostris*. The majority of these species are found quite commonly on the bottom (though not necessarily confined to this habitat). Goulden (1971) has shown that tanypodid midges are very important predators on or near the bottom. However, they also were seen crawling on the leaves of vegetation close to the bottom. Other insects observed feeding on various Cladocera and Copepoda include dragonflies, dytiscid larvae, and damselflies. One particular dytiscid larva was examined for approximately 30 minutes. During this time, it ate one *Simocephalus serrulatus*, one *Ceriodaphnia quadrangula*, and two chydorids (*Alona quadrangularis* and *Chydorus sphaericus*. The larva would stay positioned, moving its head from side-to-side. When a cladoceran swam or crawled by, it would lunge at it. If successful, it would then suck the juices from inside the shell as it was held with its mandibles. It would then drop the shell and wait for another cladoceran to swim by. Odonata naids (dragonflies and damselflies) also were seen feeding on Daphnidae, Macrothricidae, and Chydoridae (Cladocera). *Simocephalus serrulatus* and *Ophryoxus gracilis* seemed to be desirable foods, as they were consumed on a number of occasions. *Acroperus alonoides*, *Polyphemus pediculus*, *Latona setifera*, *Eucyclops* *agilis*, and *Macrocyclops albidus* were the only other forms which were observed as prey for Odonata.

Another important group of predators were Annelida such as *Chaetogaster diaphanus* L. They were usually quite numerous in the samples taken in the warmer months. The worms had anywhere from 2 to 16 Cladocera "packed" into the gut. The most common form was *Chydorus sphaericus*. In addition, *Disparalona acutirostris*, *Alona quadrangularis*, and *Pleuroxus laevis* were present, but usually in small numbers (no more than two per *Chaetogaster*). As with tanypodine midges, the bottom forms seemed to be the more important source of food. On three occasions, an unidentified flatworm was seen to contain up to five chydorids in its gut, all of which were *Chydorus sphaericus*.

Hydras also are important predators, as they can occur in rather large numbers, and consume a diversity of Cladocera and Copepoda. The following organisms were observed to be caught by hydras: *Alonella nana*, *Alona rustica*, *Biapertura intermedia*, *Ceriodaphnia quadrangula*, *Chydorus sphaericus*, *Graptoleberis testudinaria*, *Simocephalus serrulatus*, and early copepodid and nauplius stages of copepods. Most of these were only observed on one occasion and so it is difficult to speculate as to any preference by hydra. However, nauplii were the most common food observed to be caught. It is also worth noting that hydra seemed to have more success in capturing the juvenile stages of Cladocera and Copepoda.

Small fish also fed on Cladocera and Copepoda. The gut contents of trout fry (*Salvelinus fontinalis*) and three-spined sticklebacks (*Gasterosteus aculeatus*) were examined. In both instances, *Chydorus sphaericus* was the dominant invertebrate. The numbers ranged between 4 and 15 per fish. Other cladocerans included *Acroperus elongatus*, *A. alonoides*, and *Pleuroxus procurvus*, and a postabdomen of *Ilyocryptus*. The only copepods found in the gut contents included adult female *Eucyclops agilis* and copepodid stages of *Cyclops vernalis*. These fish do not seem to feed on microcrustaceans of any one habitat such as bottom forms, plant browsers, or swimming forms.

Several Copepoda (*Macrocyclops albidus* and *M. fuscus*) were observed feeding on some chydorids (*Alonella excisa*, *Chydorus sphaericus*, and juvenile *Simocephalus*). Other immature copepods were captured by *M. albidus* on several occasions. *Polyphemus pediculus* seems to be a choice food for *Macrocyclops albidus*. The copepod, *M. albidus*, has difficulty in getting a secure hold on *Chydorus sphaericus*.

The importance of *Utricularia intermedia* has already been mentioned. In the laboratory cultures, the bladders were filled predominantly with *Chydorus sphaericus*. Other forms included *Acroperus alonoides*, *Alona rustica*, *Biapertura intermedia*, and *Eucyclops agilis*. A bladder contained an average of 4 cladocerans and 1 copepod, with an occasional ostracod.

Description of *Paracyclops yeatmani* n. sp.

The body length of the female varies from 0.75 to 0.86 mm; the male is much smaller, 0.56 to 0.68 mm. Body somewhat flattened dorsal ventrally with no marked constriction between the metasome and urosome (Fig. 32). Thoracic somite 5 with a lateral fringe of hairs.

Body color usually reddish-brown.

Female

Furcal rami (Fig. 33) 3.8 to 4 times longer than wide, similar to *Paracyclops fimbriatus poppei* Rehberg. The lateral setae are attached about one-third the distance from the posterior-tip of the furcal ramus. A conspicuous dorsal row of spinules begins at the insertion of the lateral seta and runs to the anterior mid-portion of the ramus. This is similar to *P. fimbiratus poppei,* but *P. fimbriatus* Fischer has a short transverse row in front of the lateral seta. *P. affinis* (Sars) also has a transverse row of spinules, but it runs obliquely from the insertion of the lateral seta. There are no hairs on the inner and outer margins of the furcal rami. Relative lengths of terminal furcal setae, innermost to outermost, are approximately 2.5:9.8:6.0:1. Thus, the innermost terminal seta is greater than twice the length of the outermost seta, and 1.5 times the length of the ramus. Posterior margins of abdominal somites more conspicuously serrated ventrally. Anal somite having minute spinules running obliquely from the posterior margin to the edge of the anal depression, as in *P. fimbriatus poppei.* Marginal surface of anal depression with hairs.

First antenna of the female (Fig. 34) with 11 segments as in *P. affinis.* The antennae do not extend to the posterior margin of the first body segment. The first 6 segments seem to be slightly longer than those of *P. affinis,* as is the length of the entire first antenna. Segment 1 with a row of spinules. Segment 3 with a large seta swollen at its base.

The swimming legs (Figs. 35-38) with three segmented rami. The spine formula of the terminal exopod segments of legs 1-4 is 3,4,4,3. The setal formula of the same segments is 5,5,5,5. Thus, the leg structure of *P. yeatmani* n. sp. is like that of *P. fimbriatus* and *P. fimbriatus poppei* and differs from *P. affinis*, which has a spine formula of 3,4,3,3 or 3,3,3,3 for the first four swimming legs.

The terminal segment of exopod 4 is about 2.5 times longer than wide. The inner terminal spine of this segment is only slightly longer than the outer. The terminal segment of endopod 3 has 1 spine and 5 setae, while endopod 4 has 2 spines and 3 setae. The endopod of leg 2 is similar to that of leg 3.

The fifth foot (Fig. 39) is one-segmented. The segment bears a long inner spine and two outer setae. The spine is quite stout, with several minute spinules at its base. The outermost seta is slightly shorter than the spine. The inner seta is slightly longer than the spine.

The genital somite is broader than long. The seminal receptacle is more or less transversely oval and resembles that of *P. affinis*.

Male

Body shape similar to female except much smaller and the cephalothorax is more laterally compressed. The size range corresponds more closely to *P. affinis* than *P. fimbriatus*.

The antenna (Fig. 40) is short and stout, consisting of 17 segments. As is characteristic of the other species in this genus, it is difficult to distinguish the rather compressed segments at the geniculation. The first segment has one cylindrical aesthetask and a seta swollen at its base. Two long setae originate between segments 3 and 4. Segment 6 has a large seta swollen at its base. Segments 13 and 16 contain short spines. Segment 2 has a long spine which bends slightly inward.

Leg 5 of the male (Fig. 41) is similar to the female, except that the outer seta is approximately the same length or slightly longer than the spine. Leg 6 (Fig. 41) has a long inner spine and 2 setae. The spine is long and stout. The outer seta is also stout and slightly longer than the spine. The inner seta is much shorter than the spine. The ratio of the lengths of the inner spine to the outermost seta is 1:0.7:1.3.

In summary, *Paracyclops yeatmani* n. sp. resembles *P. fimbriatus poppei* in the armature of the swimming feet and fifth feet, length-to-width ratio of furcal rami, and the dorsal longitudinal row of spinules on the furcal ramus. It differs from that species in the number of segments of the first antennae. *P. fimbriatus poppei* has 8 segments, while *P. yeatmani* n. sp. and *P. affinis* have 11. Differences between *P. yeatmani* n. sp. and *P. affinis* include the armature of swimming legs, location of dorsal spinules on the furcal rami, and the length-to-width ratio of the rami.

Figures 32-41

Paracyclops yeatmani n. sp.

32. Adult female (dorsal).

33. Furcal rami, female (dorsal).

34. First antenna, female (dorsal).

35. First swimming foot, female (left).

36. Second swimming foot, female (right).

37. Third swimming foot, female (right).

38. Fourth swimming foot, female (right).

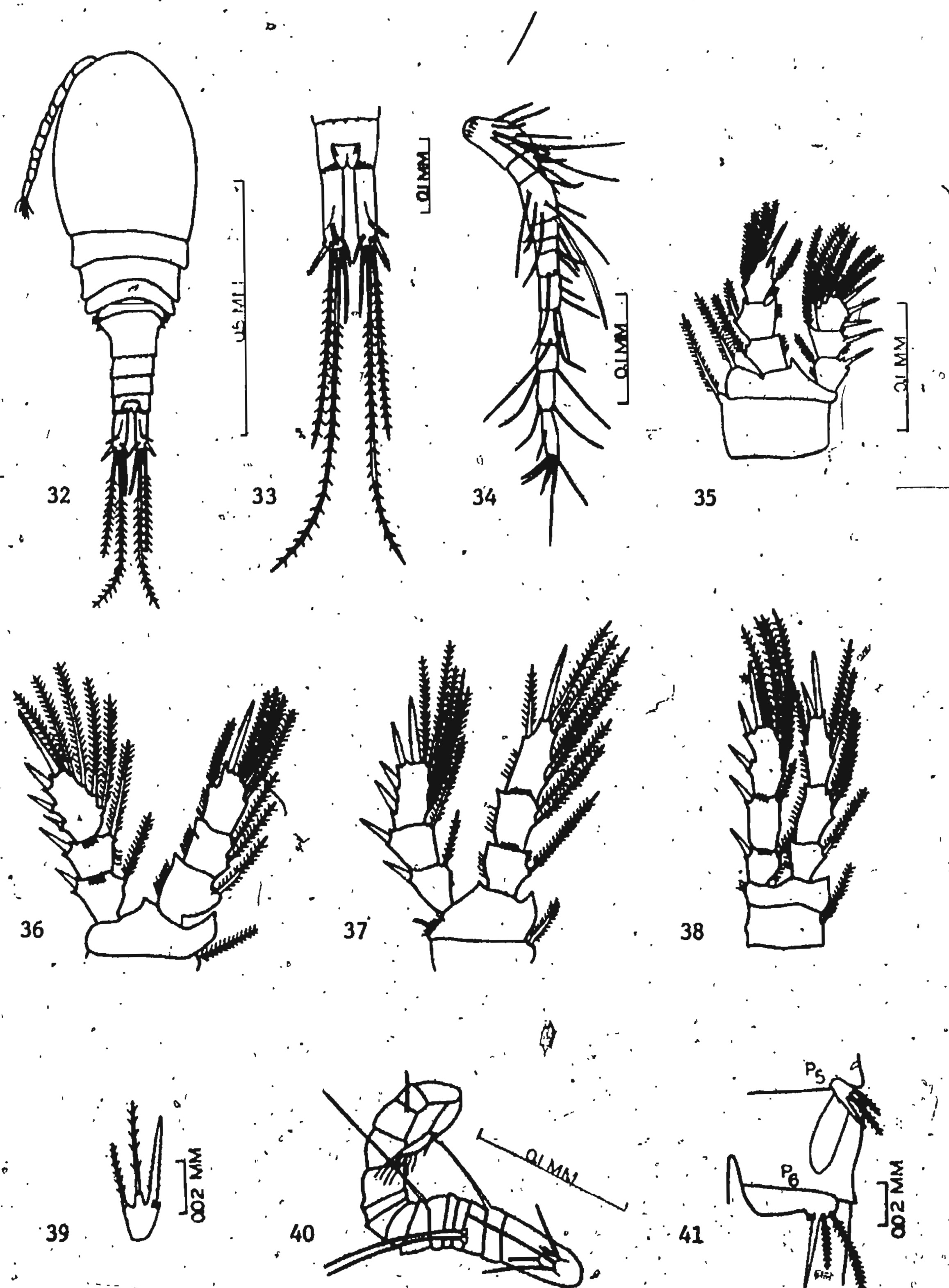
(Figures 35-38 drawn to same scale.)

39. Fifth foot, female (right).

40. First antenna, male (dorsal-lateral).

41. Fifth and sixth foot, male (left).

(All drawings were made with the aid of a camera lucida.)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DISCUSSION

New Records

Of the 62 species of microcrustaceans collected, 21 species of Cladocera and three species of Copepoda have been reported previously for Newfoundland and Labrador. Thirteen species of littoral Cladocera have been listed by Smirnov and Davis (1973). These authors also listed *Simocephalus* sp., *Scapholeberis* sp., and *Ilyocryptus* sp. from their localities. Additional studies in Newfoundland have reported *Alonella exigua* (Lilljeborg), *Camptocercus rectirostris* Schoedler, and *Diaphanosoma brachyurum* (Liéven) from several lakes in Terra Nova National Park (Megyeri, 1969). *Latona setifera* O. F. Müller was captured by Davis (1972) in plankton samples taken in Hogan's Pond. *Ceriodaphnia reticulata* (Jurine) was found in Neddy Harbour Pond on the West Coast (Dadswell, 1970). *Sida crystallina* (O. F. Müller) also was collected by Dadswell (1970) and Megyeri (1969). *Eurycercus glacialis* Lilljeborg has been listed for Battle Harbor and Great Caribou Island, Labrador by Cushman (1908). Cushman (1908) also collected *Simocephalus serrulatus* (O. F. Müller) in Lewis Inlet, Labrador. The limnetic forms, *Bosmina longispina* Leydig and *Daphnia catawba* Coker have been reported by Davis (1972, 1973) from Hogan's Pond and Bauline Long Pond. In addition, *B. (= Eubosmina) longispina* was listed by Deevey and Deevey (1971) from four localities in Newfoundland and by Frost (1940) from Murray's Pond and Long Pond, St. John's. *B. coregoni* was also collected in several ponds on the West Coast by Dadswell (1970). However, Deevey and Deevey (1971) reported that Brooks' (1959) *B. coregoni* is *B. longispina*.

Previous records for Copepoda are much less common. *Macrocyclops ater* (Herrick) was reported by Dadswell (1970) in Rocky Harbour Pond. Davis (1972) collected a benthic form, *Paracyclops* sp. in Hogan's Pond. The only other records are for the two limnetic forms, *Diaptomus minutus* Lilljeborg, which has been reported by DeGuerne and Richard (1889), Megyeri (1969), and Davis (1972, 1973), and *Epischura nordenskiöldi* Lilljeborg by DeGuerne and Richard (1889) and Davis (1972, 1973).

Twenty-six species of Cladocera and 12 species of Copepoda (Table 2) represent new records for the Province of Newfoundland and Labrador. The occurrence of *Eurycercus glacialis* from the Avalon Peninsula represents a new record for the island of Newfoundland. This also represents the most southern record of this species in North America.

Many of the Cladocera listed in Table 2 show a wide occurrence in Canada. The numerous reports listing their occurrence will not be discussed. However, some of the species show a more restricted zoogeography, and these are worth noting. *Alonella excisa* Fischer has been recorded from Ontario (Bigelow, 1922; Wilson, 1960; Brandlova *et al.*, 1972) and from British Columbia (Carl, 1940). *Chydorus bicornutus* Doolittle has been reported in southern Ontario (Brandlova *et al.*, 1972) and northern Quebec (Willey, 1925). *Chydorus faviformis* Birge occurs in southern Ontario (Bigelow, 1922; Klugh, 1926; Wilson, 1960; Brandlova *et al.*, 1972). *Chydorus ovalis* Kurz and *Alonella exigua* Lilljeborg have only been recorded from southern Ontario (Brandlova *et al.*, 1972). *Rhynchotalona falcata* (Sars) has been found in Lake

Jesse in Nova Scotia (Smith, 1938), in Ontario (Brandlova *et al.*, 1972) and in British Columbia (Carl, 1940). *Kurzia latissima* Kurz occurs in Ontario (Klugh, 1926; Wilson, 1960; Brandlova *et al.*, 1972) and Manitoba (Smith, 1968).

The literature for littoral Copepoda in Canada is not extensive. *Cyclops varicans rubellus* Lilljeborg has been found in Quebec (Willey, 1925) and Manitoba (Smith, 1968). *Cyclops vernalis* Fischer occurs in western Lake Erie (Davis, 1969b; Patalas, 1972), Quebec (Willey, 1925), northwestern Ontario (Patalas, 1971), Alberta and British Columbia (Anderson, 1971), and Manitoba (Smith, 1968). Similarly, *Eucyclops agilis* is widespread. It has been recorded from Nova Scotia (Smith, 1938), Quebec (Bernard and Lagueux, 1972), Ontario (Wilson, 1960), Manitoba (Smith, 1968), and Alberta and British Columbia (Anderson, 1971). *Macrocyclops ater* (Herrick) was listed by Klugh (1926) for New Brunswick, Willey (1925) for Quebec, and Carl (1940) and Anderson (1971) for British Columbia. *Macrocyclops fuscus* (Jurine) has been reported from Ontario (Wilson, 1960), New Brunswick (Klugh, 1926), Quebec (Willey, 1925; Bernard and Lagueux, 1972), and British Columbia (Carl, 1940). *Macrocyclops albidus* (Jurine) has been found in Ontario (Wilson, 1960), Manitoba (Smith, 1968), Saskatchewan (Moore, 1952), Alberta (Anderson, 1971), and British Columbia (Carl, 1940). *Orthocyclops modestus* (Herrick) occurs in western Lake Erie (Patalas, 1972), Alberta (Anderson, 1971), British Columbia (Carl, 1940), northern Quebec (Willey, 1934), and northwestern Ontario (Patalas, 1971). *Tropocyclops prasinus* Kiefer has been reported from Quebec (Willey, 1925), Ontario (Patalas, 1971), and the Great Lakes

(Davis, 1969b; Patalas, 1972).

The following species have not been reported previously for Canada:

Cladocera

Acroperus elongatus Hudendorff
Alona rustica Scott
Parophryoxus tubulatus Doolittle

Copepoda

Bryocamptus arcticus (Lilljeborg)
Canthocamptus vagus Coker and Morgan
Cyclops nanus Sars
C. venustoides pilosus Kiefer
Paracyclops yeatmani n. sp.

Elsewhere, *Acroperus elongatus* Hudendorff has been reported for Europe and a very restricted area in Maine and New Hampshire (Frey, personal communication). Frey (1965) described *Alona rustica* Scott as a "cosmopolitan species of the genus occurring in North America at least latitudinally from Maine to Florida." Frey also noted that superficial similarities between *A. costata* and *A. rustica* has likely resulted in the latter species often being recorded as *A. costata*. This probably explains the lack of records for *A. rustica* in Canada. *Parophryoxus tubulatus* Doolittle has been reported from the New England states (Pennak, 1953). The arctic-alpine species, *Bryocamptus arcticus* (Lilljeborg), has been listed in North America in Alaska (Wilson, 1958) and in Greenland (Røen, 1962, 1968). *Canthocamptus vagus* Coker and Morgan has been recorded from North Carolina and Washington (Yeatman and Wilson, 1959). *Cyclops nanus* is considered "rare in North America" (Yeatman, 1959), as it has been reported for only two localities in North Carolina. *Cyclops venustoides pilosus* Kiefer has been reported only from Connecticut (Kiefer, 1934). Kiefer originally described this form as a new species (*C. pilosus*). However, it is now recognized as a subspecies of *C. venustoides* (Yeatman, 1959).

Distribution

It is often difficult to account for distribution of littoral microcrustaceans within any geographical area. This results largely from our incomplete knowledge of the autecology of the various species. However, there were some differences in this study which can be related to environmental conditions. This was most evident after comparing the species recorded from the West Coast and the Avalon Peninsula. Most of the West Coast localities lie over Cambrian and Ordovician shelf deposits which result in limestones, sandstones, and shales (Williams *et al.*, 1972). For this reason, some waters are characterized by a higher pH, conductivity, hardness, and a sandy bottom. Of the West Coast localities, Pool 60, Sandy Lake, Bonne Bay Little Pond, Rocky Harbour Pond, Jack's Pond, and the backwaters of Western Brook River resembled the above characteristics. With one exception, four species of Cladocera (*Kurzia latissima, Lathonura rectirostris, Pleuroxus denticulatus*, and *Rhynchotalona falcata*) were restricted to these waters, which might indicate that they prefer such conditions. It is known that *Rhynchotalona falcata* prefers sandy sediments (Flössner, 1964; Fryer, 1968; Goulden, 1971). Similarly, Flössner (1964) found that *Lathonura rectirostris* was associated with *Myriophyllum* and sandy bottoms. However, *Kurzia latissima* was common amongst organic-sediments but absent from extremely sandy sediments in Lake Lacawac, Pennsylvania (Goulden, 1971).

Acroperus harpae also was restricted to West Coast localities but it was collected in a wider range of conditions. It is probably significant that all of the waters contained inorganic sediments.

This species has been found on plants and the bottom in lakes and smaller waters (Fryer, 1968). According to Flössner (1964), *A. harpae* prefers a sandy-type bottom. Moreover, Goulden (1971) collected this species amongst sandy sediments but it was absent from organic-rich sediments. The fact that most of the waters on the Avalon Peninsula are rich in organic material might explain why this species was lacking.

Fifteen species were collected only from the eastern portion of the island (see page 30), which is probably the result of more extensive sampling. It is possible that the most frequently collected species, such as *Acroperus alonoides* and *Pleuroxus laevis*, prefer the organic-rich sediments derived from peatlands which are characteristic of the Avalon Peninsula. However, it is more difficult to explain the occurrence of species encountered in relatively few waters. For some of the infrequent species ecological notes can be compared.

Fryer (1968) collected *Alona guttata* in both large and small waters and even several springs. Quade (1969) reported that this species was not restricted to specific lakes or plants in Minnesota. In the present study, *A. guttata* was collected from large ponds, pools, and the backwaters of a stream. There also did not appear to be a preference for a particular plant type.

Numerous ecological data has been provided for *Alona costata*, but there appears to be no clear-cut differences which might be applicable to the entire range of distribution (Fryer, 1968). Quade (1969) found that *A. costata* is limited to certain lakes in Minnesota and that within these lakes the occurrence is restricted to *Potamogeton natans* and *Chara*. In Newfoundland, *A. costata* is common in small pools and large ponds, and amongst such plants as *Utricularia intermedia*, *Potamogeton gramineus*, and submersed grasses.

Eurycercus glacialis seems to be associated with aquatic vegetation in Greenland, Alaska, and other Arctic areas (Frey, 1971b). From extensive sampling in Greenland, Røen (1962) found that this species seemed to require minimal amounts of calcium and chloride. *E. glacialis* was not collected enough in this study to determine whether calcium content was a limiting factor. It was found in Pond 48, which has a calcium content of 1-2.3 mg/l (see Davis, 1973). In Denmark, Holland, and in Iceland, *E. glacialis* cannot withstand fish predation because of its large size and low rate of reproduction (Frey, 1971b). However, at least two of the waters (Ponds 47 and 48) contained trout (*Salvelinus fontinalis*) populations which were observed feeding in weedbeds inhabited by *E. glacialis*. This possibly suggests a higher reproductive potential in Newfoundland to overcome fish predation.

Several cyclopoid species were collected only in small *Sphagnum* pools on the Avalon Peninsula; namely, *Cyclops venustoides pilosus*, *C. nanus*, and *Paracyclops yeatmani* n. sp. It is known that certain cyclopoids such as *Cyclops vernalis* and *C. nanus* are typical inhabitants of "sphagnous cushions" in Europe (Rylov, 1948). Few habitats of this nature (i.e. *Sphagnum* mats) were sampled, which might explain why these three species were not more common.

The majority of the microcrustacean species were found over a wide range of distribution in this study. The most common species, *Chydorus sphaericus*, *Cyclops vernalis*, *Eucyclops agilis*, and *Macrocyclops albidus* were found in all types of waters and amongst numerous plant species. Similarly, several benthic species, such as *Alona quadrangularis* and *Ilyocryptus spinifer* were found in sandy and organic-rich sediments, and so they have adapted to a wide range of bottom conditions. Other benthic species such as *Bryocamptus arcticus*, *Biapertura affinis*, and *Disparalona acutirostris* were collected from eastern and western localities, except from the extremely sandy sediments of Sandy Lake, Bonne Bay Little Pond, Pond 60, Rocky Harbour Pond, and Western Brook River. Goulden (1971) collected *D. acutirostris* from sediments consisting largely of organic material, but it was not found among sandy sediments in Lake Lacawac. *Biapertura affinis* is known to occur on or among sandy and muddy sediments (Flössner, 1964), or even on the surface of detritus- or algal-covered stones (Fryer, 1968).

Ecological data also can be compared for most of the other species which were collected from both portions of the island.

Chydoridae

The ecology of *Acroperus elongatus* has recently been studied in Maine and New Hampshire lakes (Kubersky, 1973). Kubersky collected *A. elongatus* most commonly on rocks or boulders, usually covered with detritus or algae. But he found that the species exhibited no well defined preference for lakes of particular origin, morphometry, or chemistry. The occurrence of this species in Newfoundland also follows no pattern. *A. elongatus* was collected amongst sandy sediments in Sandy Lake and the backwaters of Western Brook River, and among submersed grass overlying a rocky bottom in Pool 31 and Pond 50.

The type of situations in which *Alona rustica* has been collected are inconsistent. Fryer (1955) only found this species in very small pools containing *Sphagnum*, or adjacent to acid moorland. Goulden (1971) found it amongst *Typha latifolia* inhabiting a sandy bottom. Quade (1969) collected it on *Potamogeton* spp., *Ceratophyllum demersum*, and *Elodea canadensis*. In this study, *A. rustica* inhabited numerous substrates including *Utricularia intermedia*, *Myriophyllum alterniflorum*, *Sphagnum* spp., *Potamogeton gramineus*, and sunken sedge mats (Fig. 31). Frey (1965) reported that *A. rustica* and *A. costata* commonly co-occur in North American and European waters. In the present study, they occurred together in Pond 4, Pond 13, and Pond 47.

Two morphologically similar species, *Alonella excisa* and *A. exigua* were found in 15% and 7% of the localities, respectively. Quade (1969) collected *A. excisa* from bottom sediments and *Chara*, *Potamogeton* spp., and *Elodea canadensis*. In this study, *A. excisa* was associated with fine-leaved submersed plants and *Sphagnum*. *Alonella exigua* inhabited similar plants but was most abundant on *Potamogeton gramineus*. Likewise, Smyly (1958) collected *A. exigua* from the floating leaves of *Potamogeton*. There is some overlap in the substrates of these two species, but they were not found on the same plant. The other species in this genus, *A. nana*, was described by Goulden (1964) as "ubiquitous in the littoral of northern lakes living in weeds and microbenthos." Even though it was only found in 16% of the waters, it was associated with eight different plants and bottom sediments.

Goulden (1971) found that *Biapertura intermedia* was common among organic sediments but absent from the sandy sediments in Lake Lacawac. The occurrences of this species in Newfoundland suggest a similar preference for organic-rich sediments, as it was absent from the five West Coast waters with extremely sandy bottoms. Beyond that, there seemed to be no preference for substrate or type of water.

Chydorus piger and *C. ovalis* were restricted to bog pools or bog ponds, which often contained *Sphagnum*. Fryer (1968) reported *C. ovalis* from a similar spectrum of habitats in England. It occurred in small hollows in the mid-Pennines, which were sometimes peaty and often containing *Sphagnum*. Frey (as cited by Quade, 1969) has observed that *C. piger* is abundant in acid bogs in North America.

No preferences were evident for *Eurycercus* sp., as it inhabited a wide range of substrates (Fig. 31) and types of waters. It was more common than *E. glacialis*. Frey (1971b) stated that "In their regions of sympatry the two tend not to occur together in the same water bodies." Of the localities sampled, the species co-occurred in one water (Pond 32). This situation is common in Alaska (Frey, 1971b).

Fryer (1968) has demonstrated the manner in which *Graptoleberis testudinaria* has adapted to life on broad-leaved plants. Quade (1969) found that this species was common on all plants in his study except *Naias flexilis* and *Nuphar variegatum*. *G. testudinaria* was collected only on broad-leaved plants such as *Nuphar variegatum*, *Potamogeton gramineus*, and *P. richardsonii* in Newfoundland. The fact that broad-leaved plants, other than *Nuphar variegatum*, were not usually abundant in the areas sampled could explain the low frequency of occurrence and low numbers.

Macrothricidae

In general, information concerning the types of situations inhabited by these animals are poorly documented. However, the ecology of this family is being studied by Smirnov (1971b) and Fryer (1971b). Of the macrothricids, *Ophryoxus gracilis* was the species most frequently encountered. It inhabited a wide range of waters, and thus, no distribution pattern seemed evident. Quade (1969) reported minimal numbers of *O. gracilis* (less than 5% of total Cladocera) amongst *Ceratophyllum demersum* and *Chara*. Crisp and Heal (1958) observed that *Acantholeberis curvirostris* and *Streblocercus serricaudatus* preferred peaty areas in Ireland. Gurney (1933) also collected *A. curvirostris* in lime-free bog waters in the English Lake District. These observations agree with the occurrence of *A. curvirostris* in Newfoundland, since it was commonly found in bog waters, usually containing *Sphagnum*. Similarly, *Streblocercus serricaudatus* was collected in 10 waters, seven of which were *Sphagnum* bogs.

Daphnidae

Most of the species in this group were found in a rather large range of conditions, especially *Ceriodaphnia quadrangula* and *Simocephalus* spp. No definite patterns seemed to characterize their occurrence. When present, *Scapholeberis kingi* was abundant in the water adjacent to the broad leaves of *Potamogeton gramineus* and *Nuphar variegatum*, which agrees with the observations of Quade (1969).

Sididae

Of the four species, *Sida crystallina* was found in the largest number of waters (19). This species was most often associated with *Potamogeton gramineus*, which is similar to findings of Flössner (1964), Sebestyén (1948), Scourfield and Harding (1958), and Quade (1969). Entz (1946) reported a maximum of 6 individuals per dm^2 of plant surface of *Potamogeton perfoliatus*. Bigelow (1922) and Flössner (1964) collected *Latona setifera* near the bottom, which consisted of sand. However, it was restricted to muddy bottoms in this study. *Diaphanosoma* spp. were not common in the localities studied. Flössner (1964) found that *D. brachyurum* preferred *Myriophyllum spicatum* and reeds. Other investigators have reported that *D. brachyurum* is usually scarce in weedy margins (Berg, 1929; Macan, 1949). The distinction between *D. brachyurum* and *D. leuchtenbergianum* must be clearly defined before their particular preferences are understood.

Copepoda

There were four additional cyclopoids which were collected from eastern and western localities. The only pattern observed was that *Cyclops varicans rubellus* and *Orthocyclops modestus* just inhabited waters which were extremely overgrown with vegetation. It was apparent from this study that the relation between plants and littoral copepods needs more investigation. Rylov (1948) emphasized the lack of data by stating that "the association of certain Cyclopidae species with definite macrophyte formations has hardly been investigated." Lastochkin (1926) has shown that different cyclopoid groups were characteristic of the various plant-types in one Russian lake, but most of cyclopoids were not found in this study. In Rybinsk

Reservoir, Monakov (1968) found that the maximum numbers of copepods were collected in shallow waters covered with sedges, horsetails, and some *Potamogeton*, while minimum numbers were associated with reeds at deep depths. From observations in the European part of Russia, Rylov (1948) found few species in thickets of *Carex* and *Phragmites* but a diverse fauna in thickets of *Myriophyllum*, *Ceratophyllum*, *Elodea*, *Utricularia*, and *Potamogeton*. Collections amongst various reeds in this study also revealed few species, as did thickets of *Chara*, *Ranunculus trichophyllus*, and *Fontinalis giganteum*. The most diverse communities were characteristic of La Manche Marsh and Pool 60, amongst extensive growths of *Utricularia*, *Potamogeton*, *Sphagnum* (in La Manche Marsh), *Myriophyllum* (in Pool 60), and emergent grasses. But there was not enough evidence from this study to demonstrate that littoral copepods were associated with particular plants. The results suggest that *Bryocamptus arcticus*, *Cyclops nanus*, *C. venustoides pilosus*, and *Paracyclops yeatmani* n. sp. may prefer *Sphagnum* pools, but more sampling would be required to prove this. Similarly, more collections from the West Coast would be desirable, since a more diverse flora exists in those waters.

<u>Seasonal Dynamics</u>

Studies in the United States have shown slightly longer growing seasons for littoral Cladocera than were observed in Round Pond. In Indiana, Keen (1973) reported that *Acroperus harpae*, *Camptocercus rectirostris*, and *Graptoleberis testudinaria* appeared in March or April and remained until December or January. Similarly, Goulden (1971) has shown that Cladocera occurred regularly between April and October in

Pennsylvania. Studies in Europe by Smyly (1952, 1957), Stromenger-Klekowska (1960), Prosznska (1962), Flössner (1964), and Straškraba (1965) showed that several species appeared as early as March or April. Studies in northern Europe (Nordquist, 1921; Smirnov, 1963b) reported that Cladocera were dominant from May until September. But the fact that several species of Cladocera appeared at least two weeks earlier in La Manche Marsh than Round Pond showed that the growing season can vary within the same geographical region. The slower development in Round Pond was probably the result of longer ice cover and lower temperatures in the spring.

In most instances, the seasonal patterns of abundance were similar to other quantitative studies. From investigations in the Volga Reservoirs, Smirnov (1963b) stated that "the maximum abundance of Chydoridae is observed from the middle of July to September." In the same respect, Keen (1973) observed low summer populations with a well defined fall maximum for the chydorids, *Acroperus harpae*, *Camptocercus rectirostris*, and *Graptoleberis testudinaria*. Similar patterns were observed in the present study, since the majority of cladoceran species reached peak abundance in late summer or early fall. Except for *Acroperus alonoides*, *Alonella nana*, and *Chydorus piger*, there was just one well defined maximum per year. The only species which attained maximum numbers in early summer (late June or early July) were *Chydorus spahericus* and *C. piger*. *C. sphaericus* is usually regarded as a spring dominant (Flössner, 1964; Goulden, 1971; Keen, 1973). Keen (1973) observed that *C. sphaericus* peaked in March, dropped to a low summer level, rose during the fall, and remained relatively high during the winter. The seasonal periodicity of *C. piger* has been shown to be quite variable, as it peaked in spring, summer, or fall at the stations in Lake Lacawac, Pennsylvania (Goulden, 1971). Other cladocerans have been shown to peak in the spring. Straškraba (1965) found that most of the littoral Cladocera exhibited a well defined spring maximum and a less defined fall maximum. *Simocephalus vetulus* and *Ceriodaphnia quadrangula* peaked in May or June in Straškraba's study. *Polyphemus pediculus* also showed a spring maximum in an English tarn (Smyly, 1952). In the present study, these species did not appear until June or July, and peaked in August.

The sexual cycles of the cladoceran species were similar to observations by Flössner (1964) except for *Graptoleberis testudinaria* and *Chydorus sphaericus*. Overwintering populations of Cladocera have been observed by other investigators (Ward, 1940; Smyly, 1957; Flössner, 1964; Keen, 1973). Smyly (1957) found minimal numbers of *Chydorus piger*, *Ilyocryptus sordidus*, and large numbers of *Chydorus sphaericus* under ice in English tarns. Ward made an interesting observation that *C. sphaericus* was present throughout the year in deeper ponds but absent in the winter in shallow Cincinnati ponds. Both La Manche Marsh and Round Pond are relatively shallow waters, but no deep ponds were sampled to test Ward's suggestion.

In general, the seasonal periodicity of the copepods was more variable. The ubiquitous forms, *Macrocyclops albidus* and *Eucyclops agilis* showed a wide tolerance to temperature, since they were present throughout the study. Smyly (1957) also reported that these two copepods occurred throughout the year. The periodicity of *M. albidus* seemed rather inconsistent. In Round Pond, the summer generation was considerably larger than the winter generation. However, the highest numbers in La Manche Marsh occurred in February under ice. Elgmork (1964) also described the periods of abundance of *M. albidus* as "very irregularly distributed." In some instances, he reported that the numbers during the winter were high. Elgmork suggested that the winter peak was not real because it was caused by a reduction of the water volume due to extensive freezing. "Individuals living on the border of the pond most probably concentrate in the deepest part where the samples were taken." In La Manche Marsh, the water closest to the shore was almost frozen to the bottom. But different depths would have to be sampled to test whether migration actually took place. In Russian waters, Rylov (1948) reported that this species exhibited three sexual cycles, which were in the winter, summer, and fall. There was no winter reproductive period in this study. The seasonal distribution of *Eucyclops agilis* was rather regular in Round Pond and La Manche Marsh. In both waters, the summer generation was larger than the winter generation. In England Smyly (1957) found that *E. agilis* was more numerous in the colder months.

The seasonal distribution of *Cyclops vernalis* seems to vary considerably in different areas. In La Manche Marsh, there appeared to be two generations per year with adults being abundant in August and September. Rylov (1948) stated that in Central Europe, *C. vernalis* is found throughout the year in permanent water bodies. It undergoes two sexual cycles in some shallow waters; in permanent waters a third sexual cycle is often observed in the winter. In Swedish ponds, *C. vernalis* was abundant only on two occasions in December (Elgmork, 1964). Otherwise, it was found in minimal numbers sporadically during the year. Proszynska (1962) reported the *C. vernalis* adults were common between March and January of the following year in Poland. In Rybinsk Reservoir, Monakov (1968) collected this species only in May and July, but his investigations did not include winter collections. Anderson (1971) observed that *C. vernalis* was most abundant during the winter in some Alberta and British Columbia lakes but during the summer in alpine ponds.

Rylov (1948) described *Cyclops varicans rubellus* as a warm-water stenotherm in shallow waters overgrown with macrophytes. Monakov (1968) found that the highest numbers in Rybinsk Reservoir occurred amongst sedges and reeds (3,700/m^3) in the summer. According to Wolf (1905), *C. varicans rubellus* is bicyclic in shallow waters near Würtemberg, Germany. It first appeared in the spring, reached a maximum in the summer, then disappeared in the fall. This is similar to the pattern shown by *C. varicans rubellus* in La Manche Marsh.

The carnivorous species, *Macrocyclops fuscus*, was a summer and fall form. However, Börner (1917), as reported in Rylov (1948), found that *M. fuscus* was usually encountered the whole year and showed up to three maxima per year. But he also stated that it is monocyclic in some waters with a maximum in summer or fall. Unfortunately, he did not describe the type of habitat in which *M. fuscus* was monocyclic.

Elton (1929) reported that *M. fuscus* can be collected at all times of the year, but it is more abundant in the summer. The seasonal occurrences of *Macrocyclops ater* and *Orthocyclops modestus* were similar to *M. fuscus*, although *M. ater* was not collected regularly. Too little is known concerning the seasonal dynamics of these species to say whether the observed pattern was characteristic. However, *O. modestus* has been found all year in Fayetteville Green Lake (Brunskill and Culver, 1971). Likewise, there is no seasonal data for *Bryocamptus arcticus*. This copepod appeared to be restricted to the spring. Other harpacticoids, such as *Canthocamptus staphylinoides*, are known to be common in the winter and spring, disappearing as a resting egg (Fryer and Smyly, 1954).

It is usually difficult to explain differences in the productivity of various animal communities. This is especially the situation with littoral microcrustaceans, as so little quantitative work has been done. There is no standard sampling technique or units for expressing the results. This probably has a considerable affect on the different quantities which workers have reported. As is characteristic of most sampling techniques, certain limitations were apparent in this study. Sweeping an enclosed area with a net did not ensure that all animals had been collected. From the more thorough collections taken on four occasions it appeared that my numbers were slightly underestimated. Another limitation resulted from the fact that a rather large site (¼ m^2) was sampled. This made it difficult to separate the animals from the bottom material. It also meant that I only examined a small part of the total sample for the more abundant species.

Realizing the limitations of the present study and the different methods used by other workers, it is still worthwhile to review some of their findings. Smirnov (1963b) reported that *Chydorus sphaericus* was the most abundant cladoceran in the Volga Reservoirs, attaining 1,400 x 10^3 individuals on 1 m^2 of bottom and in the overlying cubic meter of water (unified meter). For species which utilize the bottom and the water column, the conversion of my data to volume (Appendix C, Tables 2 and 3) represents units somewhat similar to Smirnov's. The maximum numbers for *C. sphaericus* were 41,760/m^3 in La Manche Marsh (Appendix C, Table 2) and 10,200/m^3 in Round Pond (Appendix C, Table 3). Other abundant Cladocera in Smirnov's study included *Sida crystallina* and *Alona quadrangularis* (both between 420 and 1,400 x 10^3 individuals/unified m), and *Diaphanosoma brachyurum* (between 13.5 x 10^3 and 77 x 10^3 individuals/unified m). *S. crystallina* was the most abundant species in Round Pond but it only reached 29,960 individuals/m^3 at its peak (Appendix C, Table 3). The other two species occurred in much lower numbers (less than 2,000 over one m^2). Thus, the most abundant species in the Volga appear to be extremely more numerous than the populations in La Manche Marsh and Round Pond.

The results of other studies have shown considerably lower numbers. Straškraba (1965) reported his results as the number of individuals per liter for a weedy backwater in Czechoslovakia. The highest standing crop on any one date was approximately 700 individuals per liter. The maximum numbers for individual species which were also common in the present study included: 257 *Chydorus sphaericus* per liter, 145 *Pleuroxus* spp., 200 *Ceriodaphnia quadrangula*, and 2

Macrocyclops fuscus. All of these figures are at least 5 times higher than the maximum values found in the present study. Even though the standing crops cannot be compared, the maximum values for individual microcrustaceans suggest that the backwater was much more productive.

However, the standing crop in a pond near Windermere, England, represented only a tenth of that reported by Straškraba. Smyly (1957) observed the following maxima: 187 *Chydorus sphaericus* per liter, 2.5 *Ceriodaphnia pulchella*, 18 *Ilyocryptus sordidus*, 5 *Chydorus piger*, 10 *Macrocyclops albidus*, and 2.8 *Eucyclops agilis*. In an earlier study, Smyly (1952) also reported maxima for *Polyphemus pediculus*, *Sida crystallina*, and *Macrocyclops albidus*, which were 2.3, 3.3, and 2 individuals/liter, respectively. The maximum numbers for *C. sphaericus*, as reported by Smyly, were considerably higher than those found in La Manche Marsh and Round Pond. Again, total standing crops cannot be compared, but values for most of the species seem to be in the same range.

Pennak (1966) sampled the littoral zone of several Colorado lakes in July and August. His results show ranges that are similar to those of some of the species found in Newfoundland. He reported the following maxima: 47.2 *Ceriodaphnia quadrangula* individuals per liter, 5.9 *Chydorus sphaericus*, 2.9 *Simocephalus vetulus*, 0.6 *Diaphanosoma brachyurum*, 17.7 *Pleuroxus trigonellus*, 2.5 *Graptoleberis testudinaria*, 1.0 *Eucyclops agilis*, 18.4 *Macrocyclops albidus*, and 1.3 *Cyclops varicans rubellus*. The values for *Ceriodaphnia quadrangula*, *Pleuroxus trigonellus*, *Macrocyclops albidus*, and *Cyclops vernalis* were from three to eight times higher than the maxima observed for those species here. The quantities for the other species were quite similar to those found in this study. Pennak also found that certain species; namely, *Ceriodaphnia quadrangula*, *Cyclops vernalis*, and *Diaphanosoma brachyurum* showed higher numbers in open water.

Goulden (1971) examined sediment samples collected from the littoral of Lake Lacawac, Pennsylvania, and expressed individual cladoceran species per 2.11 cm^2 of bottom. He reported the following maxima: 1.8 *Alonella excisa* per 2.11 cm^2 of bottom, 3.2 *Chydorus sphaericus*, 3.0 *C. piger*, 9.0 *Alona rustica*, 5.8 *Disparalona acutirostris*, 8.8 *Alona (= Biapertura) intermedia*, and 11.0 *Alona (= Biapertura) affinis*. These numbers would be multiplied by 4,762 to equal numbers per $meter^2$ of bottom. The numbers for the last five species represent much higher quantities than the present study.

The combination of climate, substratum, and nature of the drainage areas makes Newfoundland lakes extremely different than the above quantitative study areas. From plankton investigations, Davis (1972, 1973) has found that the standing stocks of phytoplankton and zooplankton in Newfoundland lakes are low. The rather low productivity has resulted from the following influences: (1) most of the lakes lie over hard Pre-Cambrian rocks and thus, are low in mineral content, including calcium; (2) waters in many cases are affected by bog drainage; (3) humid boreal climate and the Labrador Current results in cool summers and long, mild winters (Davis, 1973). These help define other direct factors which could influence the dynamics of littoral microcrustaceans. For example, several workers (Smyly, 1957; Smirnov, 1963a; Straškraba, 1965; Keen, 1973) have stressed the importance of vegetation in relation to the production of littoral microcrustaceans. Differences in the extent of growth or the annual development of plants in the various investigations could have accounted, in part, for dissimilar productivities. Of equal importance with the extent of growth, is the type of vegetation. In most instances, the plant species in Round Pond and La Manche Marsh were different than the other quantitative studies. Also, the bottom in La Manche Marsh and Round Pond was composed largely of organic-rich sediments which may have had some influence on the species inhabiting the two waters. No other types of bottoms were sampled quantitatively, and so it is not possible to speculate concerning the influence of bottom types on numbers for individual species or total productivity. Water chemistry is probably not that significant in that most microcrustaceans have adapted to a wide range of chemical conditions (Fryer, 1968).

Unless an important group of predators was absent in a particular water body, predation would not explain differences in productivity. However, various workers have demonstrated that predation is an extremely important factor influencing the dynamics of cladoceran populations (Goulden, 1971; Johnson, 1973; Keen, 1973). The nature of the quantitative data in this study was descriptive, which revealed little concerning the underlying processes causing increases or decreases in the various populations. But, from observations on the relative abundances of predators, there seemed to be some relationship between cladoceran declines in the summer and the abundance of predators. Particular predators such as tanypodine midges (late instars), hydras, Odonata nymphs, and *Chaetogaster* spp. seemed to be most abundant in July and August. These predators probably caused the sharp population declines shown by a number of cladoceran species in July and August, since cladocerans were abundant in their guts. In the absence of heavy predation, some cladoceran populations increased for a brief period in the fall. Other species (e.g., *Alona quadrangularis*, *A. rustica*, *Biapertura affinis*, and *B. intermedia*) did not recover from predatory pressure, as their numbers remained low throughout the fall. Although predation probably affected copepod populations, not enough information was obtained which actually related predators to population declines.

Food is also an important factor, but from observations on the feeding habits of several species, it never appeared to be limiting in this study. Even when certain types of food become scarce (e.g., algae), Cladocera and some Copepoda are able to utilize larger amounts of detritus or organic material (Fryer, 1957b; 1968). In addition, there was no indication that parasites or an abundance of possible competitors affected the decline of microcrustacean populations.

SUMMARY

A total of 62 microcrustacean species was reported for the Province of Newfoundland and Labrador, including 47 species of Cladocera and 15 species of Copepoda. The mean microcrustacean community consisted of 8.5 species of Cladocera and 2.8 species of Copepoda. Twenty-six species of Cladocera and 12 species of Copepoda are recorded for the first time in the Province. A new cyclopoid copepod species was described, *Paracyclops yeatmani* n. sp.

The maximum standing stocks of microcrustaceans were similar in Round Pond and La Manche Marsh. The dominant microcrustaceans in the summer and fall in La Manche Marsh were Cladocera: *Acantholeberis curvirostris*, *Biapertura intermedia*, *Chydorus sphaericus*, and *Ilyocryptus spinifer*. In the winter, the copepod, *Macrocyclops albidus*, was dominant, while *Cyclops varicans rubellus* was the most abundant species in the spring. Round Pond also was dominated by Cladocera in the warmer months; namely, *Acroperus alonoides*, *Alona rustica*, *Alonella excisa*, *Chydorus sphaericus*, and *Sida crystallina*. The copepods, *Macrocyclops albidus* and *Eucyclops agilis* were dominant in the winter and early spring.

Qualitative seasonal studies showed that the seasonal distributions of some cladoceran species can vary in different localities. Such studies also showed that sampling on one date seldom revealed all species known for a particular water body.

The results of plant collections suggest that some

microcrustaceans are associated with particular plant species (or types). Also, some Cladocera may utilize particular parts of a plant.

Food of Cladocera consisted mainly of detritus and algae. Copepod species fed on numerous types of food including algae, protozoa, rotifers, other microcrustaceans, and nauplius stages and eggs of copepod.

Important predators of microcrustaceans included aquatic insects, *Chaetogaster* spp., hydras, unidentified flatworms, some copepods, fish, and the carnivorous plant, *Utricularia intermedia*.

REFERENCES CITED

American Public Health Association. 1971. Standard methods for the examination of water and sewage. 13th edition. New York. 874 p.

Anderson, R. S. 1971. Crustacean plankton of 146 alpine and subalpine lakes and ponds in western Canada. J. Fish. Res. Bd. Can. 28: 311-321.

Berg, K. 1929. A faunistic and biological study of Danish Cladocera. Vidensk. Medd. Dansk. naturhist. For. Kobenhavn. 88: 31-112.

Bernard, J. and R. Lagneux. 1972. Association planctonique (Cladocères et Copépodes) d'un lac dimictique du parc des Laurentides, Québec. Naturaliste can. 99: 381-409.

Bigelow, N. K. 1922. Representative Cladocera of Southwestern Ontario. Toronto Univ. Dept. Biol. Publ. Ont. Fish. Res. Lab. 8: 109-126.

________. 1928. The ecological distribution of microscopic organisms in Lake Nipigon. Toronto Univ. Dept. Biol. Publ. Ont. Fish. Res. Lab. 35: 59-74.

Brandlova, J., Z. Brandl, and C. H. Fernando. 1972. The Cladocera of Ontario with remarks on some species and distribution. Can. J. Zool. 50(11): 1373-1403.

Brooks, J. L. 1959. Cladocera. In Freshwater biology. Edited by W. T. Edmondson. 2nd ed. John Wiley and Sons, New York and London. pp. 587-656.

Carl, G. C. 1940. The distribution of some Cladocera and free-living Copepoda in British Columbia. Ecol. Monogr. 10: 55-110.

Chaston, I. 1969. Anaerobiosis in *Cyclops varicans*. Limnol. Oceanogr. 14(2): 298-300.

Crisp, D. T., and O. W. Heal. 1958. The Corixidae (O. Hemiptera), Gyrinidae (O. Coleoptera) and Cladocera (Subphylum Crustacea) of a bog in Western Ireland. The Irish Natur. J. 12: 297-324.

Culver, D. A. and G. J. Brunskill. 1969. Fayetteville Green Lake, N. Y. V. Studies of primary production and zooplankton in a meromictic marl lake. Limnol. Oceanogr. 14(6): 862-873.

Cushman, J. A. 1908. Freshwater Crustacea from Labrador and Newfoundland. Proc. U.S. Natl. Mus. 33(1589): 705-713.

Dadswell, M. J. 1970. A physical and biological survey of the aquatic environment (freshwater) of the proposed Gros Morne National Park, Newfoundland. Can. Wildl. Serv. Limnol. Sect. Rep. Ser. pp. 1-76. (Mimeographed).

Davis, C. C. 1969a. *Ergasilus luciopercarnum* males in an unusual collection. Can. J. Zool. 47(6): 1249-1252.

________. 1969b. Seasonal distribution, constitution, and abundance of zooplankton in Lake Erie. J. Fish. Res. Bd. Can. 26: 2459-2476.

________. 1972. Plankton succession in a Newfoundland lake. Int. Revue ges. Hydrobiol. 57(3): 367-395.

________. 1973. A seasonal quantitative study of the plankton of Bauline Long Pond, a Newfoundland lake. Naturaliste can. 100(2): 85-105.

Deevey, Edward S. and Georgiana B. Deevey. 1971. The American species of *Eubosmina* Seligo (Crustacea, Cladocera). Limnol. Oceanogr. 16(2): 201-218.

DeGuerne, Jules et Jules Richard. 1889. Revision des Calanides d'eau douce. Mém. Soc. zool. Fr. 2: 53-181.

Dussart, B. 1968. Les copépodes des eaux continentales d'Europe Occidentale. Tome 2. Cyclopoides et biologie. N. Boubée et Cie. Paris. 292 p.

Elgmork, K. 1964. Dynamics of zooplankton communities in some small inundated ponds. Folia Limnol. Scand. 12: 1-83.

Elton, C. 1929. The ecological relationships of certain freshwater copepods. J. Ecol. 17: 383-391.

Entz, B. 1946. Qualitative and quantitative studies in the coatings of *Potamogeton perfoliatus* and *Myriophyllum spicatum* in Lake Balaton. Arch. Biol. Hung. 17: 17-37.

Eriksson, S. 1935. Studien über die Fangapparate der Branchiopoden nebst einigen phylogenetischen Bemerkungen. Zoologiska Bidrag fran Uppsala. 40: 23-287.

Flössner, D. 1964. Zur Cladocerenfauna des Stechlinsee-Gebietes. II. Ökologische untersuchungen über die littoralen Arten. Limnologica. 2: 35-103.

Frey, D. G. 1958. The late-glacial cladoceran fauna of a small lake. Arch. Hydrobiol. 54(1/2): 205-275.

Frey, D. G. 1959. The taxonomic and phylogenetic significance of the head pores of the Chydoridae (Cladocera). Int. Revue ges. Hydrobiol. 44: 27-50.

________. 1965. Differentiation of *Alona costata* Sars from two related species (Cladocera, Chydoridae). Crustaceana. 8: 159-173.

________. 1967. Phylogenetic relationships in the family Chydoridae (Cladocera). Proc. Symp. on Crustacea. (Marine Biol. Assoc. India.). Pt. 1: pp. 29-37.

________. 1971a. Zoogeography and evolution. In Symposium on ecology of the Cladocera. D. G. Frey (ed.) Trans. Am. Microsc. Soc. 90(1): 119-121.

________. 1971b. Worldwide distribution and ecology of *Eurycercus* and *Saycia* (Cladocera). Limnol. Oceanogr. 16(2): 254-308.

Frost, N. 1940. A preliminary study of the Newfoundland trout. Fish. Res. Bull. Nfld. Dept. Nat. Res. 9: 1-30.

Fryer, G. 1955. A faunistic and ecological survey of the freshwater Crustacea of the Huddersfield district of West Yorkshire. Naturalist (London). No. 854: 101-126.

Fryer, G. and W. J. P. Smyly. 1954. Some remarks on the resting stages of some cyclopoid and harpacticoid copepods. Ann. Mag. Nat. Hist. 12(7): 65-72.

Fryer, G. 1957a. Freeliving freshwater Crustacea from Lake Nyasa and adjoining waters. Part II. Cladocera and Conchostraca. Arch. Hydrobiol. 53(2): 223-239.

________. 1957b. The feeding mechanism of some cyclopoid copepods. Proc. Zool. Soc. Lond. 129: 1-25.

________. 1957c. The food of some freshwater cyclopoid copepods and its ecological significance. J. Anim. Ecol. 26: 263-286.

________. 1963. The functional morphology and feeding mechanism of the chydorid cladoceran *Eurycercus lamellatus* (O. F. Müller). Trans. Roy. Soc. Edinburgh. 65(1/4): 335-381.

________. 1968. Evolution and adaptive radiation in the Chydoridae (Crustacea: Cladocera): a study in comparative functional morphology and ecology. Phil. Trans. Roy. Soc. London (B). 254: 221-385.

________. 1971a. Allocation of *Alonella acutirostris* (Birge) (Cladocera, Chydoridae) to the genus *Disparalona*. Crustaceana. 21(2): 221-222.

Fryer, G. 1971b. Functional morphology and niche specificity in chydorid and macrothricid cladocerans. In Symposium on ecology of the Cladocera. D. G. Frey (ed.) Trans. Amer. Microsc. Soc. 90(1): 103-104.

Goulden, G. E. 1964. The history of the cladoceran fauna of Esthwaite Water (England) and its limnological significance. Arch. Hydrobiol. 60: 1-52.

________. 1971. Environmental control of the abundance and distribution of the chydorid Cladocera. Limnol. Oceanogr. 16(2): 320-331.

Gurney, R. 1923. The crustacean plankton of the English Lake District. J. Linn. Soc. Zool. 35: 412-447.

________. 1933. British freshwater Copepoda. Vol. 3. Cyclopoida. London. Ray Soc. 384 p.

Hall, D. J., W. E. Cooper, and E. E. Werner, 1970. An experimental approach to the production dynamics and structure of freshwater animal communities. Limnol. Oceanogr. 15(6): 839-928.

Johnson, D. M. 1973. Predation by damselfly naids on cladoceran populations: fluctuating intensity. Ecology. 52(2): 251-268.

Keen, R. 1973. A probabilistic approach to the dynamics of the Chydoridae (Cladocera, Crustacea). Ecology. 54(3): 524-534.

Kiefer, F. 1934. Neue Ruderfusskrebse aus Nordamerika. Zool. Anz. 107(9/10): 269-271.

Klugh, A. B. 1926. Notes on Canadian Freshwater Entomostraca. Can. Field Naturalist. 40(6): 133-135.

Kubersky, Edward S. 1973. Worldwide distribution and ecology of *Alonopsis* (Cladocera: Chydoridae). (typescript). Ph.D. Dissert. Indiana Univ. 132 p.

Lastochkin, D. 1926. Pribrezhnye soobschchestva Valdaiskogo ozera (Shore Associations of Lake Valdai). Zapiski Gosudarstvennogo Gidrologicheskogo inst. 1: 1-70.

Macan, T. T. 1949. A survey of a moorland fish-pond. J. Anim. Ecol. 18: 160-187.

Megyeri, J. 1969. Néhány tó mesozooplanktonja. Szegedi Tanárkepzö Föiskola Tudományos Közlemenyeiböl. 1969: 105-119. (In Hungarian, English summ.).

Monakov, A. V. 1968. Cyclopoidae population in the inshore zone of Rybinsk Reservoir. Trudy Inst. Biol. Vnutr. Vod. 17(20): 33-40.

Moore, J. E. 1952. The Entomostraca of Southern Saskatchewan. Can. J. Zool. 30: 410-450.

Nordquist, H. 1921. Studien über das Teichzooplankton. Acta. Univ. Lund. 32(5): 1-123.

Patalas, K. 1971. Crustacean plankton communities in forty-five lakes in the Experimental Lakes area, northwestern Ontario. J. Fish. Res. Bd. Can. 28(2): 231-244.

_______. 1972. Crustacean plankton and the eutrophication of St. Lawrence Great Lakes. J. Fish. Res. Bd. Can. 29(10): 1451-1462.

Pennak, R. W. 1953. Fresh-water invertebrates of the United States. The Ronald Press Co. New York 769 p.

_______. 1966. Structure of zooplankton populations in the littoral macrophyte zone of some Colorado lakes. Trans. Amer. Microsc. Soc. 85(3): 329-349.

Proszynska, M. 1962. The annual cycle in occurrence of Cladocera and Copepoda in small water bodies. Polsk. Arch. Hydrobiol. 10: 379-422.

Pollett, F. C. 1968. Glossary of peatland terminology. Forest Res. Lab., St. John's, Nfld., Internal Rept. N-5: 1-30.

Quade, H. W. 1969. Cladoceran faunas associated with aquatic macrophytes in some lakes in northwestern Minnesota. Ecology. 50(2): 170-178.

Røen, U. I. 1962. Studies on freshwater Entomostraca in Greenland. II. Localities, ecology, and geographical distribution of the species. Medd. om. Grøland. 170(2): 1-249.

_______. 1968. Studies on freshwater Entomostraca in Greenland. III. Entomostraca from Peary Land with notes on their biology. Medd. om. Grøland. 184(4): 1-59.

Rylov, V. M. 1948. Fauna of the U.S.S.R. Crustacea. Freshwater Cyclopoida. Vol. III (3). Transl. by Israel Program for Sci. Transl. Jerusalem. 314 p.

Scourfield, D. J. and J. P. Harding. 1958. A key to the British species of freshwater Cladocera with notes on their ecology. Sci. Publ. Freshwater Biol. Assoc. No. 5. 55 p.

Sebestyén, O. 1948. Cladocera studies in Lake Balaton. II. Littoral Cladocera from northeastern shores of the Tihany Peninsula. Arch. biol. Hung. Ser II. 18: 101-116.

Sergeev, V. N. 1973. Feeding methods of some macrothricids (Cladocera, Macrothridae). Inform. Biull., Inst. Biol. Vnutr. Vod. A.N.S.S.R. No. 16: 29-33.

Shcherbina, T. V. 1970. New data on the feeding habits of *Eucyclops* (s. str.) *serrulatus* (Fisch.) (English transl.). Hydrobiol. J. 6(5): 36-39. (Gidrobiol. Zh.).

Smirnov, N. N. 1963a. On the inshore Cladocera of the Volga water reservoirs. Hydrobiologia. 20(1/2): 166-176.

________. 1963b. On the seasonal distribution of inshore Cladocera of the Volga water reservoirs. Hydrobiologia. 21(1/2): 202-208.

________. 1968. On comparative functional morphology of limbs of Chydoridae (Cladocera). Crustaceana. 14: 76-96.

________. 1969a. Morphology and functional basis for the mode of life of Cladoceran Crustacea. II. The functional complex in Chydoridae (Cladocera) ensuring the digestion of food. (English transl.). Hydrobiol. J. 5(6): 32-36. (Gidrobiol. Zh.).

________. 1969b. Morpho-functional grounds of mode of life of Cladocera. III. Oligomerization in Cladocera. Hydrobiologia. 34(2): 235-242.

________. 1971a. Morpho-functional grounds of mode of life of Cladocera. V. Structure and adaptive modifications of thoracic limbs of Anomopoda (Cladocera). Hydrobiologia. 37(2): 317-345.

________. 1971b. Evolutionary trends and adaptations of Cladocera. In Symposium on ecology of the Cladocera. D. G. Frey (ed.) Trans. Amer. Microsc. Soc. 90(1): 119.

________. 1971c. Rakoobraznye. Vol. 1, Sect. 2. Chydoridae Fauny Mira. Fauna S.S.S.R. 101: 1-529.

Smirnov, N. N. and C. C. Davis. 1973. Concerning some littoral Cladocera from Avalon Peninsula, Newfoundland. Can. J. Zool. 51(1): 65-68.

Smith, M. W. 1935. Fresh-water Cladocera and Copepoda from New Brunswick and Nova Scotia. Proc. N. S. Inst. Sci. 19(1): 11-16.

________. 1938. A survey of Lake Jesse, Nova Scotia. Proc. N. S. Inst. Sci. 19(3): 253-263.

Smith, T. G. 1968. Crustacea of the Delta Marsh region, Manitoba. Can. Field Naturalist. 82: 120-139.

Smyly, W. J. P. 1952. The Entomostraca of the weeds of a moorland pond. J. Animal Ecol. 21: 1-11.

Smyly, W. J. P. 1957. Distribution and seasonal abundance of Entomostraca in moorland ponds near Windermere. Hydrobiologia. 11: 59-72.

Straškraba, M. 1965. Contributions to the productivity of the littoral region of pools and ponds. I. Quantitative study of the littoral zooplankton of the rich vegetation of the backwater Labičko. Hydrobiologia. 24(3/4): 421-443.

Strogenger-Klekowska, Z. 1960. Annual cycles of Cladocera in fish ponds. Int. Revue ges. Hydrobiol. 45(2): 215-276.

Ward, E. B. 1940. A seasonal population study of pond Entomostraca in the Cincinnati Region. Amer. Mid. Natur. 23: 635-691.

Welsh, P. S. 1952. Limnology. McGraw-Hill Book Co. New York, Toronto, and London. Second Edit. 538 p.

Willey, A. 1925. Northern Cyclopoidae and Canthocamptidae. Proc. Trans. R. Soc. Can., Ottawa. 19(5): 137-159.

________. 1934. Some Laurentian Copepods and their variations. Trans. Roy. Can. Inst. 20(1): 77-98.

Williams, H., Kennedy, M. J., and E. R. W. Neale. 1972. The Appalachian Structural Province. In Variations in Tectonic Styles in Canada. R. A. Price and R. J. Douglas (Eds.) Geol. Assoc. Can., Spec. Paper No. 11, pp. 181-261.

Wilson, C. B. 1960. The macroplankton of Lake Erie. In Fish, C. J. (Ed.) "Limnological survey of eastern and central Lake Erie 1928-1929." U.S. Fish. Wildlife Serv. Rep. Fish. 334: 145-172.

Wilson, M. S. 1958. North American Harpacticoid copepods. 6. New records and species of *Bryocamptus* (Subgenus *Arcticocamptus*) from Alaska. Trans. Amer. Microsc. Soc. 73(3): 320-328.

Wolf, E. 1905. Die Fortpflanzungsverhältnisse unsere einheimischen Copepoden. Zool. Jahrb., Syst., 22: 101-280.

Yeatman, H. 1959. Free-living Copepoda: Cyclopoida. In Edmondson, W. T. (Ed.) Freshwater Biology. John Wiley and Sons, New York and London. pp. 795-815.

Yeatman, H. and M. S. Wilson. 1959. Free-living Copepoda: Harpacticoida. In Edmondson, W. T. (Ed.) Freshwater Biology. John Wiley and Sons. New York and London. pp. 815-861.

APPENDIX A

DESCRIPTION OF SAMPLED AREAS

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
1	1N/2; 59.3x29.8	< 1.0	0.42	*Potamogeton gramineus*, *Utricularia intermedia*	28-VIII-72	Large pond near Tors Cove. Dense plant growth. Soft bottom.
2	1N/2; 55.4x28.7	5.5	0.38	*Utricularia intermedia*, *Carex* sp.	28-VIII-72	Large, shallow pond in La Manche Valley. Soft bottom with a thick layer of decomposed reeds.
3	1N/2; 54.8x28.6	0.5	0.46-0.68	*Carex lasiocarpa*, *Nymphaea odorata*, *Potamogeton gramineus*, *Utricularia intermedia*, *Sphagnum majus*	V-72 thru V-73	Small marsh near La Manche Provincial Park completely covered with vegetation. pH = 5.52-6.28. Color = 55-90.
4	1N/2; 54.7x28.4	5.0	0.46	*Nymphaea odorata*, *Potamogeton gramineus*, *Sphagnum* sp.	28-VIII-72	Similar to the above description (No. 3).
5	1N/3W; 25.2x34.6	1.0*	0.24-0.38	*Carex* sp.	19-VI-73	Rather large pond on Salmonier Line. The bottom was soft and muddy. pH = 6.5
6	1N/3W; 21.4x31.3	< 1.0*	0.15-0.30	*Potamogeton gramineus*, submerged grasses	19-VI-73	Very small, shallow pool on Salmonier Line. Bottom was soft and muddy. pH = 6.7.
7	1N/6E; 30.7x42.6	< 1.0*	0.20-0.35	*Utricularia intermedia*, *Sphagnum* sp.	19-VI-73	Small *Sphagnum* pool on Salmonier Line. Bottom was soft, rich in organic content (peat).

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
8	1N/6E; 30.2x40.7	< 1.0*	0.30	*Carex* spp.	19-VI-73	Small marsh on Salmonier Line. Bottom was soft and muddy with a thick layer of decayed *Carex*.
9	1N/6E; 46.7x49.4	< 1.0*	0.28	*Sparganium* sp., *Utricularia intermedia*	19-VIII-72	Margins of small pool near Butterpot Provincial Park. Bottom was very soft, comprised largely of organic sediments.
10	1N/6E; 46.6x49.2	< 1.0*	0.32	*Potamogeton gramineus*, *Carex* sp.	19-VIII-72	Small pool in a boggy area on Trans-Canada Highway (TCH).
11	1N/6E; 46.6x49.2	< 1.0*	0.48	*Sphagnum* sp.	19-VIII-72	Small *Sphagnum* pool on TCH. Soft bottom, largely organic sediments.
12	1N/6E; 46.2x48.8	< 1.0*	0.30	*Potamogeton gramineus*, *Utricularia intermedia*	19-VIII-72	Backwaters of a stream which was filled with submerged vegetation (TCH). Soft bottom, largely organic sediments.
13	1N/6E; 47.9x48.2	1.0*	0.34-0.48	*Nymphaea odorata*, *Potamogeton gramineus*, *Utricularia intermedia*, emergent grass	19-VIII-72	Margins of large pond (on TCH) with an extensive growth of vegetation (1/15 area of pond). Bottom soft, consisting largely of organic sediments.
14	1N/6E; 45.5x47.7	< 1.0*	0.44	*Potamogeton gramineus*, *Carex* sp.	19-VIII-72	Large pond with sparse marginal vegetation (TCH). Bottom was soft and rich in organic material and covered with a layer of decayed reeds and grass.

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
15	1N/6E; 35.9x54.0	1.0*	0.46	*Utricularia intermedia*, *Nymphaea odorata*	4-VIII-72	Small pond with a dense vegetation. Bottom soft, comprised largely of organic material and detritus.
16	1N/6E; 31.8x58.0	2.0*	0.37	*Eriocaulon septangulare*, *Utricularia intermedia*	4-VIII-72	Large pond with a thick layer of decomposed reeds. Soft bottom.
17	1N/6W; 29.3x40.0	< 1.0*	0.25-0.48	*Hippuris vulgaris*, *Drepanocladus exannulatus*	19-VI-73	Small bog on Salmonier Line. Bottom varied from soft mud to gravel-like sediments.
18	1N/6W; 19.0x54.0	1.5*	0.40	*Nuphar variegatum*, *Utricularia intermedia*	19-VIII-72	Margins of a large pond with sparse vegetation. Rocky bottom with a rich organic, mud layer.
19	1N/6W; 16.2x54.8	1.0*	0.52	*Equisetum fluviatile*, submerged grass	19-VIII-72	Deep pond with dense vegetation. Soft bottom.
20	1N/6E; 30.4x42.3	< 1.0*	0.4	Not known.	19-VI-72	Small pool on Bay Bulls - Holyrood Road.
21	1N/6W; 14.8x54.6	1.5*	0.25	*Sphagnum* sp.	19-VIII-72	Large *Sphagnum* pool with a soft bottom.
22	1N/7W; 52.8x37.5	< 1.0*	0.20-0.46	*Sphagnum* sp., *Menyanthes tripholiata*	2-VII-73	Small pool in Mobile Big Pond Biological Research Area. Bottom was soft, consisting largely of organic material (peat).
23	1N/7W; 53.3x37.5	< 1.0*	0.25-0.50	*Sphagnum* sp.	2-VII-73	Small pool bordering Mobile Big Pond Research Area. Bottom was similar to previous locality.

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
24	1N/7W; 53.0x38.2	< 1.0	0.18–0.40	*Carex* sp.	2-VII-73	Small, shallow pond in Mobile Big Pond Biological Research Area. Bottom was soft, largely of organic sediments but low in peat content.
25	1N/7W; 52.8x37.9	1.5	0.40	*Utricularia intermedia*, *Carex* sp.	2-VII-73	Small pond in Mobile Big Pond Biological Research Area. Bottom was soft, comprised largely of organic sediments, low in peat.
26	1N/7W; 51.7x36.4	< 1.0*	0.38–0.48	submerged grasses	2-VII-73	Small shallow pool adjacent to Mobile Big Pond. Bottom was firm and rocky.
27	1N/7W; 62.8x41.0	< 1.0	0.28–0.66	submerged grass *Carex* sp.	V-72 thru XI-72	Small boggy pool near Bay Bulls. Soft bottom. pH = 5.7-6.9. Color = 40-120.
28	1N/7W; 66.6x59.0	< 1.0*	0.30	submerged grass	17-VII-72	Small roadside ditch on Route 5 near Hefferman's Line. Bottom was rocky.
29	1N/7W; 61.8x39.9	< 1.0	0.20–0.54	*Sphagnum* sp.	V-72 thru XI-72	Backwaters of a slow-moving stream between Bay Bulls and Witless Bay. Soft bottom. pH = 4.9-5.4. Color = 170-400.
30	1N/7W; 61.1x36.2	1.5	0.14–0.55	*Fontinalis giganteum*, *Utricularia intermedia*, *Nuphar variegatum*	V-72 thru XI-72	Backwaters of a slow-moving stream between Witless and Mobile Bays. Rocky bottom with a layer of mud and detritus. pH = 5.5-6.5. Color = 70-200.

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
31	1N/7W; 59.8x42.8	< 1.0*	-	Not known	19-VI-72	Small pool on Bay Bulls - Holyrood Road.
32	1N/7W; 62.1x40.1	10.5	0.45	*Utricularia intermedia*, submerged grass	17-VII-72	Maggotty Pond. Shallow pond with sparse marginal vegetation. Rocky bottom.
33	1N/10E; 69.8x71.5	< 1.0*	0.15-0.42	*Potamogeton gramineus*	V-72 thru XI-72	Shallow pool in Pippy Park. Dense stand of *P. gramineus*. pH = 6.3-6.7. Color = 15-50.
34	1N/10E; 71.4x72.6	< 1.0	0.18-0.46	*Sphagnum* sp.	V-72 thru XI-72	Small pool with dense submerged vegetation. Bottom relatively firm. pH = 5.9-6.7. Color = 60-140.
35	1N/10E; 70.8x82.5	< 1.0*	0.28-0.56	*Carex* sp.	17-VI-73	Small pool surrounded by bog. Bottom consisted of soft mud.
36	1N/10E; 70.9x82.6	1.6	0.30-0.48	*Utricularia intermedia*	17-VI-73	Small pond with a rocky bottom (gravel-like) consisting of silt.
37	1N/10E; 70.7x82.6	< 1.0*	0.28	*Sphagnum* sp.	17-VI-73	*Sphagnum* mat. Bottom was very soft.
38	1N/10E; 71.1x82.9	8.5	0.40-0.60	*Carex rostrata*	17-VI-73	Small pond with a soft mud bottom. Vegetation was sparse.
39	1N/10E; 72.0x73.7	17.0	0.20-0.64	*Nuphar variegatum*, *Drepanocladus exannulatus*	28-VII-72	Virginia Lake. Sampled both a rocky, exposed bottom and a soft bottom.
40	1N/10E; 74.4x75.3	< 1.0*	0.22-0.68	*Sphagnum* sp.	V-72 thru XI-72	Deadman's Pond. Margins of small pond in vicinity of MSRL. Soft bottom. pH = 5.1-5.7. Color = 160-450.

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date Sampled	General Description of Sample Locality
41	1N/10E; 70.9x72.0	3.0	0.20-0.70	*Nuphar variegatum*, submerged grass	V-72 thru XI-72	Kenny's Pond. Little vegetation. Soft mud bottom. H_2S present in mud. pH = 6.2-6.9. Color = 10-40.
42	1N/10E; 70.3x71.8	8.0	0.54	*Potamogeton gramineus*	14-IX-72	Kent's Pond. Dense stand of *P. gramineus*. H_2S present in mud. Bottom was soft.
43	1N/10E; 69.5 x70.5	12.5	0.16-0.68	*Nuphar variegatum*, *Utricularia intermedia*, *Potamogeton gramineus*, *Carex* sp.	V-72 thru XI-72	Pond with an extensive marshy area at its south end. Soft, mud bottom. pH = 6.3-6.7. Color = 15-50.
44	1N/10E; 70.0x71.3	1.5*	0.18-0.70	*Nuphar variegatum*, *Callitriche* sp., *Potamogeton gramineus*, submerged grass	V-72 thru XI-72	Larry's Bog. Backwaters of a slow-moving, large stream which empties out of Kent's Pond. Bottom was soft and muddy.
45	1N/10W; 61.2x82.4	< 1.0*	0.40	submerged grass	31-VII-72	Rocky Brook. Backwaters of a slow-moving stream on Bauline Road. Firm bottom.
46	1N/10W; 65.1x83.1	2.1	0.38-0.69	*Potamogeton gramineus*, *Utricularia intermedia*, *Drepanocladus revolvens*, *Equisetum fluviatile*	V-72 thru IV-73	Round Pond. Large, shallow pond on Bauline Road. Vegetation covers about 1/4 area of pond. Soft bottom. pH = 6.15-6.70. Color = 80-140.
47	1N/10W; 65.0x84.1	2.8	0.32-0.48	*Nuphar variegatum*, submerged grass	V-72 thru XI-73	Weiss Pond. Large, deep pond on Bauline Road. Soft bottom. pH = 6.0-6.7. Color = 50-130.

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
48	1N/10W; 63.5x70.6	19.7	0.28-1.5	*Eriocaulon septangulare*, *Equisetum fluviatile*, *Potamogeton gramineus*	29-VIII-72	Bauline Long Pond. Large pond with a thick growth of vegetation at its south end. Soft bottom consisting largely of organic sediments and detritus.
49	1N/10W; 63.8x85.3	1.0	0.42	*Nuphar variegatum*, *Utricularia intermedia*	31-VII-72	Triangle Brook. Backwaters of a slow-moving stream on Bauline Road. Soft bottom. pH = 6.0-6.7. Color = 50-130.
50	1N/10W; 63.3x74.0	45.0	0.30-0.42	*Callitriche* sp., submerged grass	22-VII-73	Round Pond. Large pond on Old Broad Cove Road. Bottom was soft, consisting of organic and inorganic material.
51	2C/4W; 79.7x21.2	< 1.0*	0.18	*Nuphar variegatum*, *Utricularia intermedia*	26-VII-72	Shallow pond with a very soft mud bottom, consisting of organic material and detritus.
52	2D/15; 67.9x26.0	1.0*	0.34	*Potamogeton gramineus*	26-VII-72	Large pond which had a dense plant growth. Bottom was soft.
53	2E/3E; 24.4x36.5	< 1.0*	0.16	*Nuphar variegatum*, submerged grass	26-VII-72	Shallow pond with a dense growth of submerged grass. Sampled at the mouth of a stream which empties into the pond.
54	2F/4E; 17.5x55.7	< 1.0*	-	*Sphagnum* sp.	22-X-72	Small *Sphagnum* pool near Cape Freels.
55	12G/8E; 26.8X81.7	< 1.0*	0.18	*Nuphar variegatum*	28-VII-72	Margins of small, shallow pool. Soft bottom. pH = 6.7.

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) sampled	General Description of Sample Locality
56	12G/8E; 26.8x81.6	< 1.0*	0.15	*Utricularia intermedia*	28-VII-72	Margins of a small, shallow pool. Soft bottom consisting of organic and inorganic material. pH = 6.4.
57	12G/8E; 26.9x81.7	< 1.0*	0.24	*Menyanthes tripholiata*	28-VII-72	Small, shallow pool. Soft bottom containing organic and inorganic material. pH = 6.6.
58	12H/3E; 86.7x48.0	< 1.0*	0.12	*Sparganium* sp.	28-VII-72	Very shallow pool. Firm bottom.
59	12H/5E; 57.4x69.5	< 1.0*	0.38	*Chara globularis*, *Fontinalis giganteum*	26-VII-72	Small pool surrounded by bog. Soft bottom which was entirely covered with vegetation.
60	12H/5E; 52.8x70.2	< 1.0*	0.18-0.25	*Myriophyllum alterniflorum*, *Potamogeton gramineus*, *Ranunculus trichophyllus*, *Equisetum fluviatile*	28-VII-72	Small pool just behind Bonne Bay Little Pond. Dense growths of vegetation. Firm bottom comprised largely inorganic sediments.
61	12H/5E; 57.5x69.8	1.5	0.38-0.58	*Chara globularis*, *Potamogeton gramineus*, *Eleocharis palustris*	26-VII-72	Jack's Pond. Large pond with a thin marginal area of plants along its shore (1/20 of total area). Bottom was firm with a high inorganic content. pH = 7.7.
62	12H/5E; 51.0x70.0	286.0	0.42	*Potamogeton richardsonii*	28-VII-72	Bonne Bay Little Pond. Margins of large pond with a firm bottom, consisting largely of inorganic sediments.
63	12H/6E; 99.7x68.0	< 1.0	-	Not known	26-VII-71	Small pool which occasionally dries up in the summer.

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface Area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
64	12H/6E; 83.4x65.4	< 1.0*	-	Not known	26-VII-71	Small-pool with a very soft bottom.
65	12H/7W; 5.4x59.8	8,288	0.64	Emergent grass	26-VII-72	Sandy Lake. Firm bottom composed of a high inorganic content (almost pure sand). Sparse vegetation.
66	12H/12W; 31.2x95.9	< 1.0*	0.34	*Myriophyllum alterniflorum*, *Sparganium* sp.	27-VII-72	Small permanent pool with a dense growth of vegetation. Bottom was quite firm, comprised of organic and inorganic sediments.
67	12H/12W; 32.4x8.9	< 1.0*	0.40	*Sparganium* sp.	27-VII-72	Small permanent pool. Soft bottom. pH = 6.7.
68	12H/12W; 37.5x14.4	122	0.58-0.64	*Juncus effusus*, *Potamogeton gramineus*	28-VII-72	Rocky Harbour Pond. Sparse vegetation which occurred in clumps. Bottom was quite firm, consisting largely of inorganic material.
69	12H/13W; 38.4x19.9	1.0*	0.15	*Utricularia intermedia*	28-VII-72	Margins of a bog pool. Soft bottom. pH = 6.28.
70	12H/13W; 38.9x21.0	< 1.0*	0.25	*Equisetum fluviatile*, *Utricularia intermedia*	28-VII-72	Margins of a shallow pool which received its drainage from a boggy area. Soft bottom. pH = 6.55.
71	12H/13W; 40.3x22.2	< 1.0*	0.68	*Myriophyllum exalbescens*	28-VII-72	Small pool in a *Sphagnum* bog with a dense stand of vegetation. Soft bottom. pH = 6.55.

APPENDIX A (Continued)

No.	Grid Location; (E. x N.)	Surface area (ha)	Depth Sampled (m)	Dominant Plants†	Date(s) Sampled	General Description of Sample Locality
72	12H/13W; 37.5x14.4	< 1.0*	0.48	*Sphagnum majus*, *Nuphar variegatum*	27-VII-72	*Sphagnum* bog. Bottom was soft and almost completely covered with vegetation.
73	12H/13W; 39.2x14.9	1.0	0.28	*Eleocharis palustris*	27-VII-72	Backwaters of Western Brook River. Sparse vegetation. Bottom was firm with a large amount of inorganic material.
74	Churchill Falls Labrador	< 1.0*	-	*Sphagnum* sp.	26-VII-72	Small *Sphagnum* pool near Churchill Falls, Labrador.

†Dominant plants for the sampling location(s).

*Sample locality was not shown on the map and thus the surface area represents an approximation.

APPENDIX B

TABLE 1

QUALITATIVE SEASONAL SUCCESSION AND RELATIVE ABUNDANCE OF MICROCRUSTACEA IN 10 WATERS LOCATED ON THE AVALON PENINSULA

DEADMAN'S POND – (Pond 40)

	V			VI		VII			VIII		IX		X		XI	
	10	17	24	6	18	2	16	30	15	27	14	23	7	27	10	20
CLADOCERA:																
Acantholeberis curvirostris			(+)	+	+	++	++	++	++	++	+	+	+	(+)	+	+
Acroperus alonoides											+	(+)	+			
Alona quadrangularis					+	+	++	++	++	+	+					
A. rustica					+	+	+	++	+	+	(+)		(+)	(+)		
Ceriodaphnia quadrangula					++	(+)	(+)	+	++	++	+					
Chydorus sphaericus	++	++	+++	+++	+++	+	+	++	+++	+++	++	+	+++	++	+	+
Disparalona acutirostris		+	+	++	+	+	++	++	++	++	++	+	+	(+)	(+)	(+)
Ilyocryptus spinifer					+	+	++	++	+	+				+	+	
Polyphemus pediculus					++					++	+++	+	+++			
Scapholeberis kingi										+	+					
Simocephalus serrulatus	+	+	+	++	+++	+++	+++	+++	+++	++	+	+	+	(+)	(+)	
COPEPODA:																
Cyclops vernalis			+	+	+	+	++	++	+	+	+	++	++	+	+	+
Eucyclops agilis	+	++	++	++	+	+					+	+	+	+	+	+
Macrocyclops albidus			(+)	+	++	+	++	++	++	+	+	+	+	+	+	+
Orthocyclops modestus				+	+	+	+	+	+++	+++	+++	+	+			

POOL 34

	V			VI		VII			VIII		IX		X		XI	
	9	15	24	6	18	2	16	30	13	27	14	23	9	27	10	20
CLADOCERA:																
Acantholeberis curvirostris			(+)	+	++	++	+++	+++	++	+	++	+++	+	+	+	
Biapertura affinis										+	+	+				
Chydorus sphaericus	++	++	+++	++	+	+	++	++	+++	+	+	+	+	+	+	(+)
Diaphanosoma brachyurum				(+)	(+)	+	+	+	+	+	+					
Disparalona acutirostris	+	+	++					++					(+)	(+)	(+)	
Pleuroxus procurvus				+	++	+++	++	+	+	+	+	+				
Scapholeberis kingi				(+)	+			+	+++	+++	(+)					
Sida crystallina			(+)		(+)	+	+	+	+	++	++	++	+	+		
Simocephalus serrulatus		+	+	++	++	+++	+++	+++	+++	+	(+)					
COPEDPODA:																
Cyclops vernalis	+	+	+	+	+	+	+	++	++	++	+	+			+	+
Eucyclops agilis	++	++	++	+	+	+	++	+	++	++	++	++	+	+	+	+
Macrocyclops albidus	+	+	++	+	+	+	+++	+	+	+	+	++	++	+	+	+
M. fuscus										(+)	+	+	++	+++		

Explanation of relative abundance symbols: +++ very abundant; ++ numerous; + low numbers; and (+) present but rare

TABLE 2

POOL 27

	V			VI		VII		VIII			IX		X		XI	
	8	16	23	8	18	3	17	1	14	28	11	23	11	25	6	20
CLADOCERA:																
Acantholeberis curvirostris	(+)	+	++	+	++	+++	+	+	+	+	+	+	+			
Biapertura affinis						+	+	+	++	+	+	+	+			
B. intermedia				+	+	+	++	+	++	++	+	+	+	+	+	
Chydorus sphaericus	++	+	+				+	++	+	+	+	+	(+)	+	(+)	(+)
Disparalona acutirostris	+	+++	+++	++	+	++	++	++	+	++	+	+		+	(+)	+
Ilyocryptus spinifer							+	+	+	++	+	+				
Ophryoxus gracilis			+	+++	+++	+++	+	+	+	+++	++	+	+	+	+	+
Polyphemus pediculus					+++				+	++						
Sida crystallina				(+)	++	+	+	+	+	+	+					
Streblocercus serricaudatus				(+)	+	+		+	+							
COPEPODA:																
Eucyclops agilis	++	++	++	++	+++	++	++	++	+	+	+	+	+	+	+	+
Macrocyclops albidus		+	+	+	+	+	++	+	+	++	++	+	+	+	+	+

STREAM 29

	V			VI		VII		VIII			IX		X		XI	
	8	16	23	8	18	3	17	1	14	28	11	23	11	25	6	20
CLADOCERA:																
Acantholeberis curvirostris		(+)	+	++	++	+	+	++	++	+	+	+	+	+	+	(+)
Alona quadrangularis					(+)	+	+	+	+	+	(+)					+
A. rustica				+	+											
Chydorus ovalis	+	+	++	+++	+	+	+	+	++				+	+	+	+
C. sphaericus	++	++	+	+	+	+	+	+	+	+	++	+	+	+	+	+
Disparalona acutirostris	++	+++	++	+	+	+	+	+	++	++	++	(+)	+	+	+	+
Ophryoxus gracilis		+	+	+												
Pleuroxus laevis								+	+	+						
Polyphemus pediculus										+	+					+
Streblocercus serricaudatus			++	+	+	+										
COPEPODA:																
Bryocamptus arcticus	+	+	++	+	+	+										
Cyclops venustoides pilosus	+	++	++	++	+	+	+	+	+	++	+++	+	+	(+)	(+)	(+)
C. vernalis			+	+	+	+	+	++	++	+	+	+	+	+	+	+
Macrocyclops albidus					+	+	+	+	+	+	+	+	+	+	+	+
Paracyclops n. sp.	++	+++	++	++	++	+	+	++	+	+	++	++	+	+	+	+

TABLE 3

STREAM 30

	V			VI		VII		VIII			IX		X		XI	
	8	16	23	6	18	3	17	1	14	28	11	25	11	25	6	20
CLADOCERA:																
Acroperus alonoides		+	++					+	+	+++	++	++	+	+	+	(+)
Alona guttata		+	+									+	+	+	(+)	
Biapertura intermedia				+	+	+	+	++	++	+	+	+	+	+		
Chydorus piger	+	+	++	+	+	+	+	+	+	+	++	++	+	+	+	+
C. sphaericus	+++	+++	++	+	+	+	+	+	++	+	+	+	+	+	+	+
Disparalona acutirostris			+	+	+	(+)	+			+	+	(+)		+	(+)	
Graptoleberis testudinaria					(+)	+	++	+++	+	++	++	++	++	+		
Ophryoxus gracilis		+	+						++	++	++	+	+			(+)
Pleuroxus laevis								++	+	++	+	+	+			
Polyphemus pediculus								+++	++	++	+	+				
Scapholeberis aurita								+	+++	+	(+)					
COPEPODA:																
Eucyclops agilis	++	++	+	+	+	++	+++	++	++	+	+	+	+	+	+	+
Macrocyclops albidus			+	+	+	++	++	++	++	+	+	+	+	+	+	+

Weiss Pond — (Pond 47)

	V			VI		VII			VIII		IX		X		XI	
	3	10	25	5	18	3	17	31	14	29	11	25	11	25	6	20
CLADOCERA:																
Acroperus alonoides			+	+	(+)	++	++	+++	++	++	++	+	+	(+)	(+)	
Alona costata					+	+	+	+	++	++	+	+	++	+		
A. rustica		+		(+)	(+)	+	+	+	++	++	+	+				
Alonella exigua					(+)	+	+	+	++	++	+	+	++	+	+	+
Eubosmina longispina					++	+	+	+	+			+++	+++			
Ceriodaphnia reticulata					+++	++			+	+	+	+				
Chydorus piger				+	+	+	+	+	++	+	++	+	+++	+	+	+
C. sphaericus	+	+	+++	+++	+	++	+	+	+	+	+	++	+			
Daphnia catawba						+						+	+			
Eurycercus glacialis	(+)	+	+	+	++	+	+	+	++	+	+	+	+	(+)	(+)	
Latona setifera					+++	+++	+	+++	+++	+	(+)					
Polyphemus pediculus			++	+++	+	++					++	+	+			
Simocephalus serrulatus				+	+											
Streblocercus serricaudatus			+				+	+								
COPEPODA:																
Eucyclops agilis	+	++	++	++	+	+	+	+++	+	+	(+)			+	+	+
Macrocyclops albidus	+	+	+	+	+	+	+	++	+++	++	+	+	+	+	+	+
M. fuscus								+	+			+	+			

TABLE 4

POOL 33

	V			VI		VII			VIII		IX		X		XI	
	9	15	24	6	18	2	16	30	13	27	14	23	13	27	10	20
CLADOCERA:																
Alona rustica								(+)	(+)	++	+	+	(+)	(+)		
Biapertura affinis						+	++	+	+	+						
Ceriodaphnia quadrangula						(+)	+	+	+	(+)						
Chydorus sphaericus	+	+++	+++	++	+	++	+	+	+	+	+	+	+	(+)	+	(+)
Ophryoxus gracilis				(+)	(+)	+++	++	++				+	+		+	(+)
Pleuroxus procurvus				+	+	++		+	+	+	(+)	+	+	+		
Scapholeberis kingi							+									
Simocephalus serrulatus		+	+	++	++	+	+	+	++	+	+	+				
COPEPODA:																
Cyclops vernalis			+	+	+	+	+	+	+	++	++	++	++	+	+	+
Eucyclops agilis	+	+	+	++	+	++	++	++	+	+	++	++	++	+	+	+
Macrocyclops albidus	+	+	+	+	+	+	+	++	+	+	++	++	+++	+	+	+

LONG POND – (Pond 43)

	V			VI		VII			VIII		IX		X		XI	
	9	15	24	6	18	2	16	30	13	27	14	23	13	27	10	20
CLADOCERA:																
Acroperus alonoides			+	++	+	++	++	++	+	++	(+)	+	+			
Alona quadrangularis					+	+	+	+	++	+	(+)					
A. guttata			+	(+)								+	+	+	+	
Biapertura affinis					(+)	++	+	++	++	++	++	+	(+)			
B. intermedia			+	+	+	+	+	++	+	+	++	+	+	+		
Ceriodaphnia quadrangula					(+)	+	+	++	+							
Chydorus sphaericus	++	++	+++	++	+	+	+	+	++	+	+	+	++	+	(+)	(+)
Eurycercus glacialis				+	(+)	+	+	+	++	++	+	+	(+)			
Graptoleberis testudinaria				(+)	+	+	+	+++	+	++	+	(+)				
Ophryoxus gracilis					+	+++	++	+++	+	+	+	++	+			
Pleuroxus laevis							+	+	(+)	(+)						
P. procurvus				+	++	(+)	(+)	++	+	+	+	+	(+)			
Scapholeberis kingi								+	++	+						
Simocephalus serrulatus			+	+	+	+++	+++	+	(+)	+	+	+				
COPEPODA:																
Canthocamptus vagus	+	++	++	+	+	+	+	(+)								
Cyclops vernalis		(+)	+	++	++	+	+	+	++	++	+	+	+	+	+	+
Eucyclops agilis	++	++	++	+	++	++	+	+	+		+			+	+	+
Macrocyclops albidus	++	++	+	+++	++	++	++	++	+	++	++	+++	++	+	+	+

TABLE 5

KENNY'S POND - (Pond 41)

	V			VI		VII			VIII		IX		X		XI	
	9	15	24	6	18	2	16	30	13	27	14	23	13	27	10	20
CLADOCERA:																
Acroperus alonoides	+	+	+	+		+		+	+	+			+			
Alona quadrangularis							+	+		+	+	+				
A. rustica				+		+	+	+	+				(+)	(+)		
Alonella nana								+	+	+						
Ceriodaphnia quadrangula							+	+								
Chydorus sphaericus	++	+++	+++	+++	++	++	++	++	+	+	+	+	+	+	(+)	(+)
Disparalona acutirostris		+	++	+	(+)											
Eurycercus sp.	+	+	+	+	+	+	++	+	(+)							
Pleuroxus procurvus				++	++	+	++	+	+	+	+					
Simocephalus serrulatus		+	+	++	+++	+++	+++	+	+	+	+	+				
COPEPODA:																
Canthocamptus vagus	+	+	++	+	+											
Cyclops vernalis		+	+	+	+	+	+	++	++	++	++	+	+	+	+	+
Eucyclops agilis	+	++	++	++	++	+	+	+	++	+++	++	+	+	+	+	+
Macrocyclops albidis			+	+	+	+	+	+	+	+++	+++	++	+	+	+	+

LARRY'S BOG - (Pond 44)

	V			VI		VII			VIII		IX		X		XI	
	9	15	24	6	18	2	16	30	13	27	14	23	13	27	10	20
CLADOCERA:																
Acantholeberis curvirostris		(+)	(+)	(+)	+	+	+	(+)	(+)							
Alona quadrangularis				+	+	+	+	+	+	+	+	(+)				
Alonella nana		+	+	(+)			+	+	+	+						
Biapertura affinis		+	+	+	(+)	+	+									
Chydorus sphaericus	+++	++	++	++	+	+	+	+	+	++	+	+	+	+	(+)	(+)
Eurycercus sp.			+	+	+	+	++	+	+	+						
Graptoleberis testudinaria								+	+	+						
Pleuroxus procurvus		+	+	+	+	+	++	(+)	+	+	+	+	+			
Simocephalus serrulatus									+	+	+					
COPEPODA:																
Canthocamptus vagus	+	+	+	++	++											
Cyclops vernalis					(+)	+	+	+	+++	++	++	++	+	+	+	+
Eucyclops agilis	+	+	+	+	+	+	+	++	++	++	++	+	+	+	+	+
Macrocyclops albidis		(+)	(+)	+	+	+	+	+	+	+++	++	+	+	+	+	+
M. ater				++	+	+	+	++	++	+	+					

APPENDIX B

Table 6

CHANGES IN SPECIES DIVERSITY

Locality	Number of Total Species*	Range of Number of Species Collected on any one Date	Mean Number of Species per Collection Date
3	24	14-22	20.1
27	12	9-12	10.0
29	16	7-12	9.9
30	13	6-12	9.4
33	12	7-10	8.4
34	13	9-12	10.1
40	16	8-14	11.5
41	15	6-12	9.2
43	19	12-17	14.4
44	14	6-12	10.1
46	26	11-22	17.5
47	17	9-14	12.3

*Collected between June and September, 1973.

APPENDIX C

Table 1

TOTAL NUMBER OF MICROCRUSTACEANS OVER ONE M^2 BOTTOM IN LA MANCHE MARSH AND ROUND POND

La Manche Marsh		Round Pond	
Date	Numbers over one m^2 bottom	Date	Numbers over one m^2 bottom
May 10, 1972	6,136	May 8, 1972	1,570
23	10,934	24	4,118
June 8	14,310	June 5	7,955
19	20,240	19	15,574
July 3	44,140	July 3	14,559
17	34,485	17	29,784
August 1	27,740	31	34,130
14	34,634	August 14	42,568
28	48,180	29	53,680
September 11	45,650	September 11	42,288
25	45,490	25	21,070
October 11	33,900	October 11	25,940
25	28,120	25	14,130
November 6	16,138	November 6	7,580
20	16,200	20	4,710
December 8	9,978	December 8	5,110
January 9, 1973	8,840	January 10, 1973	2,340
February 14	7,160	February 14	1,920
March 12	4,220	March 12	2,400
April 11	5,960	April 11	1,400
May 2	10,860	May 2	4,040
25	15,270	22	8,680

TABLE 2

QUANTITATIVE RESULTS FOR SWIMMING SPECIES IN LA MANCHE MARSH

NUMBER OF INDIVIDUALS/M^3

	V		VI		VII		VIII			IX		X		XI		XII	I	II	III	IV	V
	10	23	8	19	3	17	1	14	28	11	25	11	25	6	20	8	9	14	12	11	2
CLADOCERA:																					
Acantholeberis curvirostris	165	60	336	410	1,632	2,176	1,348	3,108	5,796	6,242	13,950	8,800	8,760	4,960	3,060	2,280	240	-	-	990	1,185
Biapertura intermedia	300	570	486	126	1,664	2,720	3,040	6,930	17,532	5,826	2,660	1,408	2,490	1,536	1,260	1,800	180	-	-	480	720
Ceriodaphnia quadrangula	-	-	-	126	458	5,952	2,280	504	252	58	-	-	-	-	-	-	-	-	-	-	present
Chydorus sphaericus	2,400	7,050	10,052	17,950	41,760	16,768	10,128	10,878	6,588	9,766	7,710	7,232	6,150	1,304	1,995	1,880	885	-	-	1,110	3,360
C. bicornutus	570	66	616	880	4,278	3,424	5,382	6,510	9,504	6,574	2,850	2,336	3,900	1,574	1,260	890	-	-	-	-	1,215
Diaphansoma brachyurum	-	186	285	280	282	1,344	874	2,184	1,400	3,382	795	920	-	-	-	-	-	-	-	-	-
Ophryoxus gracilis	60	135	238	352	624	560	798	1,575	1,040	1,976	5,535	3,136	600	768	765	-	-	-	-	-	480
Polyphemus pediculus	-	-	-	192	292	420	394	8,526	3,636	6,536	-	-	-	-	-	-	-	-	-	-	-
COPEPODA:																					
Cyclops varicans rubellus	885	750	728	684	1,126	1,440	1,856	3,843	2,790	2,356	1,875	2,128	1,440	1,344	270	-	-	-	765	3,045	1,650
C. vernalis	315	495	308	528	896	976	2,224	4,914	6,138	2,698	5,206	2,880	3,168	2,304	1,360	1,425	800	975	645	650	0
Eucyclops agilis	330	585	672	640	880	1,072	2,318	2,142	2,412	3,288	3,030	3,376	4,050	2,880	2,528	1,500	3,165	930	768	1,072	870
Macrocyclops albidus	720	915	714	912	1,184	2,608	1,388	5,145	6,120	5,966	4,350	3,072	2,280	2,640	2,700	1,755	765	8,420	2,700	1,560	1,320
M. fuscus	-	-	-	-	-	384	1,178	1,134	1,370	2,470	1,605	1,002	525	416	495	270	-	-	-	-	-
Orthocyclops modestus	-	-	present	640	944	2,240	5,510	4,894	3,330	2,850	1,830	3,552	1,575	1,650	1,080	-	-	-	-	-	-

TABLE 3

QUANTITATIVE RESULTS FOR SWIMMING SPECIES IN ROUND POND

NUMBER OF INDIVIDUALS/M^3

	V		VI		VII			VIII		IX		X		XI		X	I	II	III	IV	V
	8	24	5	19	3	17	31	14	29	11	25	11	25	6	20	8	10	14	12	11	2
CLADOCERA:																					
Acroperus alonoides	-	720	5,360	3,560	7,450	15,120	2,680	5,412	4,220	4,800	2,652	10,260	3,312	1,786	756	646	162	-	-	-	-
Alona rustica	-	-	-	-	-	-	1,600	5,500	23,880	9,400	1,496	1,598	1,102	550	-	-	-	-	-	-	-
Alonella excisa	-	-	-	-	375	378	920	1,562	7,100	15,440	2,686	1,805	544	722	738	884	-	-	-	-	-
A. nana	-	-	800	1,428	3,625	5,415	12,600	5,852	4,100	3,200	1,564	8,740	3,060	969	1,080	1,292	216	-	-	-	-
Biapertura intermedia	-	80	140	190	550	2,814	5,440	8,140	3,000	1,560	1,275	950	867	1,007	720	510	-	-	-	-	-
Chydorus sphaericus	1,400	5,600	6,600	18,760	10,200	4,200	4,000	3,960	3,200	4,800	4,080	4,948	1,826	2,546	1,836	1,853	720	-	-	-	1,836
Ceriodaphnia quadrangula	-	-	64	180	425	1,974	3,820	5,984	1,800	1,880	442	152	-	-	-	-	-	-	-	-	-
Ophryoxus gracilis	-	-	174	360	1,365	5,610	12,840	13,140	3,200	3,128	1,224	2,052	276	418	-	-	-	-	-	-	-
Parophryoxus tubulatus	-	-	-	-	-	407	300	384	340	3,600	884	616	162	-	-	-	-	-	-	-	-
Sida crystallina	present	168	560	1,040	2,125	8,274	8,280	21,120	29,960	16,600	5,848	3,192	-	-	-	-	-	-	-	-	342
COPEPODA:																					
Eucyclops agilis	680	640	800	1,079	1,150	1,344	3,840	6,424	4,220	4,050	2,210	2,736	2,436	2,289	1,296	1,360	972	914	1,254	988	1,458
Macrocyclops albidus	380	800	524	548	800	1,710	3,888	3,124	7,080	4,920	2,142	3,440	1,102	1,254	756	884	1,339	2,052	3,116	1,744	1,656

APPENDIX D

Table 1

APPARENT COLOR (Pt-Cobalt Units)

No. Designation of Waters \ Week of*	VI	VII			VIII		IX		X	
	19	3	17	31	13	27	10	24	8	22
27	40	70	65	60	120	80	80	75	85	40
29	200	240	400	200	200	240	300	275	200	170
30	100	160	150	70	150	120	130	130	250	120
33	40	100	150	60	120	100	70	15	35	50
34	80	140	150	60	60	60	90	65	130	130
40	160	240	450	150	350	400	300	110	180	140
41	10	20	20	20	40	15	10	10	15	15
43	20	20	20	20	40	30	15	25	15	50
44	30	40	55	60	40	60	60	15	30	20
47	60	60	60	60	50	50	80	65	80	130

*The exact sampling dates for each locality are given in Appendix B, Tables 1-5.

APPENDIX D

Table 2

TEMPERATURE (°C)

Week of*	V		VI		VII			VIII		IX		X		XI	
No. Designation	8	22	5	19	3	17	31	13	27	10	24	8	22	5	19
27	4.8	9.8	12.0	18.0	22.5	22.8	13.5	19.0	14.8	14.5	14.8	5.9	8.0	5.2	6.2
29	5.2	8.4	12.0	19.0	23.0	21.5	14.0	17.8	17.8	15.0	12.8	8.4	7.1	4.8	5.2
30	5.0	9.4	11.5	16.0	22.5	23.0	14.0	19.0	17.6	13.8	10.4	7.0	7.2	5.3	6.8
33	6.0	11.0	15.0	23.0	22.0	25.0	19.6	22.5	25.5	12.4	16.8	11.8	6.2	5.6	6.6
34	4.8	9.0	12.4	18.0	22.5	25.0	22.5	22.0	25.0	10.5	15.5	15.0	6.2	6.2	5.6
40	5.6	7.8	8.0	18.0	22.0	24.0	17.0	21.0	18.5	10.0	13.0	11.2	6.4	5.8	5.4
41	6.0	8.8	16.2	20.0	22.0	24.5	18.5	22.0	20.0	14.0	14.1	9.8	5.8	5.8	5.2
43	6.4	10.4	16.0	22.0	22.0	24.5	20.0	23.0	22.0	14.2	16.0	11.2	6.8	6.0	4.8
44	5.6	10.0	16.2	21.0	22.0	24.5	18.0	22.5	20.0	13.2	15.8	10.8	5.2	6.2	5.0
47	5.2	8.6	18.0	16.0	22.5	21.0	18.5	18.4	19.8	15.6	11.0	9.2	6.6	4.6	5.2

*The exact sampling dates for each locality are given in Appendix B, Tables 1-5.

APPENDIX D

Table 3

DISSOLVED OXYGEN* (mg/1)

Week of** / No. Designation of Waters	VI		VII			VIII		IX		X		XI
	5	19	3	17	31	13	27	10	24	8	22	5
3	8.7	8.7	9.6	10.2	8.4	7.8	6.2	7.1	7.4	6.9	6.5	6.9
27	8.4	7.0	7.8	7.5	9.3	8.9	7.6	7.2	8.0	7.1	6.5	6.0
29	9.0	7.9	7.2	6.8	6.2	4.3	8.5	6.6	6.0	6.3	7.0	4.0
30	9.0	9.1	9.8	9.7	10.3	9.0	7.5	10.6	8.2	7.0	5.8	6.9
33	7.6	9.2	11.1	10.2	6.2	6.6	6.3	6.5	7.0	5.9	8.2	5.4
34	7.1	9.9	9.4	10.2	14.2	14.8	10.8	7.2	7.4	7.1	7.4	7.0
40	8.0	8.3	5.7	9.8	7.8	6.8	8.4	4.8	7.8	7.8	4.6	6.0
41	7.7	9.9	10.9	10.3	10.0	10.2	11.6	7.2	7.0	6.9	6.7	5.9
43	9.0	10.4	9.0	8.7	8.9	12.6	10.3	8.6	8.8	7.3	6.8	6.0
44	8.5	9.9	9.8	10.8	10.4	11.9	13.9	6.3	7.3	7.5	7.9	4.9
46	7.7	9.9	9.1	8.8	9.6	10.8	11.6	11.2	9.0	8.1	5.8	5.4
47	7.4	9.9	9.1	8.6	9.0	8.2	8.5	10.8	8.5	7.0	7.3	6.3

*Mean of two titrations.

**The exact sampling dates for each locality are given in Appendix B, Tables 1-5.