DISTRIBUTION OF ZOOPLANKTON IN LAKE EDKU

By

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SUMMARY

Zooplankton hauls were taken from five stations re presenting the different habitats in the lake at monthly intervals from June, 1969 till May, 1970. These comprise station I (the region of the lake-sea connection), stations II and III (the bare area which is divoid of hydrophytes) and stations IV and V (the area covered with *Potamogeton pectinatus*). The results of this investigation can be summarised in the following points :

1. The zooplankton community in Lake Edku is composed mainly of Cladocera, larvae of Cirripedia and Copepoda. These constituted together about 90.5% by number of the total zooplankton. Other plankters of less frequency include free living nematodes, rotifers, *Gammarus* and the chironomid larvae.

2. The distribution of the zooplankton organisms in the lake was controlled by variations of the water chlorosity. Thus, the zooplankton at station I was composed mainly of marine forms particularly the larvae of Cirripedia. Stations II and III sustained a mixed community of both marine and fresh water plantkon. On the other hand the zooplankton at stations IV and V was represented by fresh water organisms.

3. The *maximum* distribution of the *zooplankton organisms*, in general, was recorded during the winter and early spring (january-May), while their numbers remained low during the other seasons.

4. Members of Cladocera are fresh water forms. They constituted about 54.1 % by number of the total planktonic organisms. Cladocera is represented mainly by *Moina micrura*, *Alona rectangula* and *Chydorus sphaericus*. The distribution of *Moina* increased gradually from station I to station III with the decrease of the water chlorosity and it attained its maximum frequency in January and May, 1970. On the other hand, the distribution of *Alona* and *Chydorus* was confined to the *Potamogeton* plant belt. The average numbers of *Alona* reached a peak in April and that of *Chydorus* in Ferbuary.

5. The nauplius larvae of Cirripedia are of marine origin They represented the second important plankters, constituting about 24.8% by number of the total zooplankton organisms. Their distribution was confined to stations I-III. They appeared in the plankton during the period from October, 1969 till May, 1970. Their maximum frequency was reached in March.

6. The Copepoda is represented by the suborders Calanoida, Cyclopoida and Harpacticoida. They constituted about 11.7% by number of the total zooplankton. Members of Cyclopoida were more frequent than the other groups. They showed their maximum distribution at stations I, II and III during October, 1969 and March, 1970. The Calanoid *Acartia latisetosa* is a marine form. It appeared in the plankton at stations I and II during the period from January till May, 1970. The Harpacticoida is represented by *Canuella* sp. Which was recorded at station I and *Harpacticus* sp. which was observed at the *Potamogeton* plant belt.

7. The free living nematodes are tychoplanktonic forms. They attained their maximum distribution at the *Potamogeton* plant belt, particularly at station V, constituting about 28.4% by number of the total zooplankton there. Their average numbers increased rapidly during the autumn, reaching a peak in January, 1970.

8. Rotifera comprises the genera *Brachionus*, *Lecane*, *Monostyla* and *Lepadella*. The maximum distribution of *Brachionus* was recorded at station IV. The distribution of *Lecane*, *Monostyla* and *Lepadella* was confined to stations IV and V.

9. The genus *Gammarus* appeared in the plankton as a few scattered individuals. It reached a peak during March, 1970.

10. The chironomid larvae were found mainly at the lake bottom and they appeared in the plankton as a few scattered individuals. They were found mainly at the *Potamogeton* plant belt. They attained their maximum frequency during December, 1969 and January, 1970.

11. Other zooplankton organisms were rarely recorded in the plankton. These include *Leander squilla*, ostracods polychaete larvae, oligochaetes and aquatic insects. Station I sustained also few specimens of marine plankters during certain months such as larvae of crabs, mysis larvae of shrimps and *Sagitta*.

12. Results of this investigation indicate that Lake Edku is relatively poor in the zooplankton population. This is attributed to the mesotrophic properties of the lake water. The increased density of the submerged hydrophytes was met with a decrease in the numbers of the zooplankton organisms.

INTRODUCTION

The present ivestigation deals with the distribution of the zooplankton population in Lake Edku. This was carried out in connection with the estimation of the biological productivity of the lake including the physical and chemical conditions, primary production and the distribution of the bottom fauna (See Samaan 1974 and 1976).

The distribution of the zooplankton in the Egyptian Delta lakes has received much attention during the last years (cf. Steuer, 1935; 1942; Elster *et al,* 1960; El-Hawary, 1960; El-Maghraby *et al,* 1963 and Samaan & Aleem, 1972). However, little work has yet been done concerning the distribution of the zooplankton in Lake Edku. This was restricted on a list of the species encountered in the zooplankton hauls taken from the lake during the period from May till July, 1959 as given by El-Hawary (1960).

THE LAKE

Lake Edku is one of the shallow Delta lakes situated at the western margin of the Delta of the Nile, at latitude 31° 15' N and longitude 30° 15' E. (Fig. 1). The total area of the lake is about 12,600 hectare. It has an average depth of about one meter. The bottom of the lake is composed mainly of clay and to a less extent of sand. The lake is connected with the Mediterranean Sea through a small channel located at the north western margin (Boughaz El-Maadiya).

The lake receives its water from the Edku and Berzik Drains situated at its eastern margins. The average amount of the drain water discharged into the lake is about 6 million cubic meters per day. On the other hand, the water Budget of the lake amounts to about 110 million cubic meters. Thus, there exists a permanent slow stream of the drain waters which flows in the lake, from the east to the west, and the surplus water is finally discharged into the sea through Boughaz El-Maadiya. Sea water may also be introduced into the lake during windy days, invading the area of the lake-sea connection i.e the Maadiya District, and on rare occasions it may reach the center of the lake. However, such a marine water is quickly expelled from the lake by the normal flow of the drain water.

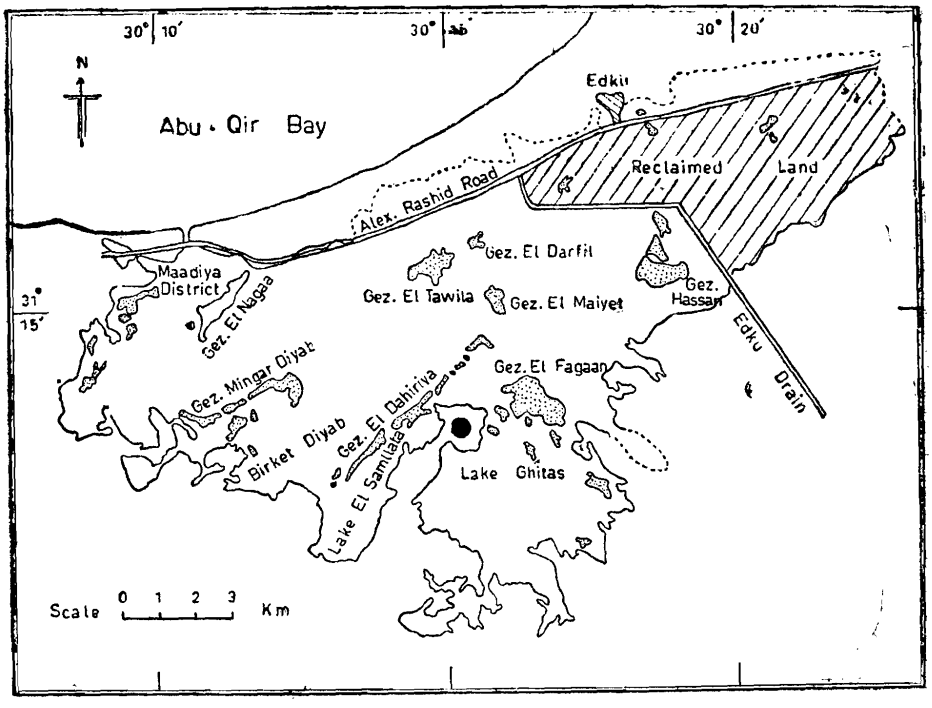

Fig. 1. Morphometry of Lake Edku

ENVIRONMENTAL CONDITIONS

The physical and chemical conditions of the lake water has been previously published (See Samaan, 1974). The following is a summary of the most important environmental conditions that may affect the distribution of the zooplankton organisms.

The annual water temperature ranges between 12.2°C and 28.5°C. It usually follows that of the air. Thus, the lowest values occur during the winter (January and February) while the highest are reached during the summer (in August). The chlorosity of the lake water usually fluctuates between 0.46 and 2.0 gm Cl/L. This value may, however, increase to 10.2 gm Cl/L at the Maadiya District and to 5.4 gm Cl/L in the middle of the lake during periods when the sea water invades the lake. Such periods are confined mainly to the winter and spring months. The pH

values of the lake water lies on the alkaline side and it ranges between 8.0 and 9.45. The areas covered with the growing hydrophytes usually attain high pH values. The total alkalinity of the lake water fluctuates between 3.7 and 6.2 milli. eq/L. The lowest values are usually recorded at the *Potamogeton* plant belt during the growing periods of the hydrophytes.

The distribution of the hydrophytes *Potamogeton pectinatus* L. and to a less extent *Ceratophyllum demersum* L. is one of the characteristic features of Lake Edlku (Samaan, 1974). They cover altogether about 50% of the total area of the lake particularly in the eastern part and around the lake margins. *Potamogeton* shows a principal growth period during the spring and a secondary one in late summer The growth period of *Ceratophyllum* extends from March till October.

The phytoplankton community in the lake, which forms the basic food supply for the zooplankton organisms, is rich in the number of species. It shows a marked periodicity during the different seasons. Thus, members of Cyanophyta are more abundant during the summer. These comprise mainly the genera *Merismopedia* Meyen. *Oscillatoria* Vauch. and *Lyngbya* Agardh. On the other hand Chlorophyta shows its maximum frequency during the spring and autumn months and it includes the genera *Pleodorina* Show, *Volvox* Ehr., *Eudorina* Ehr., *Pediastrum* Meyen, *Senedesmus* Meyen, *Oedogonium* Link. and *Spirogyra* Link. On the other hand the genus *Cladophora* kütz shows its maximum distribution during the winter. Some of the Bacillariophyta are abundant during the summer and early autumn such as *Rhoicosphaenia* Grun, *Rhopalodia* Mull and *Campylodiscus* Ehr. Others are more frequent in the spring and early autumn. These comprise the genera *Cocconeis* Ehr., *Cymbella* Agardh. and *Cyclotella*. The genus *Biddulphia* Ehr. shows its maximum frequency during the winter.

Lake Edku is considered as a mestrophic lake as regards phytoplankton production. The average value of the gross primary production in the lake attained 0.604 gm. C/m²/day during the period of this investigation. It remained relatively high at the bare area, and the margins of the plant belt (average 0.783gm C/m°/day) while the areas covered with a heavy growth of hydrophytes were the poorest in phytoplankton production (average 0·435 gm C/m²/day).

MATERIALS AND METHODS

The zooplankton samples were collected by using a small plankton net made of bolting silk and having 44 mesh/cm. The mouth of the net was 31 cm in diameter and its length amounted to one meter. Owing to th shallowness of the lake, the net was only towed horizontally for about 100 meters while the boat was moving at a slow speed. Considering the average value of the coefficient of filtration of the net as 0.67% (Samaan & Aleem 1972), the total volume of the water filtered per each station was estimated roughly as equivalent to five cubic meters. The collected plankton samples were preserved directly in 10% formaline solution. On rturning to the laboratory, the volume of the samples were concentrated to 50 ml and subsamples of 5 ml were transferred into a counting cell and each plankter was counted separately by using a binocular microscope. The distribution of the zooplankton organisms was calculated as their total numbers per cubic meter of the lake water.

Five stations were selected as representing the different habitats in the lake (Fig. 2). The positions and characteristics of these stations are as follows :

a) Station I : represents the area of the lake-sea connection which is known as the Maadiya District. The average depth of water at this station is about 50 cm and it is nearly separated from the rest of the lake by El-Nagaa Island. This area is occasionally invaded by the sea water as previously mentioned.

b) Stations II and III : represent the bare area which is devoid of hydrophytes. These stations are situated about the center of the lake. The average water depths are 115 and 125 cm at stations II and III respectively.

c) Stations IV and V : represent the *Potamogeton* plant belt located in the eastern part of the lake. Station IV lies at themargins of the plant belt and it remained devoid of hydrophytes during the autumn

and winter months, otherwise it sustained a moderate growth of *Potamogeton* throughout the spring and the summer. On the other hand, station V, being located about the center of the plant belt, sustained a heavy growth of hydrophytes during most of the year. The average water depths at stations IV and V are 120 and 110 cm respectively.

Sampling of the zooplankton hauls was carried out monthly at these stations during the period from June 1969 till May, 1970, covering one year cycle.

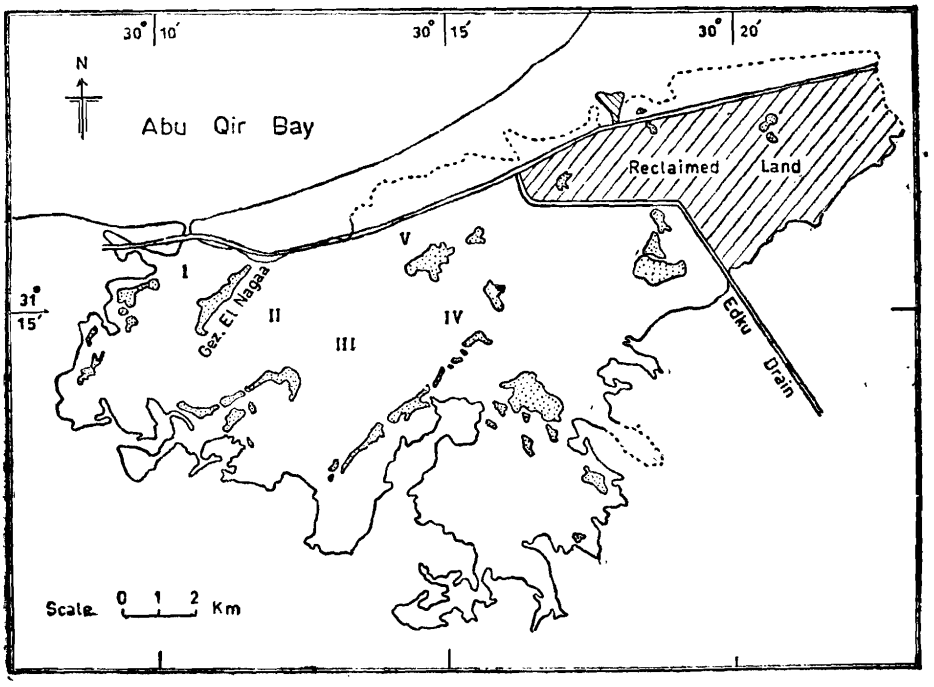

Fig. 2. Position of stations.

DISTRIBUTION OF THE ZOOPLANKTON POPULATION

1 — *The zooplankton community :*

The zooplankton community in Lake Edku is represented mainly by Cladocera, nauplius larvae of Cirripedia and Copepoda. They constitute altogether about 90.5% by number of the total zooplankton population. Other forms of less frequency include free living nematodes, rotifers, *Gammarus* and chironomid larvae

The rare forms comprise aquatic insects, polychaete larvae, oligochaetes, larvae of *Leander* and *Sagitta*. The following is a list of the organisms recorded in the plankton. The organisms marked by (+) represent those plankters of frequent distribution.

CLADOCERA

(+) Moina micrura Kurz (= Moina dubia De Guerne and Richard).

Bosmina longirostris Müller.

Diaphanosoma excisum Sars.

(+) Alona rectangula Sars.

(+) Chydorus sphericus Müller.

COPEPODA

(+) Acartia latisetosa Kriczaguin.

(+) Cyclops sp.

(+) Mesocyclops sp.

Halicyclop sp.

Canuella sp.

(+) Harpacticus sp.

CIRRIPEDIA

(+) Nauplius larvae of Balanus improvisus (Darwin).

OSTRACODA

Cyprideis litoralis Brady.

AMPHIPODA

(+) Gammarus foxi Schellenberg.

(+) Gammarus aequicauda Martynov.

DECAPODA

Zoea larvae of crabs.

Mysis larvae of Leander squilla elegans Rathke.

ROTIFERA

Brachionus angularis Gosse.
Brachionus plicatilis Müller.
Brachionus quadridentatus Hermann.
Lecane luna Müller.
Monstyla sp.
Lepadella sp.

NEMATODA

(+) Species of free living nematodes.

CHAETOPODA

Oligochaetes.
Spinoid larvae of polychaetes.

CHAETOGNATHA

Sagitta sp.

INSECTA

Adult insects of the order Odonata, Coleoptera, Diptera; Nymphs of adult insects.

2 — *Distribution of the total number of the zooplankton population :*

The maximum frequency of the zooplankton population was recorded at stations III and IV. This was mainly due to the increased numbers of both Cladocera and the larvae of Cirripedia at station III and to Cladocera at station IV (Table 1, & Fig. 3). Station 1 attained lower values and the zooplankton there was dominated by the nauplii of Cirripedia. Staton II attained further lower values than station I where the Cladocera was more frequent than the other groups. The lowest numbers of the zooplankton population in the lake were observed at station V i.e in areas covered with a heavy growth of *Potamogeton.* The dominant plankton at station V included Cladocera and to a less extent free living nematodes.

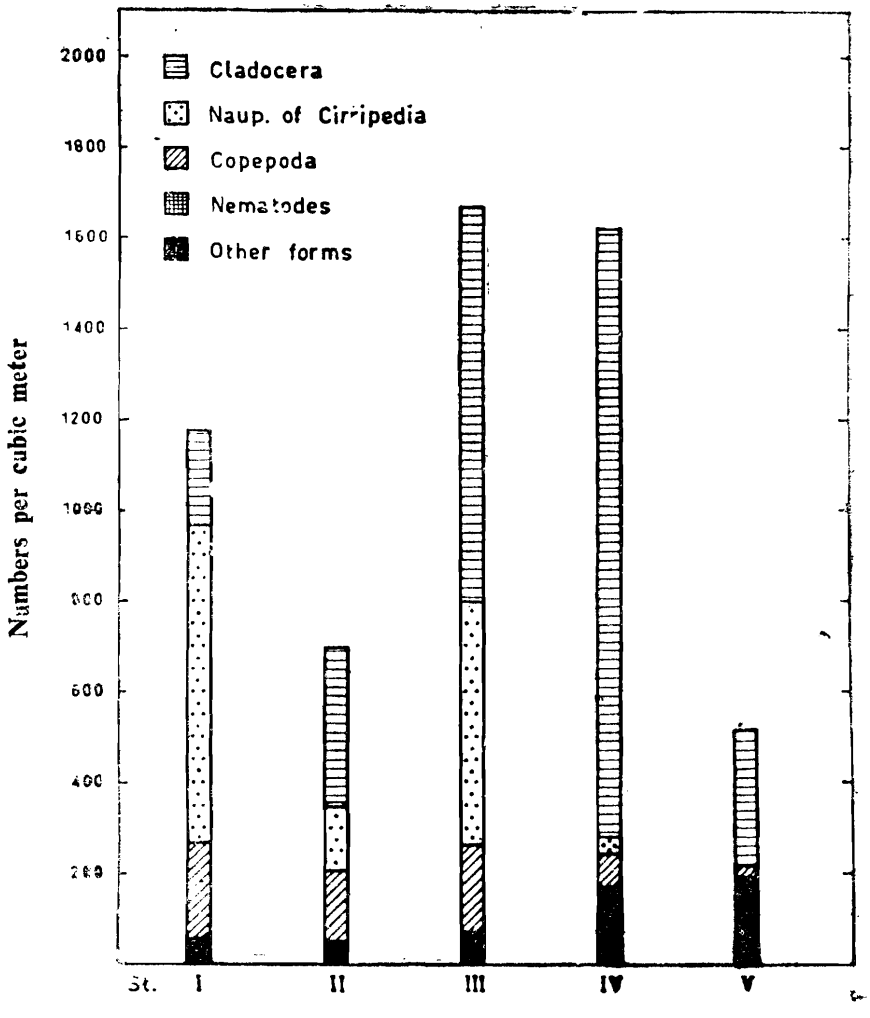

Fig. 3. Average numbers per cubic meter of the different groups of zooplankton recorded at the different stations during the period from June, 1966 still May, 1970.

TABLE 1. **Average numbrs per cubic meter of the different groups of the zooplankton recorded at the different stations during the period from June, 1969 till May, 1970.**

St. No. / Plankton	I	II	III	IV	V
Copepoda	233	168	187	66	19
Cladocera	215	348	873	1366	292
L. of Cirripedia	692	142	535	35	8
Nematodes	5	2	8	41	151
Other forms	26	33	72	121	59
Total plankton . . .	1171	693	1675	1629	529

3 — *Seasonal variations :*

The seasonal variations in the total numbers per cubic meter of the zooplankton organisms recorded at the different stations are shown in Table (2) and Figure (4). The following is a summary of the results obtained :

1 — The total numbers of the zooplankton organisms at station I remained low during the summer and autumn months of 1969. A slight increase in their numbers was observed during the winter of 1970 and this was succeeded by a sharp increase in March due to the increased numbers of the nauplii of Cirripedia. The total numbers of the zooplankton organisms dropped again in April and May.

2 — The total numbers of the zooplankton organisms at station II were relatively high during the months of June 1969 and January 1970 due to the increased numbers of Cladocera and also in February due to the increase in the numbers of the larvae of Cirripedia. It remained at a more or less constant lower values during the rest of the year.

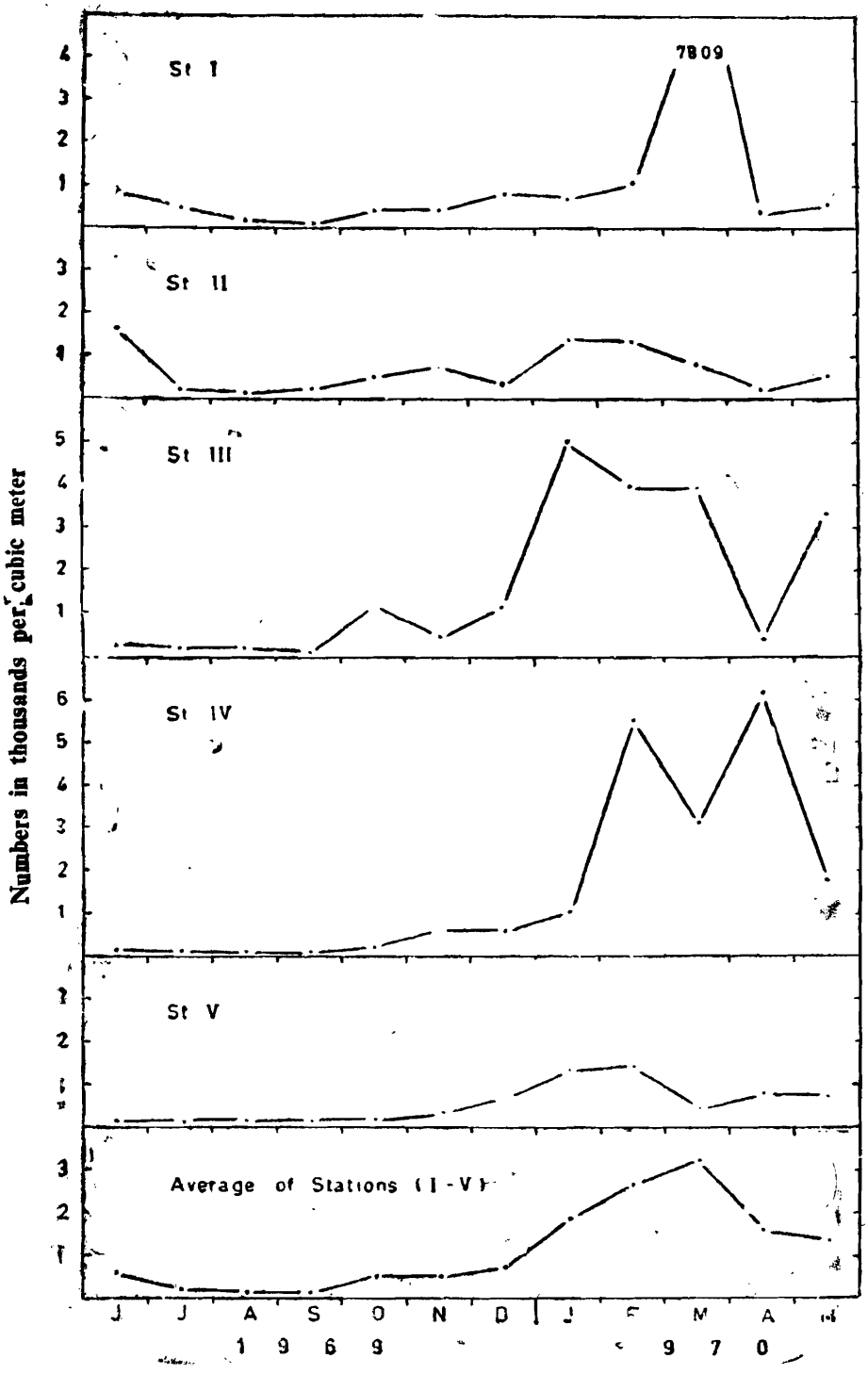

Fig. 4. Seasonal variations in the total numbers per cubic meter of zooplankton recorded at the different stations

TABLE 2. **Seasonal variations in the total numbers per cubic meter of the zooplakton population recorded at the different stations during the period of investigation.**

St. No. / Month	I	II	III	IV	V	Average
June, 1969 . . .	890	1584	265	151	114	601
July	488	176	200	103	101	214
August	222	*142*	*195*	*100*	*139*	*160*
September . . .	142	223	131	85	100	136
October	439	530	1072	222	176	488
November . . .	480	737	454	604	328	521
December	820	373	1123	632	711	732
January, 1970 . .	692	1430	5019	1005	1347	1899
February.	1075	1434	3956	5542	1393	2680
March	7809	868	3954	3124	462	3243
April	384	262	345	6215	792	1600
May.	610	549	3388	1762	679	1398

3 — The total numbrs of the zooplankton organisms at station III reached a peak during the period from January till March, 1970 due to the increased numbers of Cladocera (in January) and larvae of Cirripedia (in February and March). Another increase was also recorded in May which was also dominated by Cladocera.

4 — The maximum distribution of the zooplankton organisms at station IV was attained during the period from February till April, 1970 due to the increased numbers of Cladocera.

5 — The total numbers of the zooplankton organisms at station V remained low during most of the year with the exception of the months of January and February, 1970 which sustained a relatively big numbers of both Cladocera and nematodes.

6 — The average numbers of the total zooplankton organisms at the five stations, remained low during the summer and autumn months. A gradual increase in the zooplankton population was observed during the period from December, 1969 till March, 1970. This was succeeeded by a rapid drop in April and May.

Distribution and Seasonal Variations of the Different Groups

1. Cladocera

Distribution (Table 3 and Fig. 5)

Members of Cladocera were the most important group in the zooplankton population since they constituted about 54.1% by number of the total planktonic organisms. Cladocera is represented mainly by three species namely; *Moina Micrura Kurz, Alona rectangula* Sars and *Chydorus sphaericus* Müll. Two other species of a very rare occurrence include *Bosmina longirostris* Müll and *Diaphanosoma excisum* Sars. They were sporadically observed at stations II and III during the summer and autumn months.

Moina Micrura is a true planktonic form. Its average numbers increased gradually from station I to station III, indicating that it increased with the decrease of chlorosity. It was poorly represented at station V which sustained a heavy growth of *Potamogelon*.

The species *Alona reclangula* and *Chydorus sphaericus* are littoral forms and they were found mainly at the *Potamogeton* plant belt represented by stations IV and V. They were also obsrved in considerable numbers gliding on the *Potamogeton leaves.*

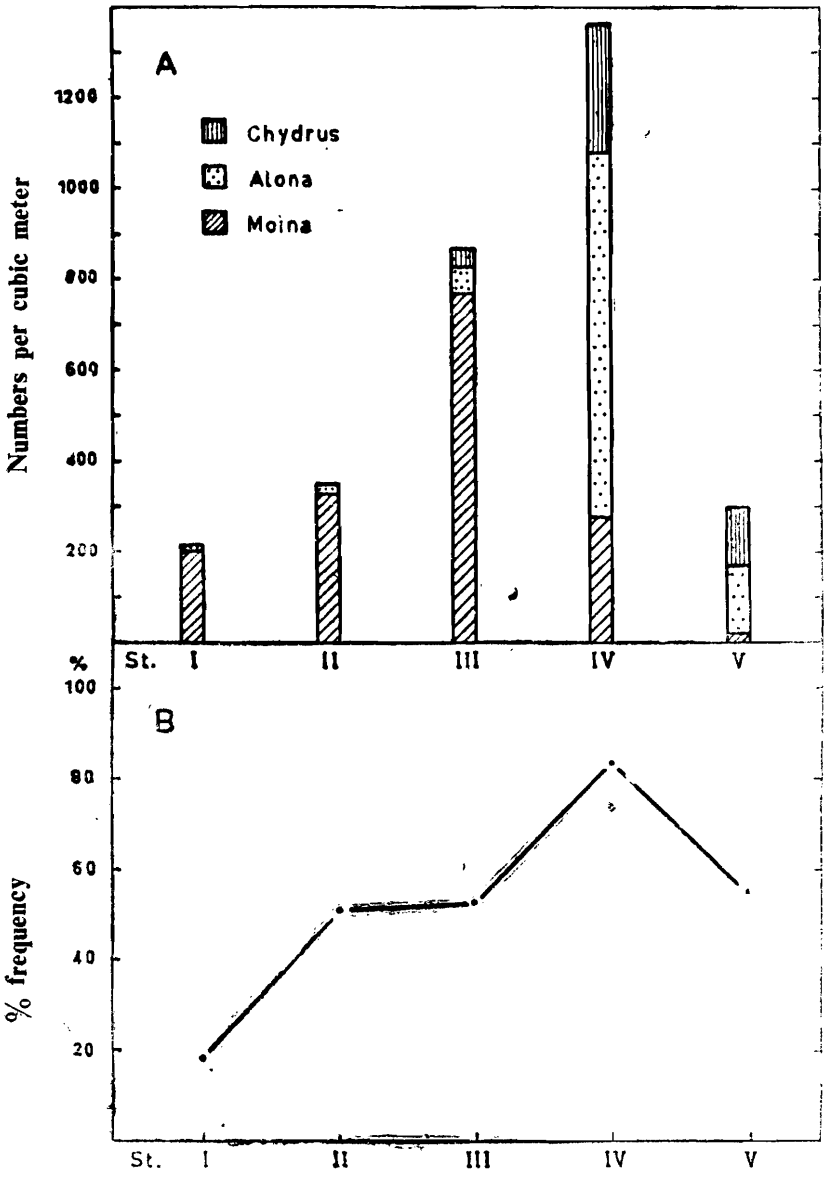

Fig. 5. Distribution of the different members of Cladocera at the different stations during the period from June, 1969 till May, 1970.

A — Average numbers per cubic meter.

B — Percentage frequency.

TABLE 3. **Average numbers per cubic meter of the different members of Cladocera recorded at the different stations during the period from June, 1969 till May, 1970 and their percentage frequency by number to the total zooplankton.**

Cladocera \ St. No.	I	II	III	IV	V
Moina Micrura	203	327	770	277	25
Alona rectangula	9	17	62	791	145
Chydorus sphaericus	3	4	41	298	122
Total Cladocera	215	348	873	1366	292
% frequency	18.5%	51.8%	52.2%	83.8%	55.0%

Seasonal variations : (Table 4 and Fig. 6)

Moina appeared in the plankton hauls all the year round. Its average numbers reached a peak in January, 1970 and it dropped rapidly in February and March. A second peak was recorded again for *Moina* during the month of May, otherwise it remained low throughout the rest of the year.

The average numbers of *Alona* remained low during the period from June, 1969 till January, 1970. It increased rapidly in March and April but dropped again in May.

The distribution of *Chydorus* in the lake was restricted to the period from December, 1969 till May, 1970. Its maximum frequency was observed in February and it remained low during the other months.

The total numbers of Cladocera, in general, showed their maximum distribution during the winter and the spring but they remained low throughout the other seasons.

TABLE 4. **Average monthly numbers per cubic meter of the different genera of Cladocera recorded at stations (I-V) during the period of investigations.**

Month \ Cladocera	Moina	Alona	Chydorus	Total
June, 1969	439	27	—	466
July	91	17	—	108
August	57	5	—	62
September	65	12	—	77
October	76	8	—	84
November	156	100	—	256
December	261	98	46	405
January, 1970	1240	73	104	1417
February	615	182	623	1420
March	19	433	100	552
April	13	1076	235	1324
May	815	436	12	1263

2. Nauplius larvae of Cirripedia :

Distribution : (Table 5 and Fig. 7).

The Nauplius larvae of the cirriped *Balanus* are characteristic members of the zooplankton population of the Egyptian Delta lakes (cf. Broch, 1935; El-Maghraby *et al*, 1963; Samaan and Aleem, 1972). The nauplius larvae of *Balanus improvisus* Darwin represent the second important plankter in Lake Edku since they constituted about 24.8% by number of the total zooplankton organisms. Their disribution was confihd at stations I and III, and less so at station II. On the other hand, they were poorly represnted at the *Potamogeton plant belt*.

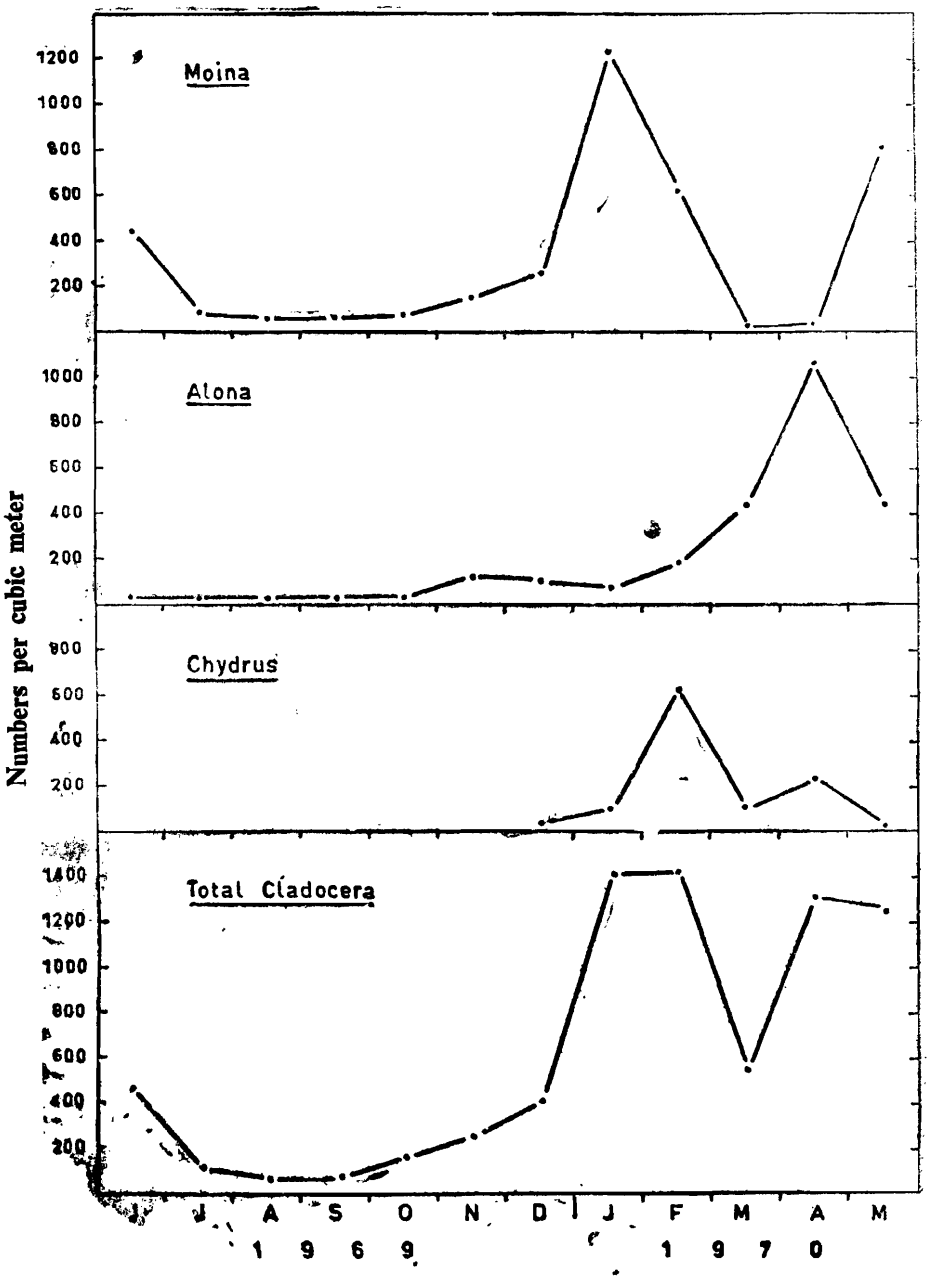

Fig. 6. Average monthly numbers per cubic meter of the different members of Cladorded at stations (I-V)

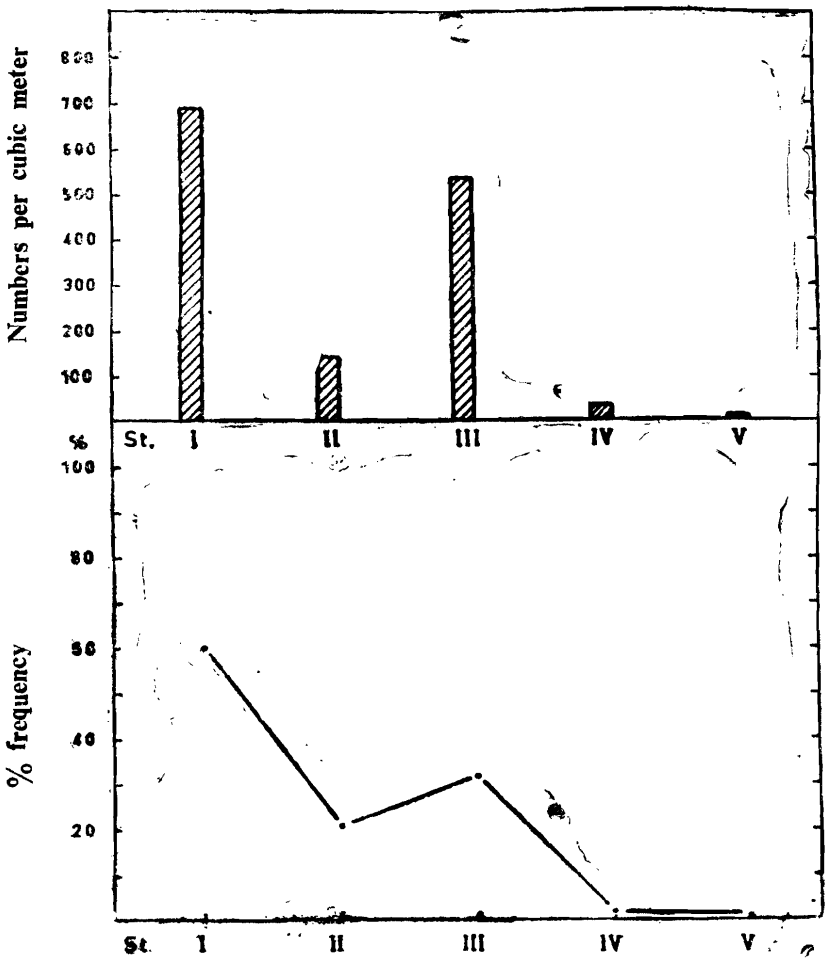

Fig. 7. Distribution of the nauplius larvae of Cirripedia at the different stations during the period from June, 1969 till May, 1970.

A — Average numbers per cubic meter.

B — Percentage frequency.

TABLE 5. **Average numbers per cubic meter of the nauplius larvae of Cirripedia recorded at the different stations during the period from June, 1969 till May, 1970 and their percentage frequency by number to the total zooplankton.**

Station No.	I	II	III	IV	V
No./m³	692	142	535	35	8
% frequency	60.5%	21.1%	32.0%	2.2%	1.1%

Seasonal variations : (Table 6, and Fig. 8) :

The distribution of the nauplius larvae of *Balanus* in the lake was confined to the period from October, 1969 till May, 1970. It appeared first at station I in October, and this was accompanied by an increase of the water chlorosity to 7.28 gm Cl/L. Their distribution was extended to stations II and III in November They showed a rapid increase in their numbers during February, and March, 1970 and this was succeeded by a sharp drop in April.

TABLE 6. **Average monthly numbers per cubic meter of the nauplius larvae of *Balanus* recorded at stations (I-V) during the period of investigation.**

Month	no/m³	Month	no/m³
June, 1969	—	December	79
July	—	January, 1970	87
August	—	February	1012
September	—	March	2192
October	4	April	17
November	10	May	13

The absence of the nauplii of Cirripedia during the period July-September, 1969 is attributed to the lower salinity of the lake water during that period. Thus, El-Maghraby *et al,* (1963) indicated that the nauplius larvae of Cirripedia survived in Lake Manzalah when the water chlorosity ranged between 0.7 and 24.7 gm Cl/L. They appeared also in Lake Edku when the water chlorosity was over 0.6 gm Cl/L but they attained their maximum distribution when the water chlorosity exceeded 3.0 gm Cl/L.

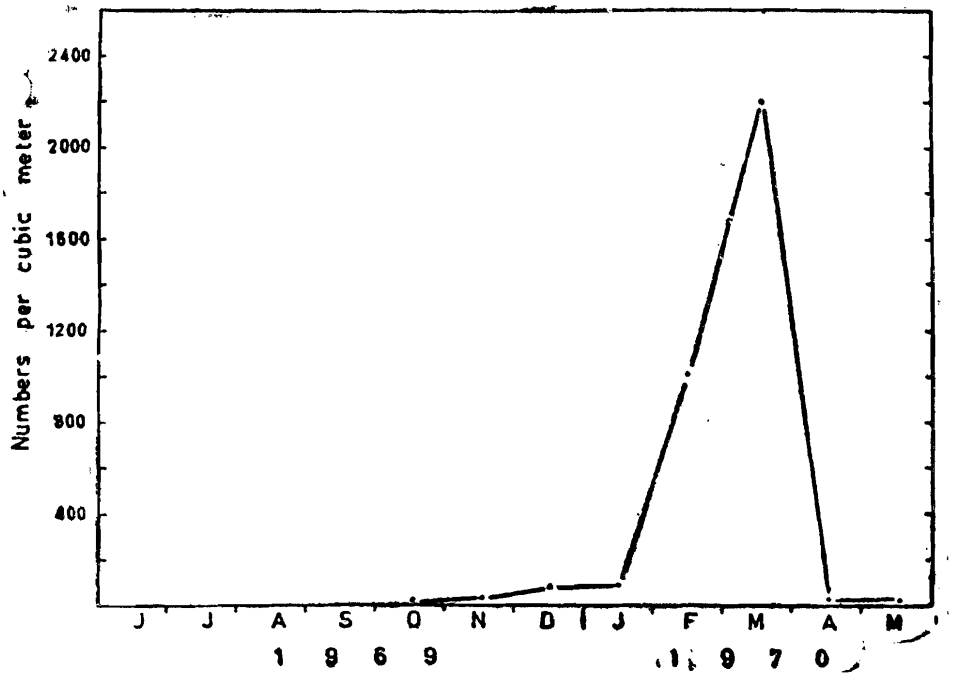

Fig. 8. Average monthly numbers per cubic meter of the nauplius larvae of Cirripedia recorded at stations (I–V)

3. Copepoda

Distribution : (Table 7 & Fig. 9).

Copepoda is represented in Lake Edku by members of the suborders Calanoida, Cyclopoida and Harpacticoida. They constituted altogether about 11.7% by number of the total zooplankton organisms.

TABLE 7. **Average numbers per cubic meter of the different groups of Copepoda recorded at the different stations during the period from June, 1969 till May, 1970 and percentage frequency by number of Copepoda to the total zooplankton.**

St. No. / Copepoda	I	II	III	IV	V
Calanoida	80	41	10	—	—
Cyclopoida	128	102	163	30	4
Harpacticoida	2	2	2	28	12
Nauplius of Copepoda . . .	23	23	12	8	3
Total Copepoda	233	168	187	66	19
% frequency to the total plankton	20.1%	24.8%	11.2%	4.1%	3.6%

The distribution of the Calanoid *Acartia latisetosa* Kriczaguin was confined to station I and its numbers decreased rapidly at stations II and III. This is due to the fact that *A. latisetosa* is a marine form and it favours localities of high salinity (euryhaline).

The Cyclopoida inhabiting the lake comprises members of the genera *Cyclops, Mesocyclops* and *Halicyclops.* They consitituted the main groups of Copepoda in the lake. Their maximum distribution was recorded at stations I, II and III while the *Potamogetom* plant belt remained poor in Cyclopoida.

The Harpacticoida comprises *Canuella* sp. and *Harpacticus* sp. Harpacticus was mainly observed at the *Potamogeton* plant belt and to a much less extent at the other stations. On the other hand the distribution of *Canuella* was confined to station I where it appeared as a few scattered individuals.

The nauplius larvae of Copepoda were also frequently met with at stations I and II, and to a less extent at the other stations.

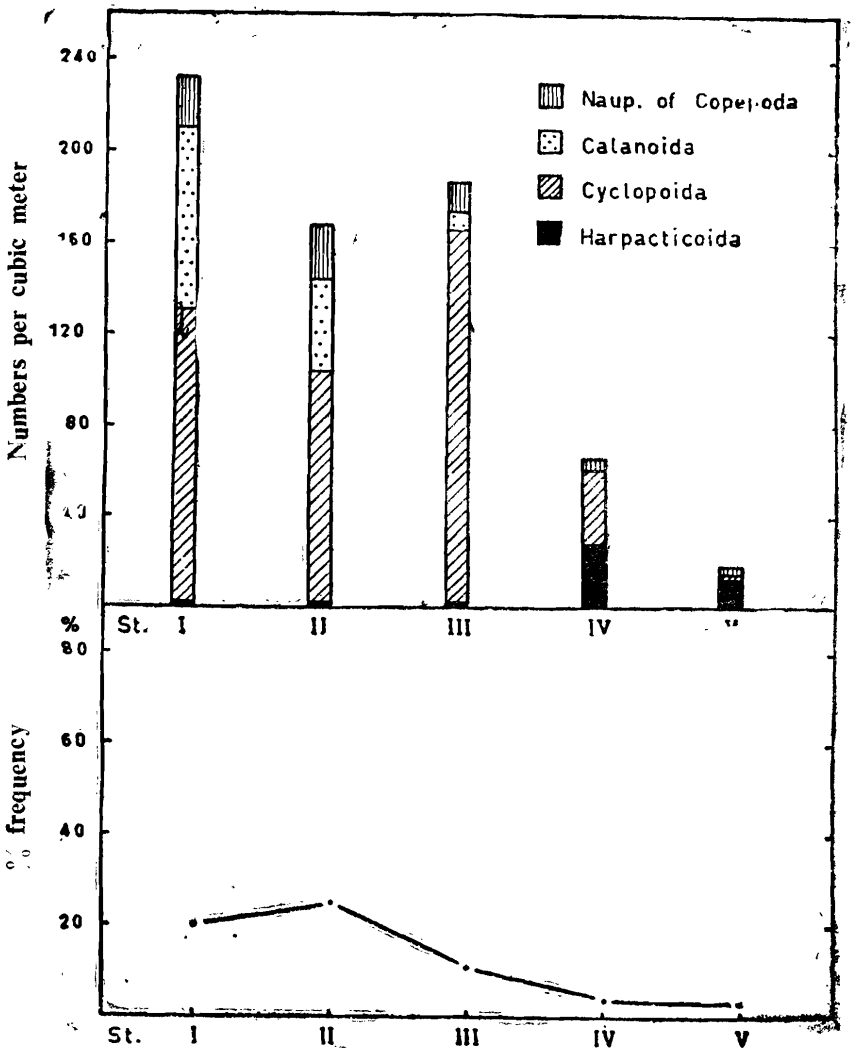

Fig. 9. Distribution of the different groups of Copepoda at the different stations during the period from June, 1969 till May, 1970.

A — Average numbers per cubic meter.
B — Percentage frequency.

Seasonal variations (Table 8 & Fig. 10).

Acartia appeared at stations I & II in considerable numbers during the period from January till May, 1970. This was accompained by a pronounced increase of the water chlorisity. It was also recorded as a few scattered individuals during July, November and December 1969.

Cyclopoida appeared in the plankton hauls all the year round. Their average numbers remained low during the period from June till September, 1969. A sharp increase in their numbers was recorded in October, particularly at stations II and III. This was followed by a gradual decrease in their numbers, reaching a minimum in February, 1970. Another increase was observed for Cyclops in March, succeeded by a rapid drop in April and May.

The Harpacticoida appeared in small numbers all the year round but they tended to increase during March and April, 1970.

The nauplii of Copepoda appeared in the plankton all the year round as a few scattered individuals, they tended to increase during the months, June, October and December, 1969.

TABLE 8. **Average monthly numbers per cubic meter of the different groups of Copepoda as recorded at stations (I-V) during the period of investigation.**

Copepoda / Month	Calanoida	Cyclop.	Harpact.	Nauplius. Iarv. of Copepoda	Total Copepoda
June, 1969	—	46	9	25	80
July	2	30	1	13	46
August	—	20	4	3	27
September	—	18	—	3	21
October	—	286	2	26	314
November	2	163	—	17	182
December	1	59	3	25	88
January, 1970	47	64	8	3	122
February	133	5	7	11	156
March	9	237	29	18	293
April	42	50	33	12	137
May	38	45	12	6	101

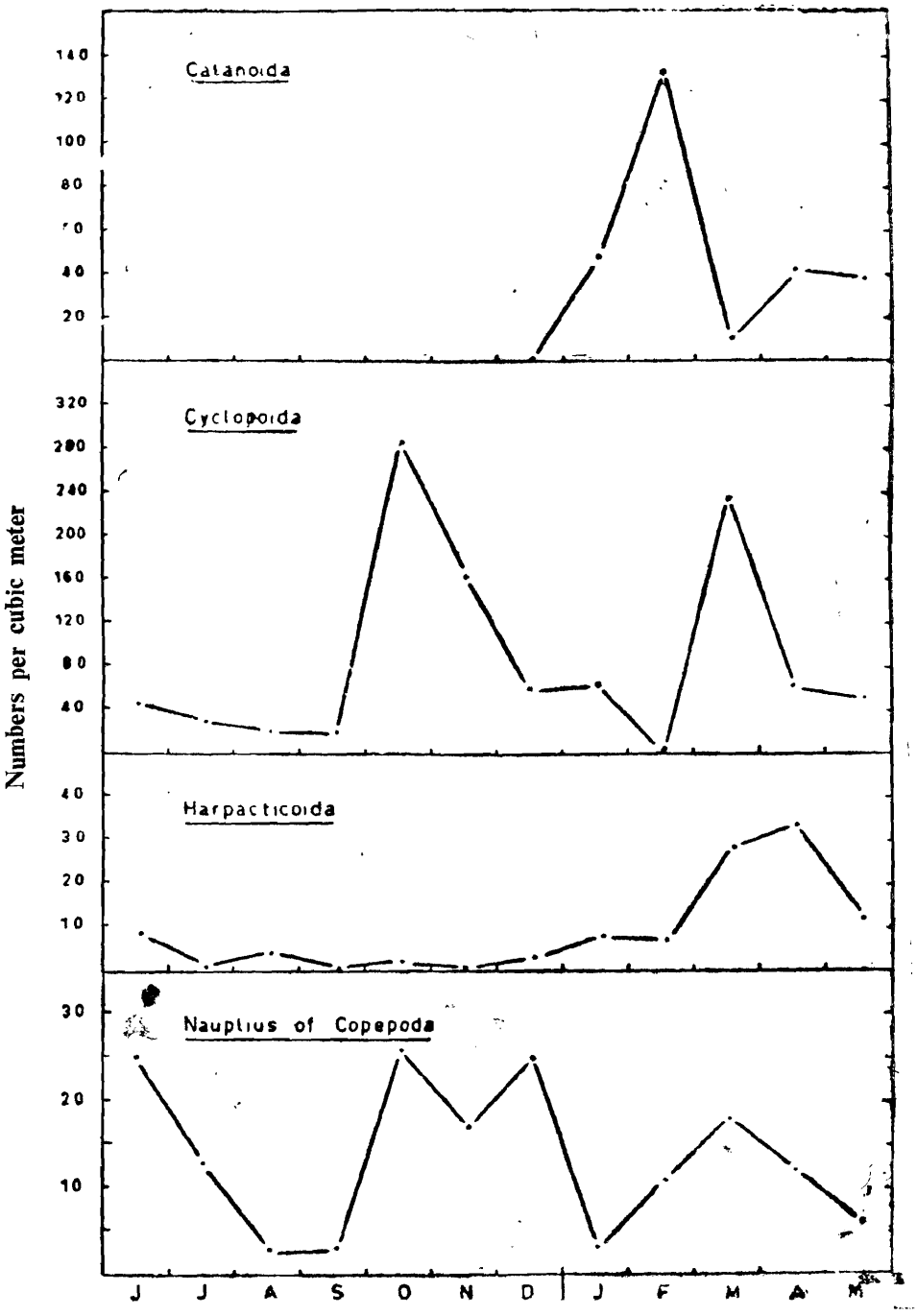

Fig. 10. Average monthly numbers per cubic 'meter of the different groups of Copepoda recorded at stations (I–V)

4. Free Living Nematodes

Distribution : (Table 9).

The free living nematodes are considered as tychoplanktonic forms since they are met with in the plankton as well as at the lake bottom. Nematodes were recorded at stations I, II and III as a few scattered individuals. On the other hand, they attained their maximum distribution at the *Potamogeton* plant belt particularly at station V, constituting about 28.4% by number of the total population. The same observation was recorded in Lake Mariut (Samaan & Aleem, 1972).

TABLE 9. **Average numbers per cubic meter of the free living nematodes as recorded at the different stations during the period from June, 1969 till May, 1970.**

St. No.	I	II	III	IV	V
No./ m^3	5	2	8	41	151

Seasonal variations : (Table 10 & Fig. 11).

The average numbers of nematodes remained low during the period from June till September, 1969. It increased rapidly throughout the autumn months, reaching a peak in Jaunary, 1970. This was succeeded by a rapid drop in their numbers during the period from February till May.

TABLE 10. **Average numbers per cubic meter of nematodes recorded monthly for stations I-V during the period of investigation.**

Month	No. /m^3	Month	No. /m^3
June, 1969	4	December	65
July	4	Jan., 1970	205
August	9	February.	45
September	15	March	42
October	37	April	14
November	54	May.	4

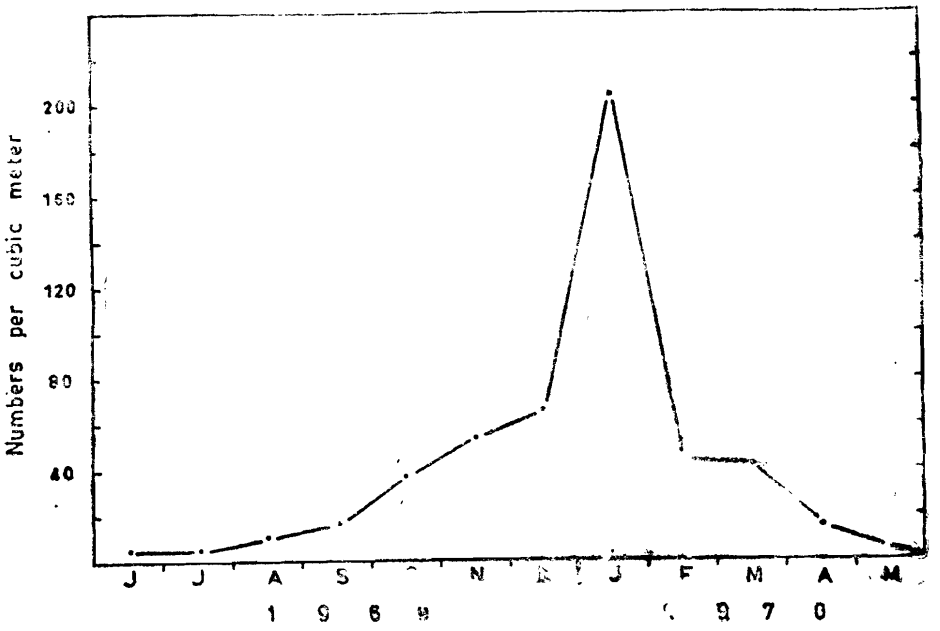

Fig. 11. Average monthly numbers per cubic meter of nematodes recorded at stations (I–V)

5—Rotifera

Distribution (Table 11) :

The rotifers inhabiting Lake Edku comprise members of the genera *Brachionus* Pallas, *Lecane* Nitzsch. *Monostyla* Ehr. and *Lepadella* Bory. The genus *Brachionus* include 3 species namely; *B. plicatilis, B. angularis* and *B. quadridentatus.* It is known to inhabit alkaline waters and it is a characteristic member of eutrophic lakes (cf. Hutchinson, 1967). Thus it was recorded in big numbers in the neighbouring eutrophic Lake Mariut (Samaan and Aleem, 1972). However, its presence in Lake Edku remained poor and this may be attributed to the mesotrophic properties of the lake water. The maximum distribution of *Brachionus* was observed at station IV·

TABLE 11. **Average numbers per cubic meter of the different genera of Rotifers recorded at the different stations during the period from June, 1969 till May, 1970.**

Rotifers \ St. No.	I	II	III	IV	V
Brachionus	5	7	5	19	3
Lecane.	—	—	3	10	8
Monostyla	—	1	1	3	4
Lepadella	—	—	—	8	6
Total numbers	5	8	9	40	21

The genera *Lepadella, Lecane* and *Monostyla* are considered as littoral forms (Edmondson, 1957). They were found mainly at the *Potamogeton* Plant belt.

Seasonal variations (Table 12) :

The maximum distribution of *Brachionus* was observed in April, 1970, particularly at station III, while it persisted as a few scattered individuals throughout the rest of the year.

The distribution of *Lecane* and *Monostyla* was confined to the summer months (June-August) where their survival appears to be correlated with the growth of *Potamogeton*. Lepadella appeared also as few scattered individuals at stations IV and V during the period from January till April, 1970.

6 — Gammarus

Distribution : (Table 13).

The genus *Gammarus* is represented in Lake Edku by *G. foxi* Schellenberg and *G. aequicauda* Martynov (Schellenberg, 1936). It servives mainly at the lake bottom (See Samaan, 1976), while it

appears in the plankton as a few scattered individuals. The maximum distribution of *Gammarus* in the plankton hauls was observed at station III and it decreased gradually as we approached station I or station V. On the other hand, it was more dominant at the lake bottom at stations I & II. Table (13) represents the average numbers of *Gammarus* recorded in the plankton (no/m^3) and at the lake bottom (no/m^2) at the different stations during the period from June, 1969 till May, 1970.

TABLE 12. **Average numbers per cubic meter of the different genera of Rotifers recorded monthly at the different stations during the period of investigation.**

Rotifera / Month	Brachionus	Lecane	Monostyla	Lepadella	Total Rotifers
June, 1969	12	21	5	—	38
July	7	12	3	—	22
August	8	13	16	—	37
September	—	—	—	—	—
October	2	—	—	—	2
November	1	—	—	—	1
December	9	—	—	—	9
January, 1970	6	—	—	4	10
February	5	—	—	—	5
March	10	—	—	3	13
April	35	—	—	5	40
May	—	—	—	—	—

TABLE 13. **Average numbers of *Gammarus* recorded at the different stations in the plankton (no/m³) and at the lake bottom (no/m²) during the period of investigstion.**

Station No.	I	II	III	IV	V
Planktonic (no/m³)	4	13	34	15	5
Benthic (no/m²).	1164	1243	642	257	—

Seasonal variations (Table 14 & Fig. 12) :

Gammarus appeared in the plankton as a few scattered individuals at one station or the other during the period from August till October, 1969 and it was not observed in November and December. It appeared again in January, 1970 reaching a peak in March. This was succeeded by a rapid drop in their numbers during April and it disappeared again in May.

TABLE 14. **Averags monthly numbers per cubic meter of *Gammarus* recorded at stations (I-V) during the period of investigstion.**

Month	No/m³	Month	No/m³
June, 1969	—	December	—
July	—	January, 1971	11
August	2	February.	8
September	1	March	105
October	2	April	36
November	—	May.	—

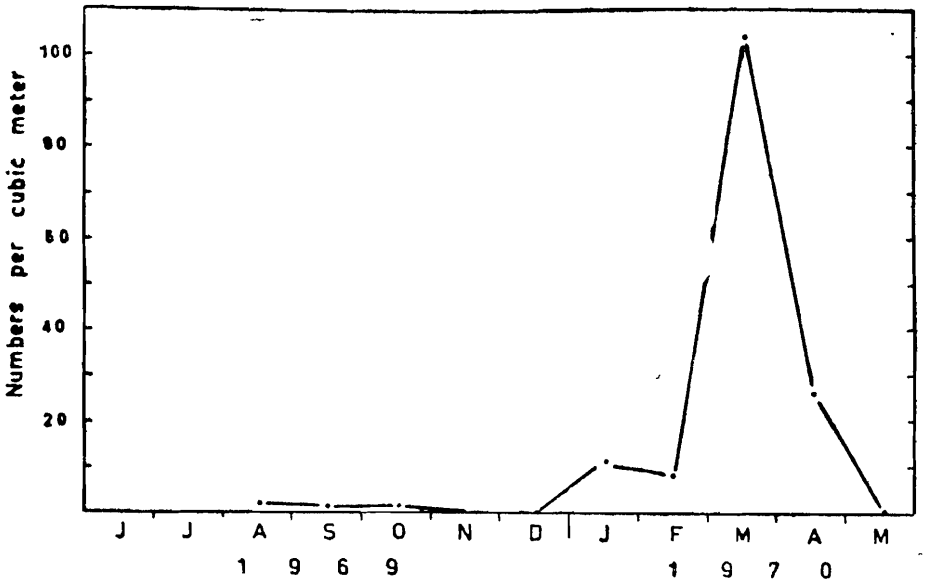

Fig. 12. Average monthly numbers per cubic meter of Gammarus recorded at stations (I–V)

7—Chironomid Larvae

Dirstribution: (Table 15).

The chironomid larvae are mainly benthic forms, they may also appear in the plankton of such shallow lakes particularly in their early stages of development. The chironomid lavae constituted the most important benthos at the *Potamogeton* plant belt (Samaan, 1976). They were also present in the plankton, mainly at the plant belt.

TABLE 15. **average numbers of the chironomid larvae recorded at the different stations in the plankton (No/m³) st the lake bottom (No/m²) during the period from June 1969 till May 1970.**

Station No.	I	II	III	IV	V
In Plankton (no/m³)	1	3	14	56	17
On bottom (no/m²)	4	9	—	818	537

Seasonal variations: (Table 16 & Fig. 13).

The chironmid larvae appeared in the plankton hauls as a few scattered individuals during the period from June till September, 1969. Their numbers increased slowly in October and November and rapidly during December. The frequency of the chironomid larvae remained high during January. 1970, but it showed a sharp drop in February and it remained low during the spring months. The maximum distribution of the chironomid larvae was also recorded at the lake bottom during January, 1970 (Samaan, 1976).

TABLE 16. **Aversge numbers per cubic meter of the chironomid larvae recorded montly for stations I-V during the period of investigstion.**

Month	No/m³	Month	No/m³
June, 1969	1	December	77
July	1	January, 70	61
August	6	February	16
September	4	March	20
October	16	April	12
November	22	May	7

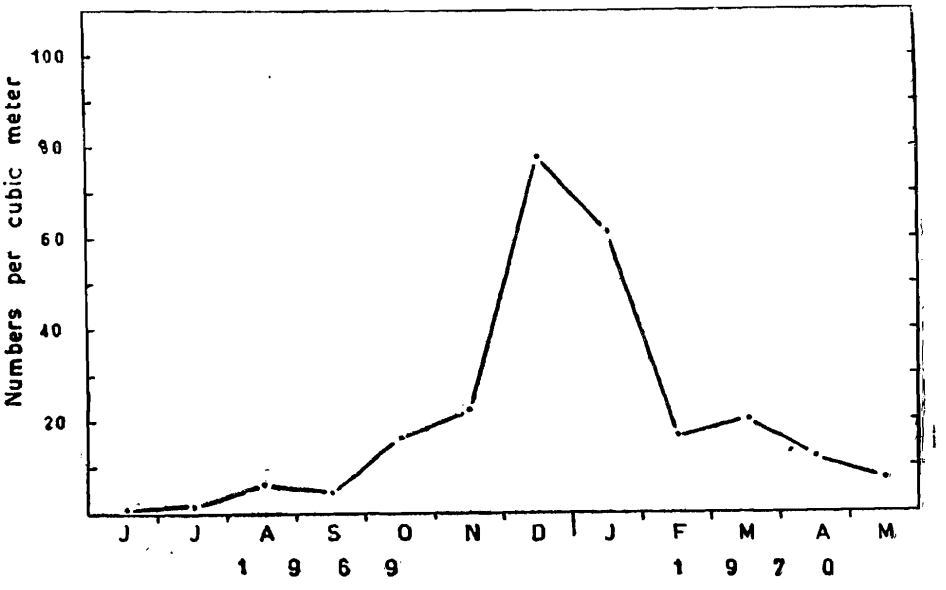

Fig. 13. Average monthly numbers per cubic meter of the Chironomid larvae recorded at stations (I–V)

8 – Other Plankters of rare Occurrence

Other zooplankton organisms were rarely met with in the plankton hauls. These are numerically of much less importance than those previously mentioned. Their distribution can be summarized in the following points :

a) *Larvae of Leander :*

while the larvae of *Leander squilla* Rathke constituted the main bulk of the zooplankton organisms in Lake Mariut (See Samaan & Aleem, 1972), it was rarely observed in Lake Edku at stations I-IV. Its distribution was confined to the periods July-August, 1969 and March-April, 1970. These periods represent the breeding seasons of *Leander* as shown in Lake Mariut. The limited distribution of *Leander* in Lake Edku appears as due to the lower salinity of the lake water and/or to the inhibiting effect produced by the growing hydrophtyes.

b) *Ostracoda :*

The Ostracod *Cyprideis litoralis* Bardy is a Tychoplanktonic form since it appears in the plankton as well as at the lake bottom. Its distribution was observed at the different stations particularly at stations II and III. It was more frequent during the summer and early spring while it disappared totally from the plankton during the winter months.

c) *Polychaete larvae* :

The spinoid larvae of polychaetes were recorded at stations II and III during June and July, 1969. Their average numbers attained 6 and 14 larvae/m^3 at stations II and III respectively during these 2 months.

d) *Oligochaeta :*

Few specimens of Oligochaetes were observed at stations II, III, IV & V during the period from September till November, 1969. Their maximum distribution was observed at stations IV and V in October, reaching 50 and 100 ind./m^3 respectively. They were also recorded at station IV in April, 1970 attaining 25 ind./m^3.

e) *Zoea larva of crabs :*

The distribution of the Zoea larvae of crabs were confined to station I i.e. the area of the lake-sea connection, during March and April, 1970 attaining an average of 8 larvae/m^3.

f) *Mysis larvae of shrimps :*

Few specimens of the mysis larvae of shrimps were observed at station I during January and February, 1970. This was accompanied by an increase of the water chlorosity indicating its marine origin.

g) *Sagitta :*

Sagitta species were only recorded in considerable numbers at station I during May, 1970, raching 100 ind./m^3. *Sagitta* is a marine form (euryhaline) and its presence was accompanied by an increase of the water chlorosity to 10.2 gm Cl/L.

h) *Aquatic insects :*

Adult insects of the orders Hemiptera, Diptera as well as nymphs of May fly and stone fly were rarely met with in the plankton hauls. They were mainly observed in the plant belt and its surroundings.

i) *Hydrochnida :*

Individuals of water mites were recorded at station II in April, 1970 (5 ind./m^3).

DISCUSSION

The zooplankton population of any water mass represents the second trophic level in the food cycle as it feeds mostly on phytoplankton (cf. Welch, 1952). The zooplankton in turn, forms the basic food supply for fish and bottom fauna, particularly in the form of detritus.

The zooplankton community of Lake Edku is composed mainly of Cladocera, nauplius larvae of Cirripedia and Copepoda. They constituted about 90.5% by number of the total zooplankton

population. Members of Cladocera are fresh water organisms. These comprise *Moina micrura* which is a true planktonic form, and *Alona rectangula* and *Chydorus sphaericus.* The two latter species are littoral forms. Thus, the maximum distribution of *Moina* was recorded at the bare area while that of *Alona* and *Chydorus* were observed at the *Potamogeton* plant belt.

The nauplius larvae of Cirripedia are of marine origin. Their distribution was confined to stations I-III. They attained their maximum frequency at station I, constituting about 60.5% by number of the total zooplankton organisms there. The copepoda inhabiting the lake includes both marine and brackish water forms. Thus, the distribution of *Acartia latisetosa* and *Canuella* sp. which are marine organisms, was confined to station I, while the maximum distribution of *Harpacticus* sp. was observed at the *Potamogeton* plant belt. On the other hand, members of Cyclopoida were more frequent at stations I, II and III. Rotifera was poorly represented in Lake Edku. It includes *Brachionus* which is a true plankter and *Lepadella, Lecane* and *Monostyla* which are littoral forms , their distribution was confined to the *Potamogeton* plant belt.

According to the shallowness of the lake, some tychoplanktonic forms were recorded in the plankton. These include *Gammarus* spp. free living nematodes, chironomid larvae and the ostracod *Cyprideis litoralis.* Such organisms, inspite of their existance in the plankton in small numbers, mav contribute a considerable part in the total biomasses of the zooplankton hauls due to their relative big size.

The most important environmental conditions that may affect the distribution of the zooplankton in the lake include both the water chlorosity and temperature variations. The chlorosity of the lake water usually flutuates between 0.46 and 2.0 gm Cl/L. These values may, however, increase to 10.2 gm Cl/L at the Maadiya District and to 5·4 gm Cl/L in the middle lake during periods when the sea water invades the lake. Such periods are confined mainly to the winter and spring seasons. Thus, the average chlorosity values were highest at station I and these decrease gradually towards the eastern lake (Table 17).

TABLE 17. **Range and mean values of chlorosity (in gm Cl/L) recorded at the different stations diring the period from June, 1069 till May, 1970.**

Station No.	Range	Mean
I	0.47 — 10.20	2.77
II	0.46 — 5.37	1.20
III	0.44 — 3.00	1.00
IV	0 46 — 2.18	0.88
V	0.47 — 1.46	0.81

Accordingly, the distribution of the different plankters in the lake was controlled by their tolerance to variations of salinity. Thus, the average numbers of *Moina,* which is a fresh water organism increased gradually from station I to station III i.e it increased with the decrease of the water chlorosity. The distribution of *Alona and Chydorus* was also confined to stations IV and V which represent a fresh water habitat. The nauplii of cirripedia and *Acartia latisetosa* are marine forms and they showed their maximum frequency at station I, particularly during the winter and spring months when the water chlorosity was high. The distribution of the Zoea larvae of crabs and mysis larvae of shrimps was confind to station I during the winter. The genus Sagitta was also recorded in considerable numbers at station I during May, 1970. Most of the other members of the zooplankton inhabiting the lake are considered as brackish water forms which can tolerate a wide range of salinity. They were met with in the different localities of the lake.

The annual water temperature ranges between 14.2°C (in January) and 28.5°C (in June). Between these two extremes, the water temperature increases gradually during the spring and summer months but decreases again throughout the autumn and the winter. The seasonal variations of the water temperature show a certain

periodicity on the zooplankton population. However, such fluctuations in the numbers of the zooplankton during the different seasons appear as mainly due to the interaction of more than one factor including the water chlorosity and temperature variations.

The average numbers of the zooplankton population, in general, remained low during the summer and the autumn months. They increased rapidly during the period from December, 1969 till March, 1970. This was succeeded by a rapid drop in their numbers during April and May. Thus, the dominant organisms of the zooplankton in the lake can be considered as winter and early spring forms. It is to be mentioned that the breeding period of the dominant fish inhabiting the lake, namely; *Tilapia* spp., extends from April till November. The young fishes produced feed mostly on the plankton and thus they may be responsible for the reduction of the zooplankton population during that period.

In conclusion, the zooplankton population in Lake Edku can be considered as composed mainly of both marine and fresh water plankters. The zooplankton organisms of marine origin were mostly confined to the area of the Lake—sea connection (station I). The fresh water plankters were more frequent at the *Potamogeton* plant belt (stations IV and V). On the other hand, the bare area (stations II and III) sustained a mixed community of both marine and fresh water plankters. The average numbers of the zooplankton population in Lake Edku was relatively low (1140 ind./m^3) when compared with that recorded in the neighbouring Lake Mariut (see Samaan and Aleem, 1972). This is attributed to the mesotrophic properties of the lake water. The most suitable habitat for the growth and survival of the zooplankton organisms in the lake was attained at stations III and IV. These stations represent the bare area about the center of the lake and the margins of the *Potamogeton* plant belt which sustained a moderate density of the growing hydrophytes. On the other hand, the area covered with a heavy growth of *Potamogeton* (station V) remained poor in the true planktonic forms. Station I sustained also a relatively high standing stock of zooplankton which was composed mainly of marine forms as mentioned before. Results of the present investigation indicates also that, reducing the density of hydrophytes in areas covered with a heavy growth of submerged plants may lead to a pronounced increase in the zooplankton population of the lake.

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