THE ECOLOGY OF ZOOPLANKTON IN LAKE MARIUT

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INTRODUCTION

The distribution of zooplankton in Egyptian Delta lakes has received little attention during the past. A list of some zooplankton organisms was given by Faouzi (1937) and Steuer (1835, 1942). More recently, Elster & El-Hawary (1959) studied the population dynamics of *Arctodiaptomus salinus* and *Diaphanosoma excisum* in the Nozha Hydrodrome which was a part of Lake Mariut. El-Hawary (1960) and Elster & Vollenweider (1961) enumerated the species of zooplankton of Lake Mariut and Lake Edku. El-Maghraby *et al* (1963) have also investigated zooplankton in Lake Menzala.

This present investigation has been undertaken in connection with the estimation of primary production of Lake Mariut with the view of assess the rôle played by zooplankton in the food cycle of the lake. The ecological conditions that may affect the distribution and periodicity of the zooplankton organisms in such shallow lakes are also considered. The physical and chemical aspects of Lake Mariut in addition to primary production has been previously published (Aleem & Samaan, 1969, I & II).

Description of the lake :

Lake Mariut is a brackish shallow water basin adjoinng the Mediterranean Coast beside Alexandria ; with no free exit to the sea. Its surface area amounts to 20,000 feddans (15,000 for the lake proper and 5000 for two separate basins). The lake is intersected from the north-east to the south-west by the Desert Road. However, these two parts are connected with each other through Moharrem Bey Bridge (fig. 1). The depth of water in the lake ranges between 80 and 120 cm with an average of one meter. The lake receives irrigation water from the cultivated land in the Beheira Province through the Umum Drain. It receives also some sewage at the north margin by the side of Karmous District.

The chlorosity of the lake water ranges between 1.53 and 5.6 gm Cl/l. Lower values usually occur at the vicinity of the Umum Drain. Chlorosity shows also seasonal fluctuations, with low values occur in December and January, while higher values occur in the summer. A decrease in the salt budget of the lake was observed during 1961 when compared with the records of 1960. The pH of the lake water lies on the alkaline side and it ranges between 7.8 and 9.35. The water temperature usually follows that of the air. Thus, lowest values (about 12°C) are recorded during December and January, while the highest (about 29°C) occur in August. Between these two extremes the water temperature increases gradually during the spring and summer but decreases again during the autumn and winter.

Lake Mariut is considered as a highly eutrophic lake which sustains a dense growth of phytoplankton and submerged hydrophytes, namely *Potamogeton pectinatus*. The lake provides also the highest fish yield as compared with the other Egyptian Delta Lakes, with an annual fish catch of about

360 kg/feddan. The major fish community inhabiting the lake comprises *Tilapia* spp. (about 94% of the fish catch) succeeded by *Mugil* spp. (2%), both being omnivorous fishes. *Clarius anguillaris* and *Anguilla vulgaris* (4%) represent the carnivorous fishes inhabiting the lake.

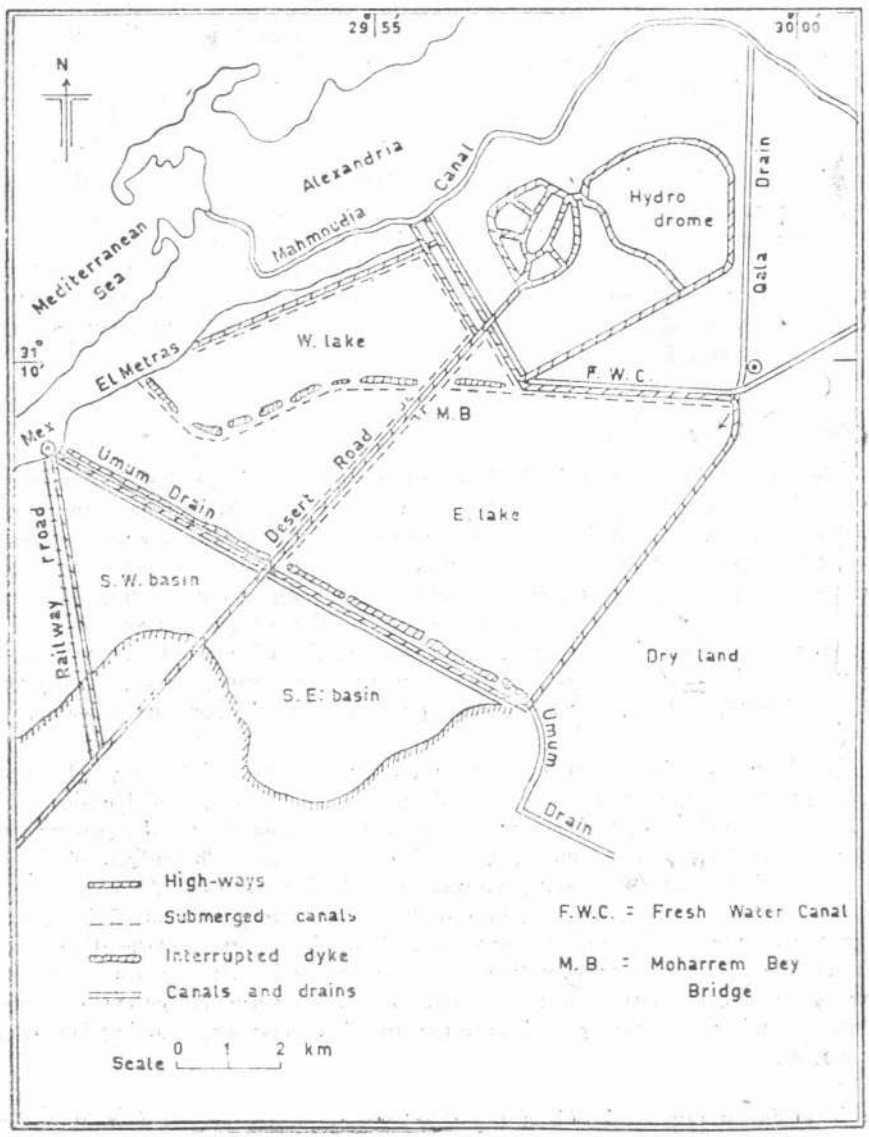

FIG. 1.—Morphometry of the lake

Methods of Collection and Treatment of the Samples :

Collections of zooplankton were carried out semiquantitatively by using a simple small Nansen-type plankton net made of bolting silk, having 44 mesh/cm. The diameter of the brass ring fixed at the top of the net is 28 cm and the length of the net is one meter. Owing to the shallowness of the lake, the net was only towed horizontally for about 50 meters, while the boat is moving at a slow speed. Rough estimation indicates that the average value of the coefficient of filtration of the zooplankton net is about 0.67. Thus the total vloume of water filtered per each station is about two cubic meters. Collected samples were directly preserved in 10 % formaline solution. Samples were examined carefully in the laboratory ; the macroorganisms were sorted and counted. Samples were then diluted to a suitable volume according to the concentration of microorganisms and subsamples of 1 cc were transferred into a counting cell and each plankter is counted separately using a binocular microscope. The total number of organisms per cubic meter is then calculated.

Eight stations were chosen as sampling stations which represent the different habitats in the lake proper (fig. 2). The general features of these stations are :

(*a*) Stations I and II represent the polluted area which is affected by sewage disposal beside Karmous District.

(*b*) Stations III and IV represent the bare area which is devoid of hydrophytes and it receives its water from the Umum Drain. It may be also affected at certain times by water introduced from the polluted area.

(*c*) Stations V and VIII represent the bare area around the *Potamogeton* plan belt.

(*d*) Stations VI and VII represent the *Potamogeton* belt.

Sampling was carried out monthly (around the middle of the month) at all stations during the period from January, 1960 till March, 1962 with the exception of August 1961, Sampling from stations VI, VII & VIII was, however, discontinued from April onwards, as this area has been separated from the lake for land reclamation.

Distribution of Zooplankton in the lake :

The zooplankton population in lake Mariut is represented mainly by tychoplanktonic forms which constitute about 80 % by number of the plankton. These are mainly nauplius larvae of *Balanus* as well as other plankters which inhabit the lake margins among the *Phargmites* vegetation, such as *Leander squilla.* True plankters such as Copepoda, Rotifera and Cladocera, on the other hand, are poorly represented in the lake.

The zooplankton population in the lake can be classified according to size into two main groups, viz : macroplankton and net zooplankton. The macroplankton attains more than 5 mm in length. Members of this group usually form the bulk of the zooplankton hauls during their breeding periods. The maximum quantities of macroplankton as measured by volume range between 30–70 cc/m^3. The bulk of this macroplankton is mainly due to *Leander squilla elegans* and its

larval stages and to a less extent to *Mysis* and *Gammarus* spp. The net zooplankton comprises the following members : larvea of *Balanus improvisus*, rotifers, nematodes, ostracods, oligochaetes and polychaete larvae. These compenents show great fluctuations in numbers of individuals throughout the year with the exception of ostacods, nematodes, oligochaetes and polychaete larvae which are almost of rare occurrence.

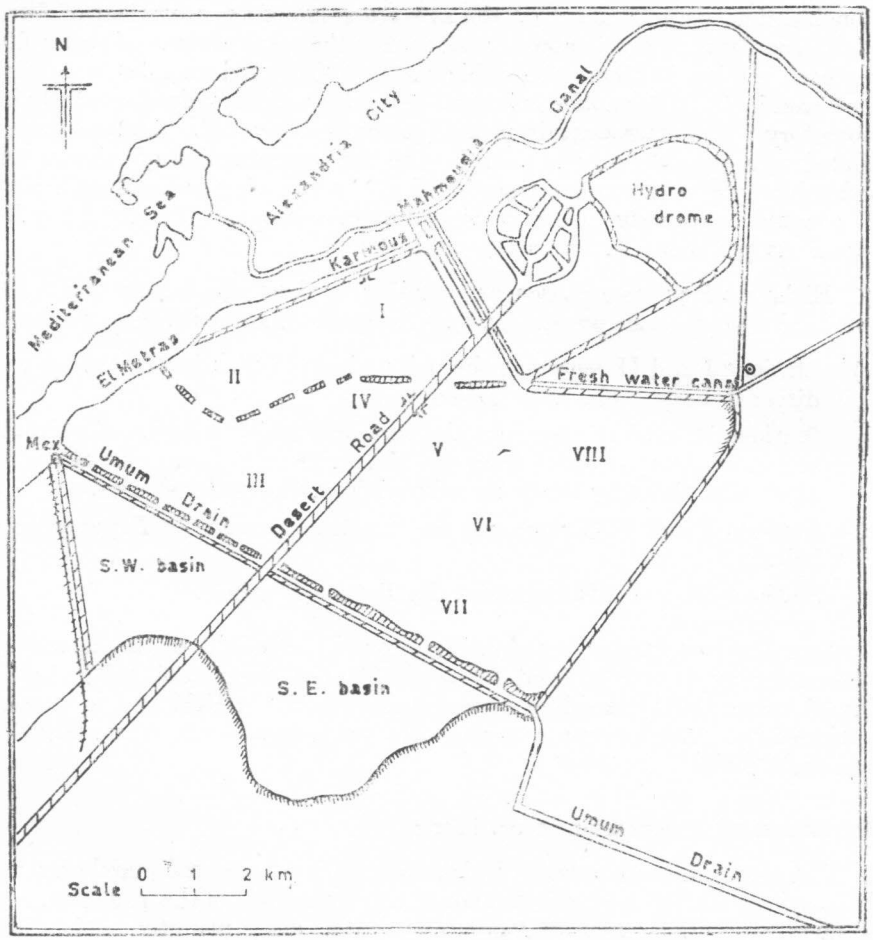

FIG. 2.—Position of satations

The production of zooplankton is usually high at both the polluted and bare areas. The *Potamogeton* belt, on the other hand, is very poor in zooplankton organisms. This may be explained as due to shortage of food, since phytoplankton production in this belt is poor (Aleem & Samaan, 1969). The presence of fish like *Gambusia affinis* in large quantities in the *Potamogeton* belt may be also responsible for reducing the number of zooplankton that might be developed in this belt. On the whole, the zooplankton population showed higher production in the lake during 1961 than in 1960.

The zooplankton orgainisms inhabiting Lake Mariut are given in the following list Most of the organisms had previously been identified by El Hawary (1960) and Elster & Vollenweider (1961).

CLADOCERA

Moina dubia (De Guerne & Richard)

OSTRACODA

Cyprideis litoralis (Brady)

AMPHIPODA

Gammarus locusta (Lin.)
Gammarus oceanicus (Segerstale)

MYSIDACEAE

Mesopodopsis slabberi (Van Beneden)

DECAPODA

Leander squilla var. elegans Rathke)

COPEPODA

Arctodiaptomus salinus (Daday)
Harpacticus sp.
Halycyclops sp.
Diacyclops bicuspidatus (Claus)
Mesocyclops leukarti (Claus)
Thermocyclops neglectus
Thermocyclops Ergasilus nanus

ROTIFERA

Brachionus plicatilis (Müller)
Branchionus urceolaris (Müller)
Brachionus anguillaris
Brachisnus quadratus var. Cluniorbicularis (Skorikov)
Brachionus quadridentatus var. rhenanus (Lauterb)

CIRRIPEDIA

Nauplius larvae of Balanus improvisus (Darwin)

GASTROPODA

Bithynia sp.

NEMATODA

Species of free living nematodes.

CHAETOPODA

Oligochaetes

Larvae of Polychaetes

INSECTA

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

A-Notes on the distribution and periodicity of macroplankton :

1. *Leander squilla var. elegans (Rathke)* :

Larvae of *Leander squilla* form the main bulk of the plankton during the breeding period of this species. For convenience, the stages of development of the larvae of *Leander* are treated as one unit in assessing the seasonal variations.

While the adult *Leander* is found mainly at the margins, intermingled among the stems of *Phragmites*, its larvae are distributed all over the lake with the exception of the *Potamogeton* belt (Table 1 and Figs. 3 A & B).

TABLE 1.—AVERAGE NUMBERS PER CUBIC METER OF LARVAE OF *Leander* RECORDED AT THE DIFFERENT STATIONS DURING 1960 AND 1961.

St. No. / Year	I	II	III	IV	V	VI	VII	VIII
1960	429	447	1806	865	23	-ve	=ve	482
1961	863	755	822	174	20	under reclamation		

The seasonal variations of the larvae of *Leander* show a typical bimodal curve corresponding with their broods. The same two peaks were also recorded for the same species in Lake Quarun (Wimpenny, 1931). During 1960, the first peak in Lake Mariut was recorded in April but dropped again during May and June,

while the second peak was recorded in September (Table 2 and fig. 4). The two peaks were recorded again respectively during May and October of 1961. The interval between these two peaks is about 5 months. These two peaks coincide with a water temperature ranging between 20° and 24°C. Gravid females of *Leander* were hauled during the periods of maximum abundance of the larvae.

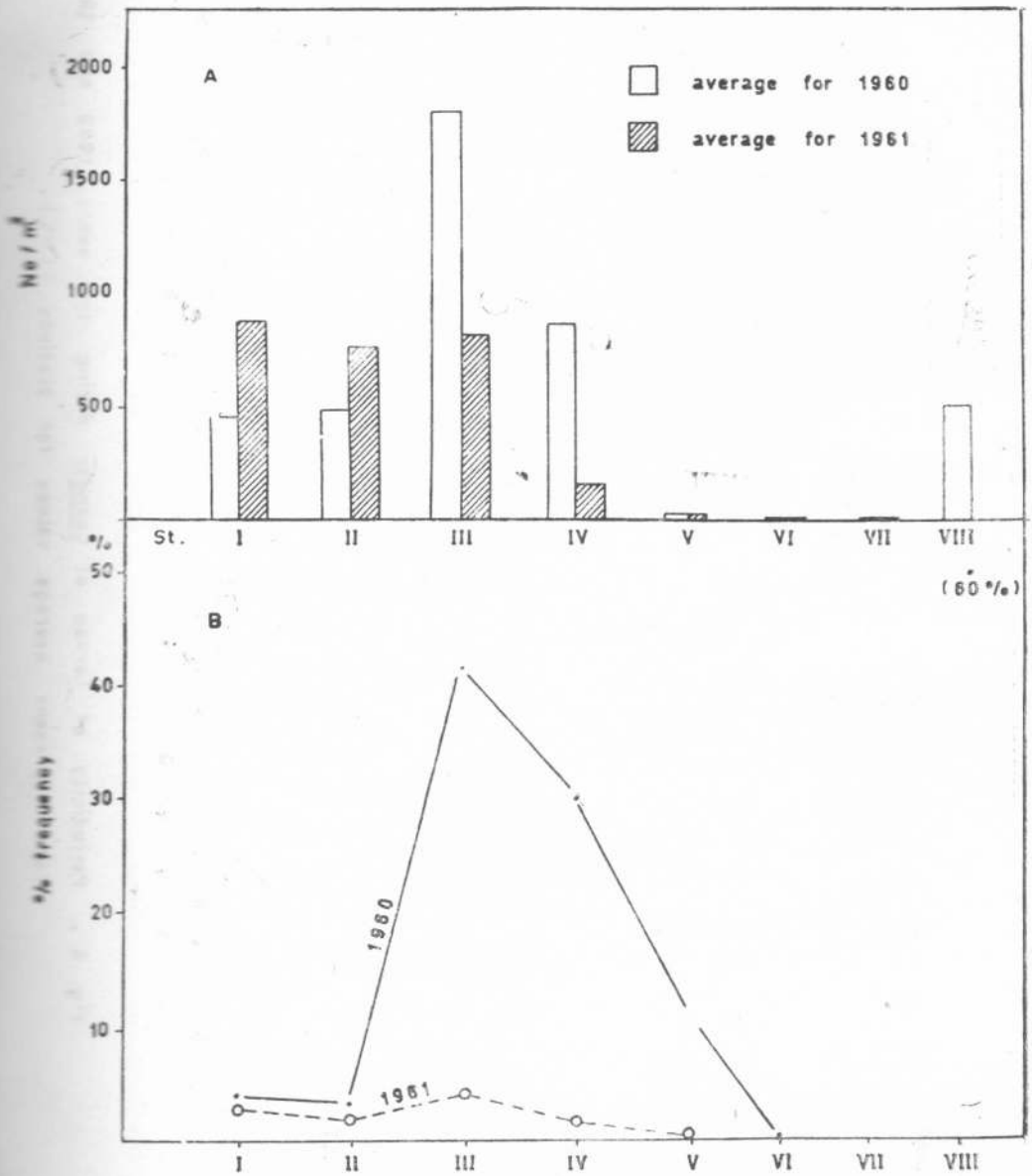

FIG. 3.—Distribution of the Larvae of *Leander* at the different stations during 1960 and 1961.

A. Average numbers per cubic meter.

B. Percentage frequency.

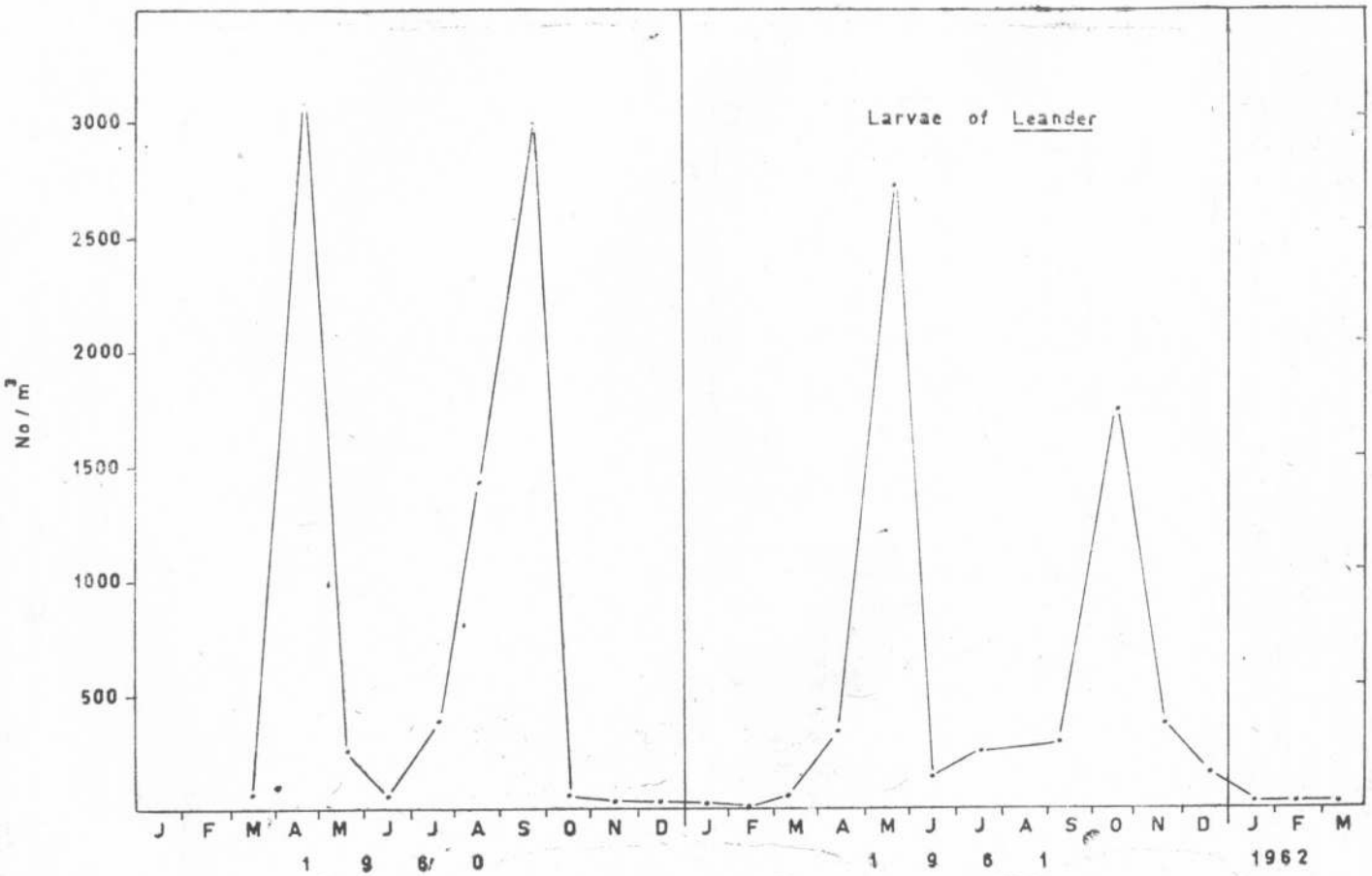

Fig. 4 . Periodicity of larvae of Leander during the years 1960 and 1961. Data represent average values for stations (I-V).

2. *Gammarus spp.*

Gammarus is represented in Lake Mariut by two species, namely *Gammarus locusta* and *Gammarus oceanicus*. This genus is a characteristic member of zooplankton in the lake, although it has been observed only during the winter and at the beginning of spring. It is also widely distributed in all Egyptian lakes. In Lake Quarun, it survives in relatively high brackish water (salinity about 25%) among the red algae *Polysiphonia*. It was also observed in the Nouzha Hydrodrome (Salinity about 3%) thriving on epiphytes growing on submerged substrate as well as in Lake Menzala (El Maghraby *et al*, 1933), in Lake Burollus and Lake Edku (personal observations).

TABLE 2.—AVERAGE NUMBERS PER CUBIC METER OF LARVAE OF *Leander* RECORDED AT STATIONS I–V DURING THE DIFFERENT MONTHS OF THE YEARS 1960 AND 1961.

months	1960	1961
January	2	1
February	6	5
March	54	86
April	3126	351
May	275	2741
June	68	135
July	370	249
August	1454	—
September	3105	314
October	68	1736
November	18	369
December	18	176

Gammarus is considered as a tychoplanktonic form as it appears also in the bottom samples. It was only recorded in abundance at the margins of the *Potamogeton* belt i.e. at stations V and VI, but failed to appear in the polluted area (Table 3).

TABLE 3.—AVERAGE NUMBERS PER CUBIC METER OF *Gammarus* RECORDED AT THE DIFFERENT STATIONS DURING THE WINTER AND SPRING OF 1960 AND 1961.

St. No. / Year	I	II	III	IV	V	VI	VII	VIII
1960	—ve	—ve	14	2	110	32	3	14
1961	—ve	—ve	—ve	2	82	under reclamation		

Gammarus appears in the plankton hauls during the period from January to June, but seems to be absent during the rest of the year. It usually attains a peak in March (Table 4 and fig. 5). It appears also in the bottom samples two months earlier than in the plankton.

TABLE 4.—AVERAGE NUMBERS PER CUBIC METER OF *Gammarus* RECORDED AT STATIONS III–VIII) DURING 1960 AND 19 61.

Month	Average No/m³	
	1960	1961
January	3	1
February	10	10
March	91	71
April	66	35
May	2	16
June	1	—ve
July	—ve	—ve
August	—ve	—
September	—ve	—ve
October	—ve	—ve
November	—ve	—ve
December	—ve	—ve

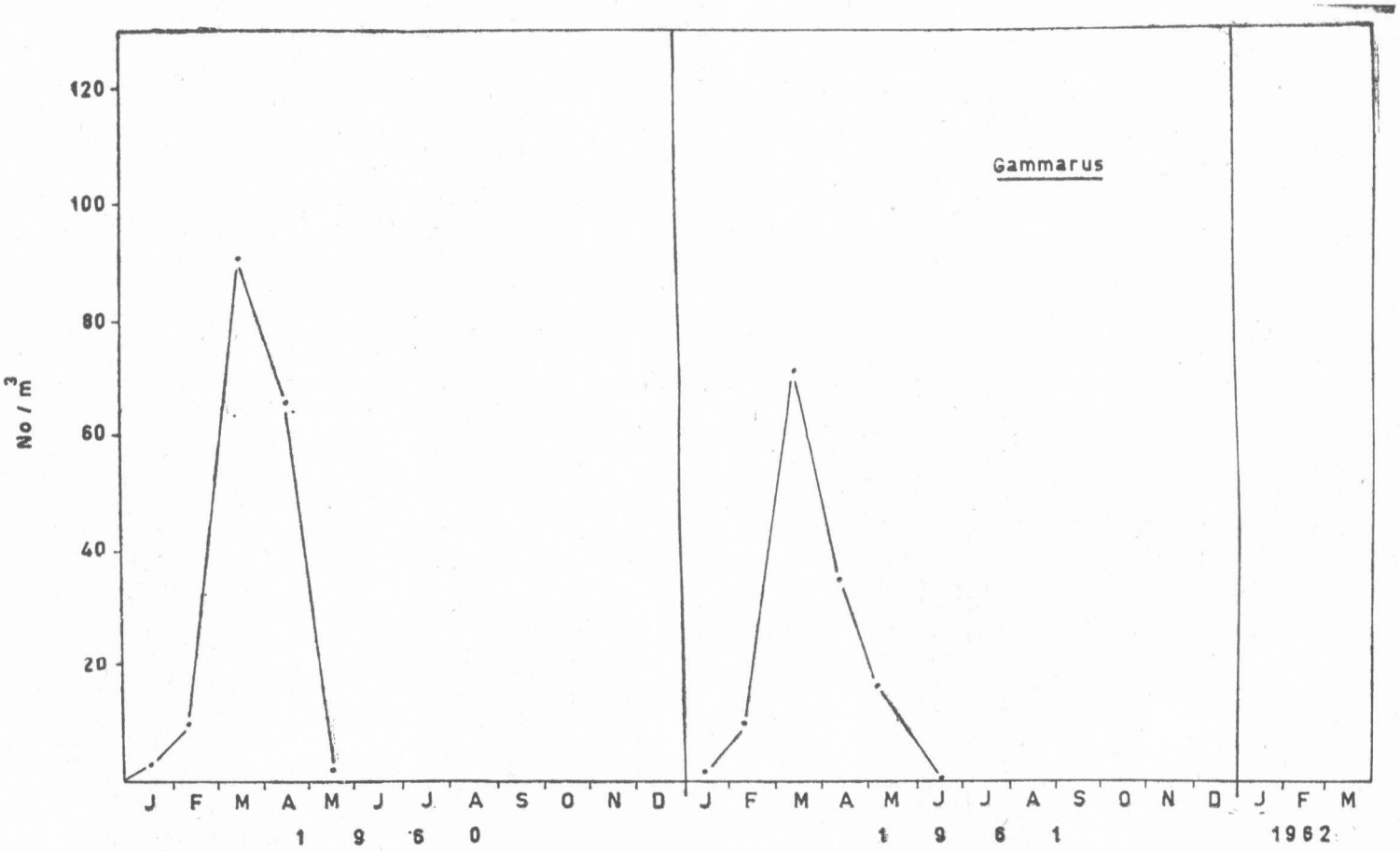

FIG. 5.—Periodicity of *Gammarus* during the years 1960 and 1961. Data represent average values for stations (III—VIII)

3. *Mesopodopsis slabberi* (*Van Beneden*):

The mysis *Mesopodopsis slabberi* was recorded in Lake Mariut as a few scattered individuals at the different stations. Although this plankter was sparingly represented during the whole year, yet on few occasions it may occur in high concentrations, such as observed at station II during September, 1960 (1150 individual/m^3) and May 1961 (26000 individual/m^3); also at station VI during July, 1960 (450 individual/m^3). The average numbers of *Mesopodopsis* as recorded at the different stations show maximum distribution of this species at station III (Table 5).

TABLE 5.—AVERAGE NUMBERS PER CUBIC METER OF *Mesopodopsis* RECORDED AT THE DIFFERENT STATIONS DURING 1960 AND 1961.

St No. / Year	I	II	III	IV	V	VI	VII	VIII
1960	1	7	102	12	1	58	1	8
1961	3	6	2500	10	2	under reclamation		

4. *Gastropoda*:

The gastropod *Bithynia* sp. was recorded only during April and May, 1960 at stations V and VI, i.e. at the margins of the Potamogeton belt. The numbers of individuals recorded at station V were 69 and 43 per cubic meter respectively during April and May, 1960. The corresponding numbers for station VI are 3 and 13 per m^3 respectively.

5. *Post larvae of Tilapia*:

Tilapia is the principal fish inhabiting Lake Mariut since it forms about 94% of the fish population of the lake. The total body length of the post larvae of *Tilapia* spp. (mostly *Tilapia zillii*) collected ranges between 7 and 12 mm. indicating that its age is from 10 to 20 days (Imam & Hashem, 1959). This length represents the stage at which the mouth appears and the larvae starts to feed on plankton.

The post larvae of *Tilapia* are most abundant at the polluted area; they were not recorded in the *Potamogeton* belt (Table 6).

Breeding of *Tilapia* seems to start from April and extends to November, depending mainly on the water temperature. Larvae of *Tilapia* spp. were recorded in the zooplankton hauls during this investiagtion when the water temperature ranges between 18.6 and 29°C. Post larvae of this fish appeared firstly during April, 1960 reaching a peak in September of the same year. In 1961 they appeared again in April reaching a peak in July, after which the number of the larvae declined steadily until November and disappeared totally in December, 1961 (Table 7).

TABLE 6.—AVERAGE NUMBERS PER CUBIC METER OF POST LARVAE OF *Tilapia* SPP. RECORDED AT THE DIFFERENT STATIONS DURING 1960 AND 1961.

Year \ St. No.	I	II	III	IV	V	VI	VII	VIII
1960	170	34	7	2	1	—ve	—ve	1
1961	132	81	7	11	2	under reclamation		

TABLE 7.—AVERAGE NUMBERS PER CUBIC METER OF POST LARVAE OF *Tilapia* SPP. RECORDED AT STATIONS I–V DURING 1960 AND 1961.

Month	Average No./m³	
	1960	1961
January	—ve	—ve
February	—ve	—ve
March	—ve	—ve
April	1	1
May	—ve	9
June	3	—ve
July	1	31
August	3	—
September	36	6
October	—ve	—ve
November	—ve	1
December	—ve	—ve

B—Notes on the distribution and periodictiy of net zooplankton :

1. *Nauplius larvae of Cirripedia* :

Nauplius larvae of *Balanus* are widely distributed in Egyptian Delta Lakes, in Lake Menzala (El Maghraby *et al*, 1963), in Lake Edku (Broch, 1935) and in Lake Burollus (personal observations).

The nauplius larvae of *Balanus improvisus* (Darwin) represents the most important net plankter in Lake Mariut. The larva in question is a meroplanktonic form since the plank onic phase of *Balanus* is confined to the early stage of life after which the larva sttles to the bottom or attaches itself to submerged stems of *Phragmites* and continues its life to the adult stage. In spite of the fact that the nauplius larvae dominate the plankton population, adult *Balanus* were met with only on few occasions at stations II and III,where it formed samll patches on hard bottom.

distribution of nauplii during 1960 were confined mainly to stations I and II, i.e. to the polluted area, and to a less extent to stations III and IV. These larvae were not recorded in the *Potamogeton* belt nor in its neighbouring station VIII. During 1961, they were much more represented at stations I, II, III, and IV and to a less extent at station V (Table 8 and fig. 6 Q & B).

TABLE 8.—AVERAGE NUMBERS PER CUBIC METER OF THE NAUPLIUS LARVAE OF *Balanus* RECORDED AT THE DIFFERENT STATIONS DURING 1960 AND 1961.

Year \ St. No.	I	II	III	IV	V	VI	VII	VIII
1960	10062	14452	1893	1726	24	—ve	—ve	—ve
1961	14000	34515	17834	6962	221	under reclamation		

The seasonal variations of nauplius larvae show wide fluctuations from one month to another, as well as in the different stations (Table 9 and fig. 7). In general, the numbers of nauplii were much higher in 1961 than in 1960.

2. *Genus Brachionus* :

Brachionus is the only genus of rotifera present in Lake Mariut. Members of this genus are also recorded in Lake Manzala (El-Maghraby *et al*, 1963) in Lake Burollus and Lake Edku (personal observations). This genus is represented in the lake by five species as mentioned previously which are treated here collectively.

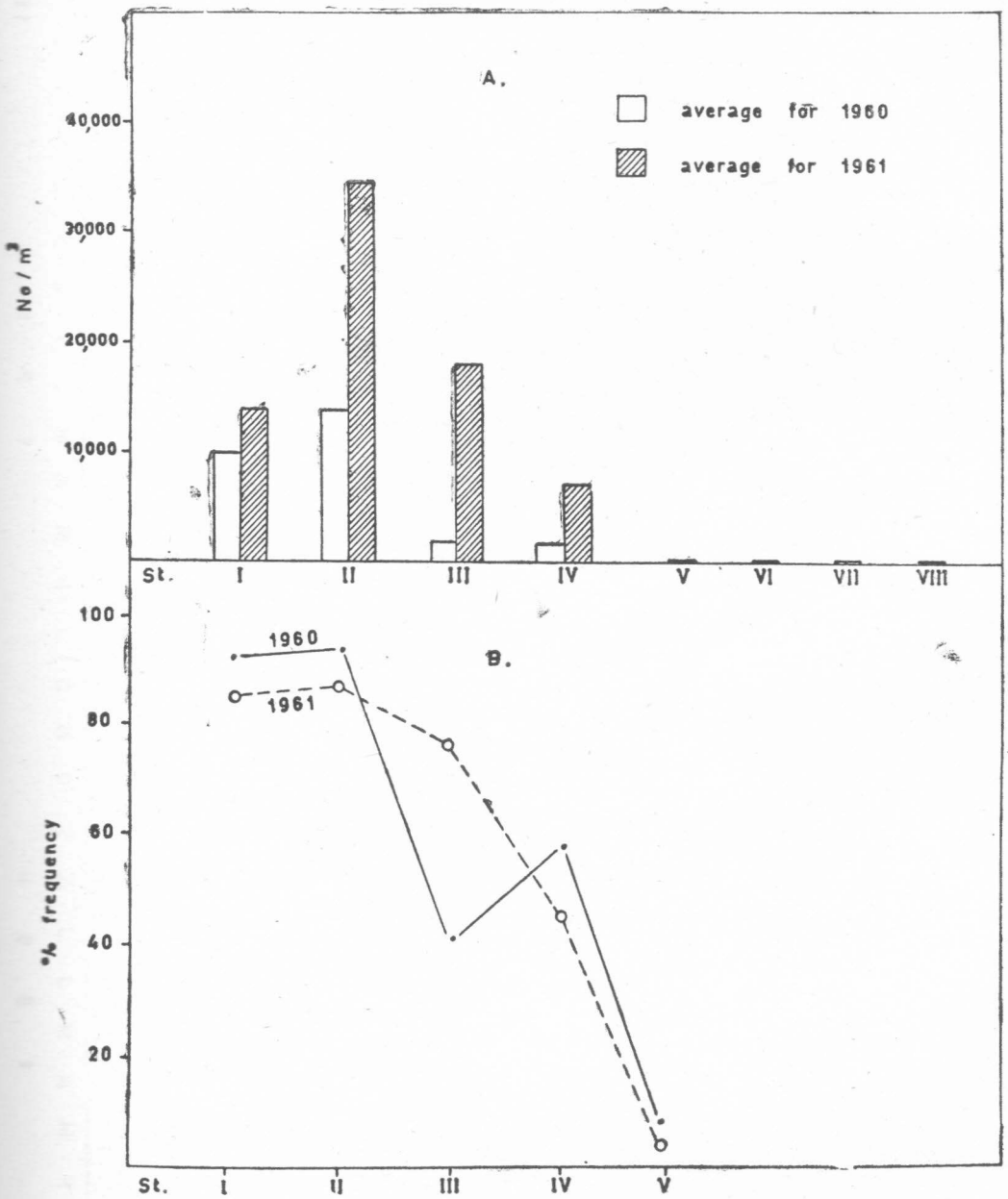

FIG. 6.—Distribution of nauplius larvae of *Balanus* at the different stations during 1960 and 1961.

A. Average numbers per cubic meter.

B. Percentage frequency.

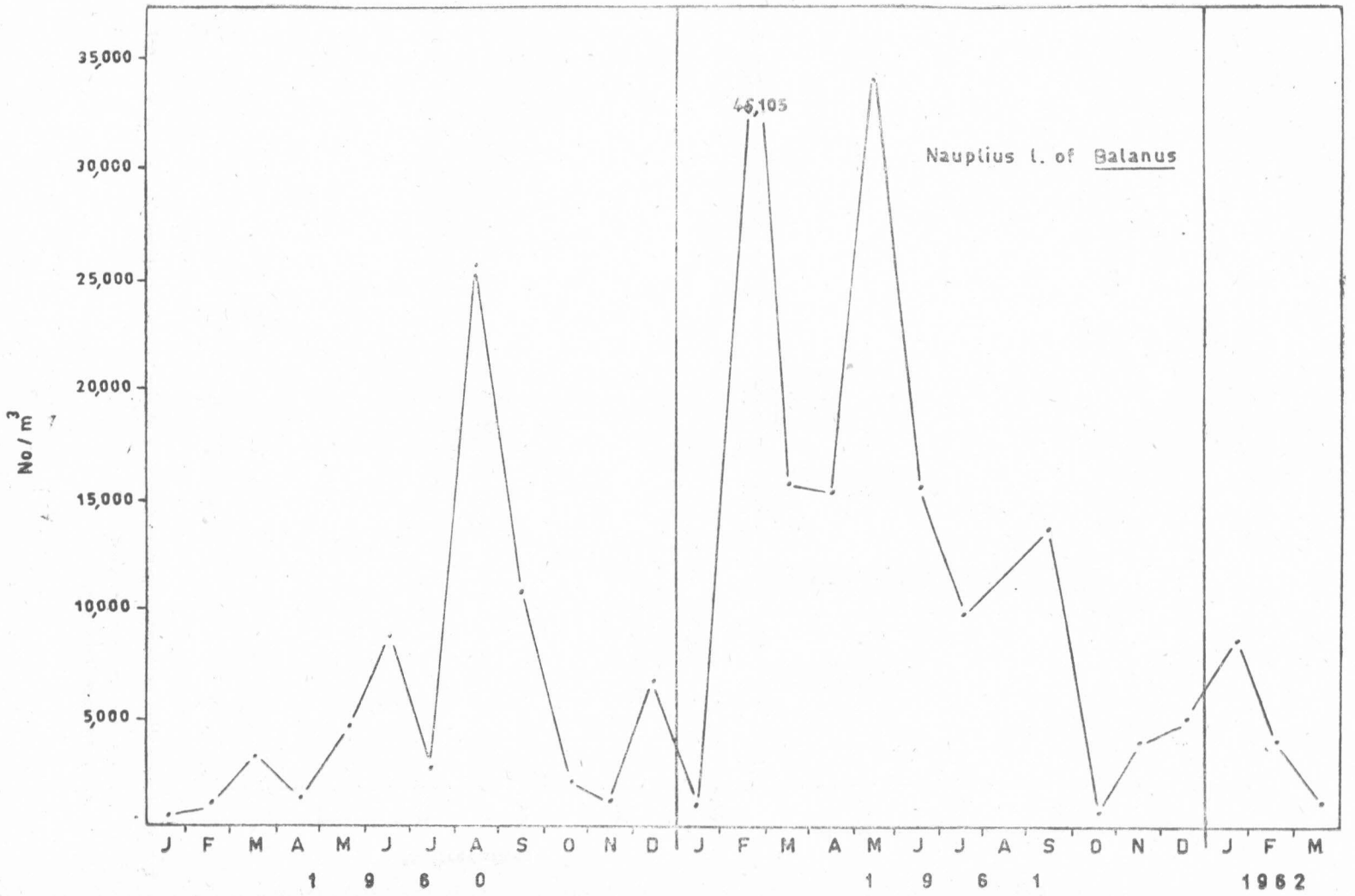

FIG. 7.—Average monthly numbers of nauplius larvae of *Balanus* for stations (I—V) during 1960 and 1961.

TABLE 9.—AVERAGE NUMBERS PER CUBIC METER OF THE NAUPLIUS LARVAE OF *Balanus* RECORDED FOR STATIONS (I–V) DURING THE DIFFERENT MONTHS OF 1960 AND 1961.

Month	Average No./m³	
	1960	1961
January	633	2191
February	830	46105
March	3252	15598
April	1287	15220
May	4635	31900
June	8865	15610
July	2526	9844
August	25442	—
September	10442	13765
October	1726	653
November	1207	3845
December	6698	4580

During 1960, *Brachionus* was found mainly at the polluted and bare areas It does not seem to occur in the Potamogeton belt nor at the adjacent station VIII. *Brachionus* showed an extensive increase in numbers of individuals during. 1961 with peaks at stations IV and V (Table 10 and fig. 8 A & B).

Brachionus was poorly represented during the winter and spring of 1960. Higher values were observed throughout the rest of the year. *Brachionus* showed wide fluctuations during the year 1961. It increased in April and attained its maximum abundace during May. The numbers dropped again during the summer, but showed a gradual increase by the end of the year (Table 11 and fig. 9).

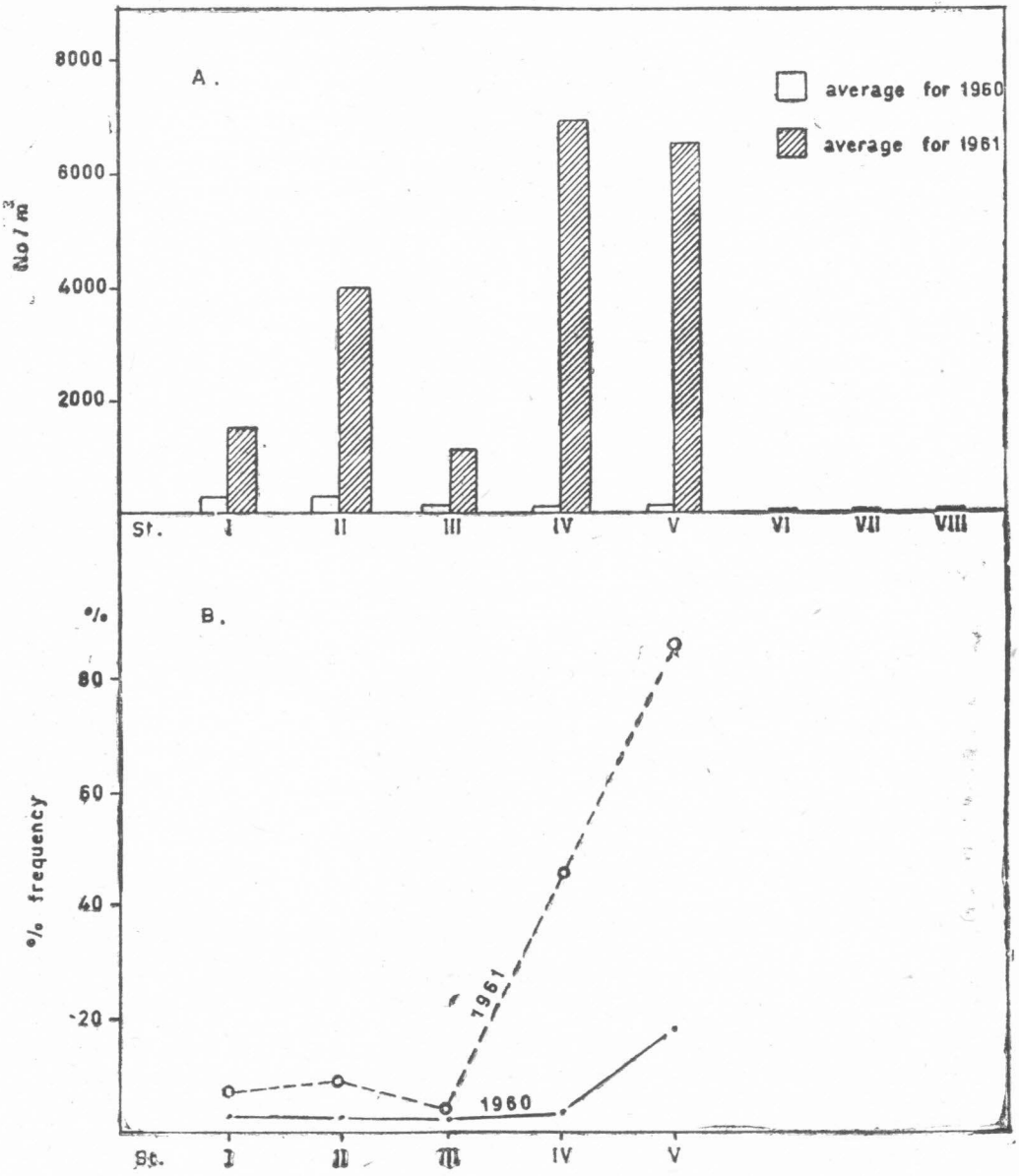

FIG. 8.—Distribution of *Brachionus* at the different stations during 1960 and 1961.

A. Average numbers per cubic meter.

B. Percentage frequency.

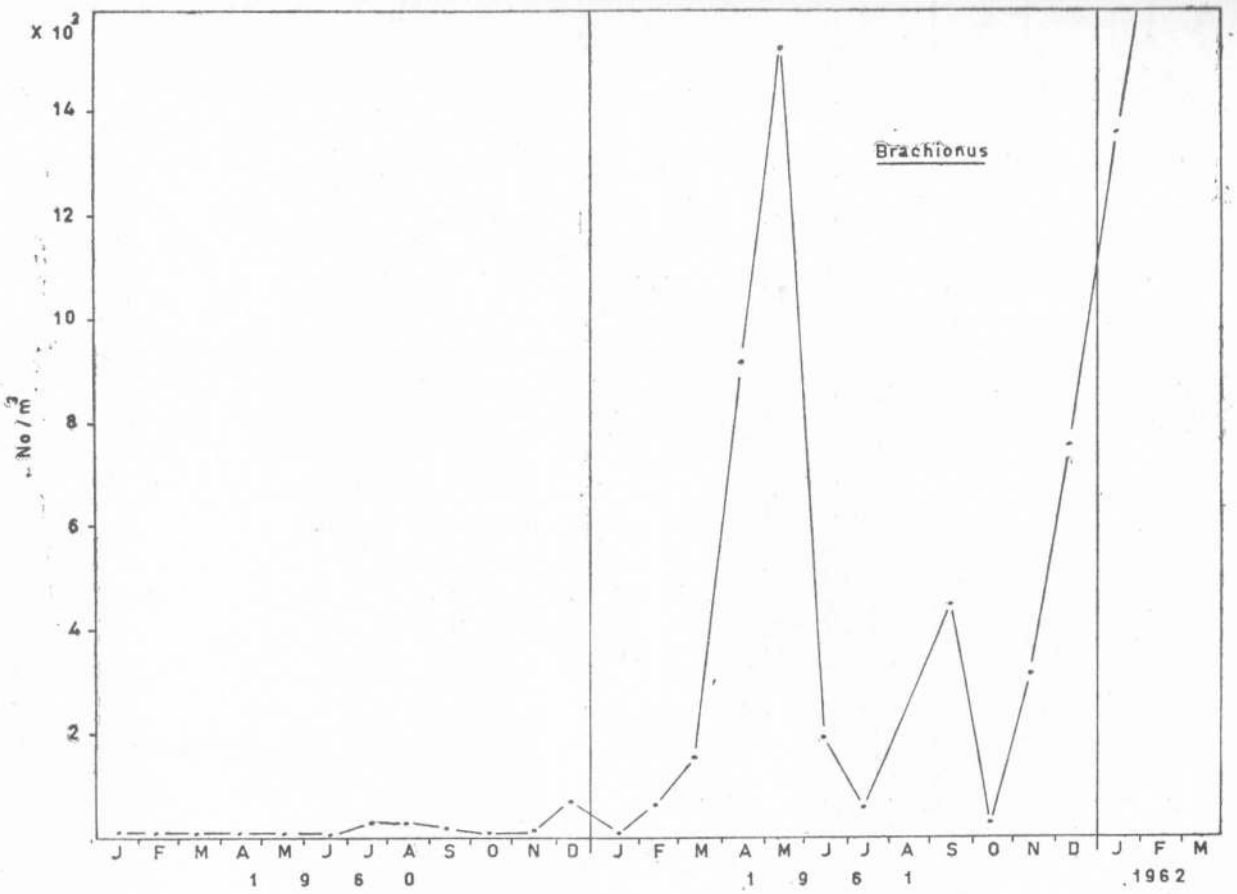

FIG. 9.—Average monthly numbers of *Brachionus* for staticns (I—V) during 1960 and 1961.

TABLE 10.—AVERAGE NUMBERS PER CUBIC METER OF *Brachionus* RECORDED AT THE DIFFERENT STATIONS DURING 1960 AND 1961.

Year \ St. No.	I	II	III	IV	V	VI	VII	VIII
1960	266	345	101	103	42	—ve	—ve	—ve
1961	1499	3909	1172	7020	6612	under reclamation		

TABLE 11.—AVERAGE NUMBERS PER CUBIC METER OF *Brachionus* RECORDED AT STATIONS (I–V) DURING THE DIFFERENT MONTHS OF 1960 AND 1961.

Month	Average No./m³	
	1960	1961
January	22	99
February	20	574
March	38	1488
April	30	9365
May	160	15400
June	51	2030
July	286	550
August	333	—
September	220	4540
October	84	185
November	71	3235
December	780	7007

Sub-class Copepoda :

Copepoda are represented in Lake Mariut by 5 cyclops spp., one harpacticoid and one calanoid species. While the cyclops represent the main bulk of of copepods, individuals of harpacticoid species are rather rare. The calanoid species *Arctodiaptomus salinus* appears only during the winter months. The distribution of these three groups of Copepoda in the lake is summarized as follows:

(a) *Cyclopoida* :

Cyclops are widely distributed all over the lake, with the exception of station VII, i.e. centre of the *Potamogeton* belt (table 12 and figs. 10A & B).

TABLE 12.—AVERAGE NUMBER PER CUBIC METER OF CYCLOPS RECORDED AT THE DIFFERENT STATIONS DURING 1961 AND 1960.

St. No. / Year	I	II	III	IV	V	VI	VII	VIII
1960	56	153	370	212	53	42	—ve	322
1961	102	168	1014	589	370	under reclamation		

Cyclops were poorly represented during the winter and spring of 1960. They increased in numbers during the summer where they reached a peak in June and August. The numbers of cyclops decreased again during the rest of the year. Maximum numbers of cyclops were recorded again during the spring of 1961, but decreased again throughout the rest of the year (table 13 and fig. 11).

(b) *Harpacticoid sp.* :

The harpacticoid copepod was mainly found at the polluted area and to a less extent at the bare area as shown in table (14).

It was recorded during the period from August 1960 to January, 1961. It was not observed until June, after which time it occurred as few scattered individuals until October, 1961. It disappeared again during November and December of the same year (table 15).

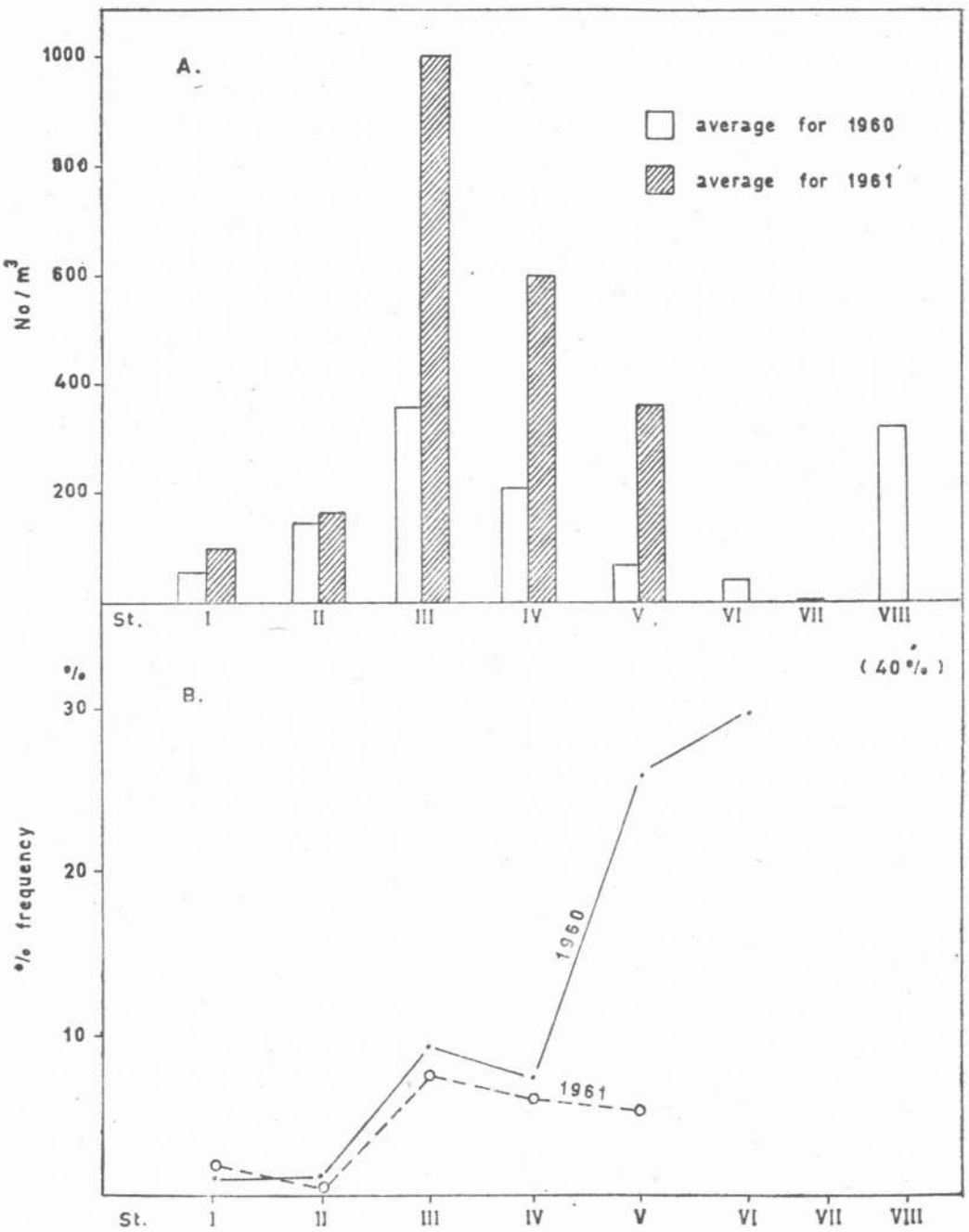

Fig. 10.—Distribution of cyclops at the different stotions during 1960 and 1961.

A. Average numbers per cupic meter.

B. Percentage frequency.

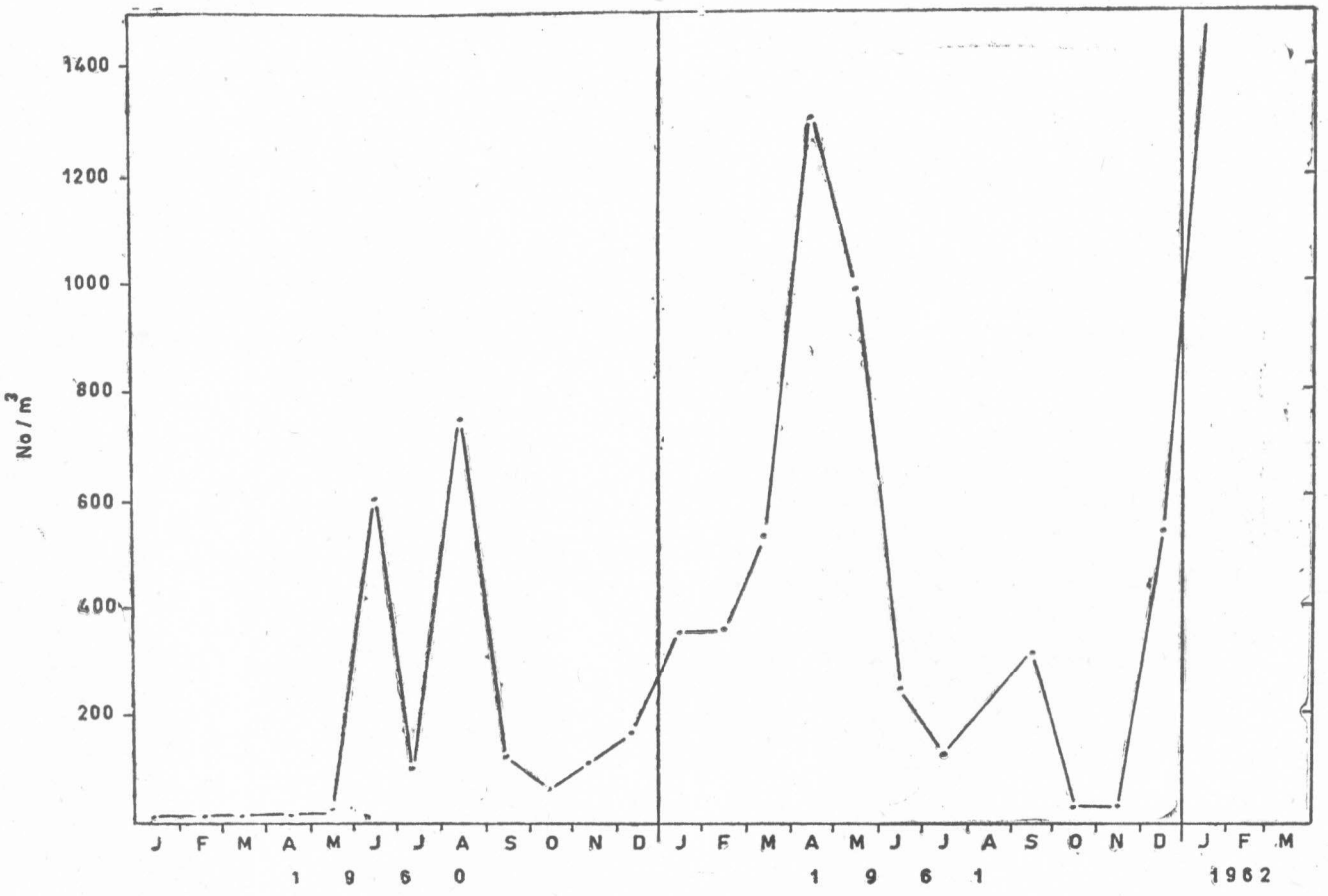

FIG. 11.—Average monthly numbers of cyclops for stations (I—V) during 1960 and 1961.

TABLE 13.—AVERAGE NUMBERS PER CUBIC METER OF CYCLOPS RECORDED AT STATIONS (I-V) DURING TEH DIFFERENT MONTHS OF 1960 AND 1961.

Month	Average No./m³	
	1960	1961
January	11	350
February	8	345
March	13	540
April	17	1325
May	32	987
June	606	233
July	106	123
Agust	772	—
September	120	323
October	65	38
November	116	32
December	159	550

TABLE 14.—AVERAGE NUMBERS PER CUBIC METER OF THE HARPACTICOID COPEPOD RECORDED AT THE DIFFERENT STATION DURING 1960 AND 1961

St. No. / Year	I	II	III	IV	V	VI	VII	VIII
1960	23	31	5	—ve	15	— ve	—ve	—ve
1961	14	50	2	—ve	3	under reclamation		

TABLE 15.—AVERAGE NUMBERS PER CUBIC METER OF HARPACTICOID COPEPODA RECORDED FOR STATIONS (I–V) DURING THE DIFFERENT MONTHS OF 1960 AND 1961.

Month	Average No./m³	
	1960	1961
January	—ve	20
February	—ve	—ve
March	—ve	—ve
April	—ve	—ve
May	—ve	—ve
June	—ve	68
July	—ve	10
August	38	—
September	8	18
October	53	23
November	16	—ve
December	10	—ve

(c) *Calanoida*:

The calanoid Copepoda is represented in the lake by *Arctodiaptomus salinus* Dady. It was only recorded during the winter of 1961, by a few scattered individuals at stations I. II. III and IV, but was absent during the rest of the year. This species appeared again in the winter of 1962 reaching a peak in March. Elster *et al* (1960) recorded maximum numbers of *Arctodiamtomus salinus* in the Nouzha Hydrodrome during the winter months but these numbers decreased rapidly during late spring and summer. This was attributed to the high mortality rate due to increased temperature.

4—*Nematodes* :

Free living nematodes were represented in Lake Mariut by scattered indivi duals. These nematodes are tychoplanktonic organisms that are met with in the bottom samples as well as on the leaves of *Potamogeton*. They are recorded at almost all stations with maximum numbers at station V, i.e. at the margins of the Potamogeton belt (table 16).

TABLE 16.—AVERAGE NUMBERS PER CUBIC METER OF NEMATODES RECORDED AT THE DIFFERENT STATIONS DURING 1960 AND 1961.

St. No. / Year	I	II	III	IV	V	VI	VII	VIII
1960	18	4	2	5	31	26	4	20
1961	10	12	4	3	74	under reclamation		

The seasonal variations of these organisms are shown in table (17) and figure (12). Nematodes were poorly represented during the winter and spring of 1960. A peak was then recorded during the summer months (June-August), which dropped again gradually throughout the rest of the year. Another increase was recorded in February, 1961 but the number of individuals decreased again rapidly. A second peak was recorded again in May, 1961. The nematodes persisted by few numbers during the rest of the year.

5 – *Cladocera* :

Cladocera is reperesented in Lake Mariut by *Moina dubia* (DeGuerne and Richard). This species was, however, rare in the lake during 1960. It started to appear in considerable numbers during May, 1961 at station IV, and was rather common at the bare area during June and July of the same year. The numbers of *Moina* dropped throughout the rest of the year. This species thrived well in the lake also during the winter of 1962 (table 18). El-Maghraby *et al* (1963), on the other hand, recorded maximum distribution of this species in lake Manzala during April, 1960 and regarded it as a typical spring plankton, which had a short duration. The gradual decrease of salinity in Lake Mariut during the successive years may explain the increased numbers of cladocera obsereved during the autumn of 1961 and winter of 1962.

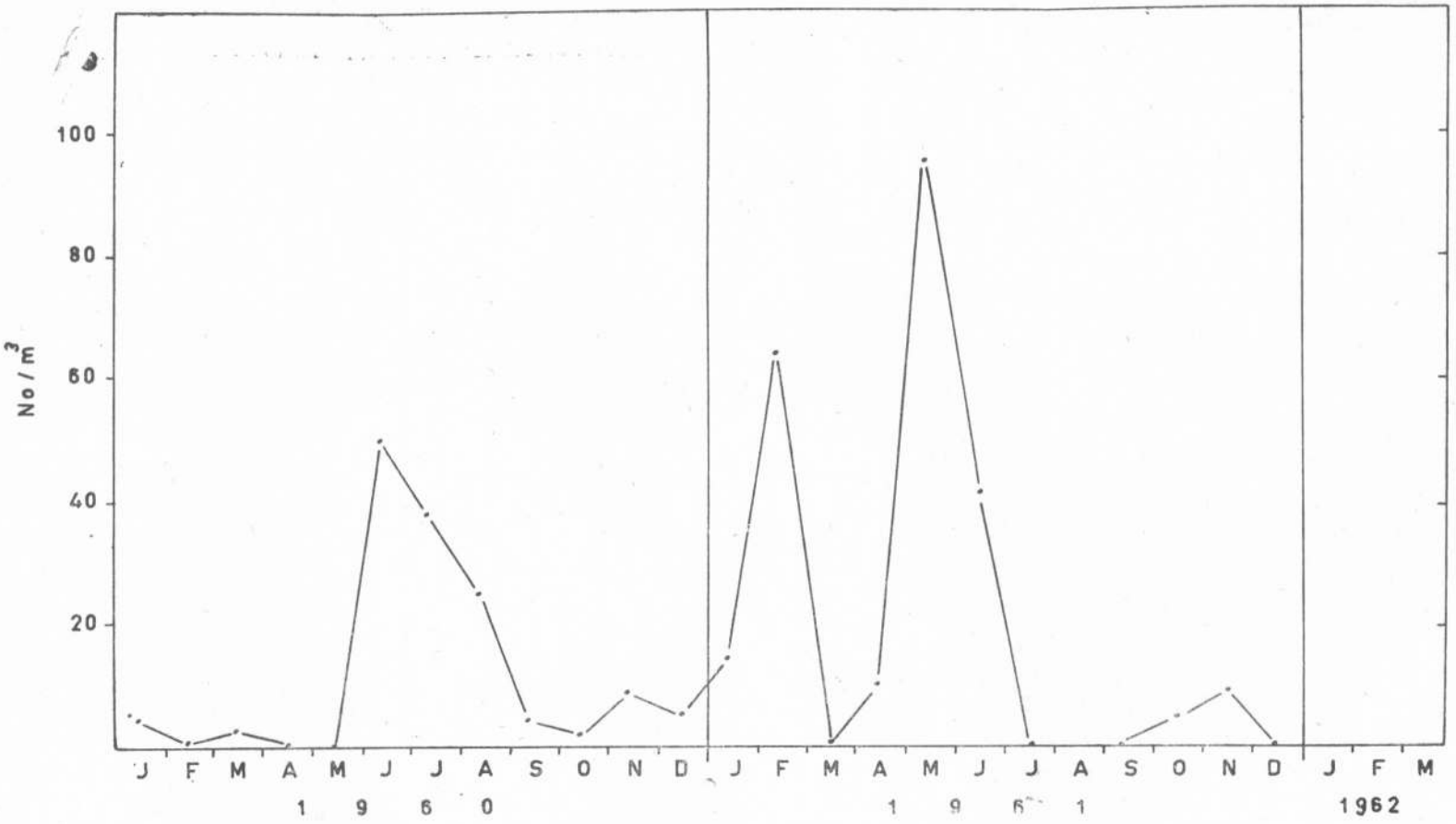

FIG. 12.—Average monthly numbers of nematode for stations (I—V) during 1960 and 1961.

TABLE 17.—AVERAGE NUMBERS PER CUBIC METER OF NEMATODES RECORDED AT STATIONS (I-V) DURING THE DIFFERENT MONTHS OF THE YEARS 1960 AND 1961.

Month	Average No./m³	
	1960	1961
January	4	15
February	1	65
March	3	—ve
April	1	10
May	—ve	97
June	51	42
July	38	—ve
August	25	—
September	4	— ve
Octover	2	5
November	9	10
December	6	—ve

TABLE 18.—AVERAGE NUMBERS PER CUBIC METERS OF *Moina dubia* RECORDED AT THE DIFFERENT STATIONS DURING 1961.

St. No. / Year	I	II	III	IV	V	VI	VII	VIII
1961	14	16	109	145	100	Under reclamation		

TABLE 19.—AVERAGE NUMBERS PER CUBIC METER OF *Moina dubia* RECORDED AT STATIONS (I–V) DURING THE DIFFERENT MONTHS OF 1961 AND WINTER OF 1962.

Month	Average No./m	Month	Average No./m³
January 1961	—ve	September 1961 . . .	130
February	—ve	October	115
March	—ve	November.	100
April	—ve	December	10
May	165	January 1962	846
June	1280	February	2580
July	44	March	8000
August	—		

DISCUSSION

The fact that the zooplankton organisms play an important rôle in the biological productivity of the different water masses was fully discussed by many authors (cf. Welch, 1952).

The zooplankton population represents the main herbivores which graze directly on phytoplaknton and it constitutes the sencond trophic level in the food cycle. The controlling effect of zooplankton on phytoplankton production in the sea has been discussed by many investigators (e.g. Harvey, 1950; Harvey *et al*, 1945; Hardy, 1936; Hardy and Gunther, 1935; Riley, 1946; Bainbridge, 1953; Steemann Nielsen, 1962, etc. However, in highly porductive areas as in Lake Mariut, it appears that the grazing of zooplankton on phytoplankton has no proncounced effect on the standing stock of phytoplankton as the rate of growth of the plants exceeds the rate of consumption by grazing. Zooplankton organisms form the basic food for fish and bottom animals, particularly in the form of detritus. They also add to the releaze of nutrients through the rapid decomposition of their bodies (Cooper, 1935; Gardiner, 1937; Hoff-mann, 1956; Harris, 1959; Barlow *et al*, 1965).

Lake Mariut possesses the main features of ponds. Thus, the majority of zooplankton organisms are tychoplakntonic forms, while true plankters are few. Most of the zooplankton in the lake shows great fluctuations in numbers at the different stations as well as during the different months. The abundance of zooplankton shows also great fluctuations in the lake from one year to another.

The macroplankton is represented mainly by *Leander squilla elegans* and its larvae, *Gammarus* spp. and *Mesopodopsis slabberi*, while the net zooplankton comprises the nauplius larvae of *Balanus improvisus*, *Brachionus* spp., cyclops, calanoid sp. harpacticoid sp. and the cladoceran *Moina dubia*. The highest production of zooplankton occurs in the polluted and bare areas while the *Pota mogeton* belt is considered as poor. It is to be noticed that the food requirements of zooplankton is usually present in exceess at both the pollutted and bare areas (Aleem and Samaan, 1969 II). The scarcity of zooplankton in the *Potamogeton* belt is attributed to its poorness of phytoplankton and the presence of large numbers of the fish *Gambusia affinis* which may be responsible for the reduction of zooplankton organisms.

The two important environmental factors that may affect the succession of zooplankton include water temperature and salt content expressed as chlorosity. The response of zooplankton population to the changes of temperature varies with the different species. Certain forms like *Brachionus* spp. and the nauplius larvae of *Balanus* do not show a clear seasonal periodicity in accordance with temperature variations. Others may, however, respond to the changes of temperature. Thus, *Gammarus* appears mainly during the winter and spring. Cyclops spp. are poorly represented in winter and increase in numbers during the spring and summer. The distribution of *Arctodiaptomus salinus* is confined to winter months. *Leander squilla* has shown tow breeding seasons, the first during the spring and the second at the beginning of the autumn. Thus coincides with an amplitude of temperature ranging between 20 and 24°C. The spawning of *Tilapia zillii* which constitutes the main fish inhabiting the lake is controlled mainly by water temperature (Welman, 1941 ; El Bolok and Koura 1960 ; El Zarka, 1962). Thus, larvae of *Tilapia* were recorded in the zooplankton hauls during this investigation from April until November when the water temperature ranged between 18.6 and 29°C. Peaks of larval abundance were recorded when the water temperature is over 26.0°C.

Lake Mariut forms a brackish water environment to the zooplankton organisms of the lake. The chlorosity of the water ranges between 1.5 and 5.6 gm Cl/l. It remains low during the autumn and winter months but increases gradually during the spring and summer. The typical zooplankton of fresh water origin recorded in the lake include the rotifer *Brachionus* spp. and the cladoceran *Moina dubia*, these two forms were widely distributed in the lake during the year 1961 when the chlorosity of water decreased. Most of the other plankters are brackish water forms and appear to tolerate a wide range of salinity.

Certain morphometric features appear to be of importance in determining the magnitude of the standing stock of zooplankton in such shallow brackish water lakes. The dominance of tychoplanktonic forms and other plankters

which inhabit the lake margins in the adult stage like *Leander squilla* reflects the importance of the bottom and margins of the lake which serve as a home for such organisms. Thus, stablization of the lake bottom against strong wind action and the presence of emergent plants like *Phragmites* at the lake margins appear to be in favour of zooplankton production. In contrast to the *Phragmites*, submerged plants like *Potamogeton* seems to have an inhibiting effect on the distribution of zooplankton and have to be controlled so as to grow in small in patches.

SUMMARY

1.—Lake Mariut, the field of the present investigation, is a shallow brackish water basin; with a total area of about 20,000 feddans and an average depth of one meter; It receives irrigation water from the Umum Drain and some sewage at the vicinity of Karmous District. The lake is considered as a highly eutrophic lake and it provides a high fish yield (mainly *Tilapia* spp.).

2.—The zooplankton in the lake shows great fluctuations in number of individuals at the different stations as well as during the different seasons. The zooplankton was generally richer in the polluted and bare areas than in the *Potamogeton* belt.

3.—True planktonic forms such as copepods, cladocerans and rotifers are poorly represented in the lake, while tychoplanktonic forms represented mainly by *Gammarus*, larvae of *Leander* and *Balanus* are abundant.

4.—The macroplankton is mainly represented by larvae of *Leander squilla*, *Gammarus* and *Mesopodopsis slabberi*. The net zooplankton comprises: nauplius larvae of *Balanus*, Brachionus spp., cyclops, calanoid and harpacticoid spp. and the cladocera *Moina dubia*. Species of free living nematodes were also recorded in the plankton hauls.

5.—Larvae of *Leander squilla elegans* form the bulk of zooplankton during the breeding period of the adult animals. These larvae inhabit both the polluted and bare areas.

6.—*Gammarus* is represented in lake Mariut by *G. locusta* and *G. oceanicus*. These are recorded at the *Potamogeton* belt and the bare area. *Gammarus* appears in the plankton hauls during the period January-June and in bottom is samples two months earlier.

7.—*Mesopodopsis slabberi* is occasionally represented at the different stations during the whole year. It sometimes shows a sudden increase in numbers at one station or the other during certain months.

8.—The post larvae of *Tilapia* are the only fish larvae recorded in abundance in the plankton hauls. They were observed mainly in the polluted area and to a much less extent in the bare area.

9.—Nauplius larvae of *Balanus* represent the most important net zooplankton in the lake. They are confined to the polluted and bare areas. They are present all the year round with great fluctuations from one month to the other.

10.—The genus *Brachionus* survives in both the polluted and bare areas. Brachionus is represented all the year round with great fluctuations during the different months.

11.—Copepoda are represented in the lake by 5 species of cyclops, one harpacticoid and one calanoid forms. Cyclops form the bulk of copepods. They are distributed all over the lake with a maximum in the bare area. Cyclops were recorded all the year round, reaching a peak during the summer of 1960 and spring of 1961.

12.—Free living nematodes are recorded as few scattered individuals at all stations with maximum distribution at the margins of *Potamogeton* belt. They are also recorded in the bottom samples as well as on the *Potamogeton* leaves.

13.—The cladocera *Moina dubia* started to appear in considerable numbers during the summer of 1961 at the bare area and soon spread into the polluted area. Such increase is attributed to the decrease of the salinity of the lake water.

14.—Other forms of rare occurrence which is recorded in the plankton hauls include Oligochaetes, polychaete larvae, ostracods and adult insects as well as Nymphs of May fly and stone fly.

15.—The part played by zooplankton population in the biological productivity of the lake is discussed. It represents the main herbivores which graze directly on phytoplankton and forms the basic food for fish and bottom fauna. It also adds to the release of nutrients through the rapid decomposition of their bodies.

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