THE NERITIC ZOOPLANKTON OF THE SOUTH EASTERN MEDITERRANEAN AT ALEXANDRIA

I—Distribution and Ecology of the Zooplankton Organisms with Special Reference to Copepoda

By

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INTRODUCTION

A detailed study on the ecology and distribution of both phytoplankton and zooplankton was carried out in Alexandria region for two complete years (1961-1963). Such a study is very important since it fills a gap in the plankton investigations in the Eastern Mediterranean region, and it is urgently needed for it throws light on several contemporary fisheries problems. Moreover the annual discharge of huge amounts of Nile water to the Mediterranean in front of the Nile Delta from late summer throughout autumn has given the area certain unique biological and hydrographical features. Since 1966, and by the complete construction of the High Dam South of Aswan, the flood water was completely stroed in front of the Dam for irrigation purposes, consequently the hydrographical and biological features of the neritic area in front of the Nile Delta, at least during the flood season, are altered. This study is thus considered as an important reference for establishing a condition which will no larger exist in the area and will form a basis for the future comparisons.

The area investigated :

The area investigated lies between latitudes 31° 8′ & 31°27′ N and longitudes 29° 46′ & 30°3′ East, extending for about 30 kilometers between Abu Qir peninsula to the East and Agami island to the West.(c.f. Chart Fig 1). Altogether 5 stations were selected to represent the offshore and inshore conditions in the area. Stations I, II, and III represent the offshore neritic zone and lie at a depth of about 40 meters. There positions from the shore are as follows :

Station I : 13 km. off Abu Qir peninsula.

„ II : 7.5 km. off the Eastern Harbour.

„ III : 8 km. off Agami island.

Each of these stations represent a distinct habitat. Thus station I, lying on the eastern boundary of the area near the shallow Bay of Abu Qir is mostly affected by the Nile water during the flood season. Station III, lies at the extreme West of Alexandria is little affected by land drainage and it thus represents rather normal neritic conditions. While station II is more or less affected by sewage effluents of the Metropolitan Alexandria and also by polluted-water from the Eastern Harbour.

Stations IV and V represent the inshore conditions.

Station IV : lies at the entrance of the semiclosed Eastern Harbour, depth of water 9 m. and is affected by the sewage effluents of Alexandria and by the refuge of the fishing boats and ships.

Station V lies at the entrance of the Western Harbour, depth of water 16m. and is affected by fresh and brackish water from respectively, mahmoudiah Canal and Mex pumps.

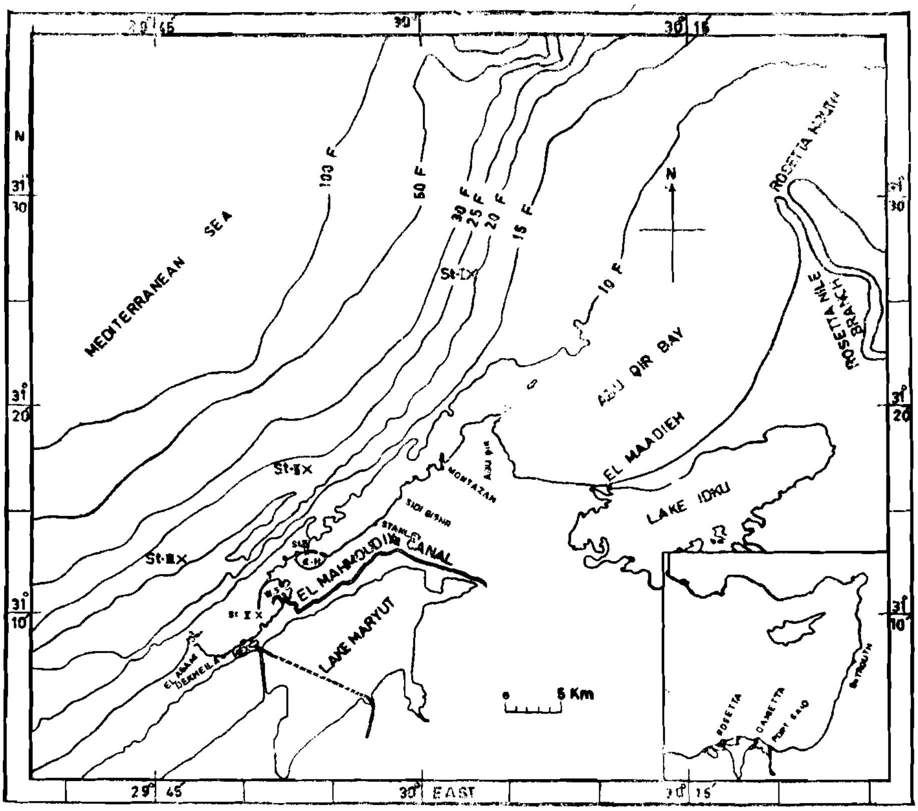

FIG. 1.—The aiea investigated (Alexandria region).

Upper : Chart showing the position of the stations sampled and depth contours in fathoms.

Lower : showing the position of the area investigated with respect to the Nile months and the Nile Delta.

Method of collection :

Two types of nets were used, a fine net of bolting cloth No. 25 (200 mesh/inch) and a coarse net of bolting cloth No. 5 (66 mesh/inch). The diameter of the mouth of the fine net was 20 cm, while that of the coarse net was 30 cm. vertical net hauls (from bottom to surface) and horizontal hauls (5 minutes duration) were operated regularly at each station twice per month. The coefficient of filtration of the fine net was calculated on several occasions by the use of a flow meter and was found to be on the average 0.74; it ranges from 0.60 (during the flood period) and 0.80 in other seasons. On assesing the numbers of zooplankton organisms, the samples of the vertical hauls of the fine net were considered, because they contained all the zooplankton organisms (both large and small) sampled from the whole water column. The quantitative representation of the organisms recorded were expressed in numbers per cubic meter. The horizontal hauls of both the fine and coarse nets as well as the vertical hauls of the coarse net were only used for qualitative study.

Some hydrographic features of the area :

It is essential before dealing with the results of zooplankton studies to give a brief outline on the hydrographic conditions of the area as well as the annual cycle of phytoplankton.

The area investigated could be considered as representing a warm temperature region. The maximum temperature (about 29°C at the surface and 27° at 30 meters depth) occurs in August; the minimum about 16.5°C at the surface and 15.5 at 30 meters depth) occur in February. The annual average is 22.4°C at the surface and 20.8°C at 30 meter depth. In figure (2) is shown the seasonal variation of temperature (average of the whole water column) in the area during the period of investigation. Apart from the flood season, the salinity of the area reflects the normal condition in the Levantine; its variations are on the whole very small and mostly of local nature. The maximum salinity (about 39 %°) occurs in August. During the flood season (late August to November) the surface salinity decreases to a minimum in September being 24%° at station I (the nearest to Rosetta Nile Mouth); it gradually decreases towards the West. Throughout the area this dilution is hardly detected below 10 m. depth. It is worth to mention that the dilution of water during the flood season has imparted a unique feature to the area viz : the coincidence of high temperature and low salinity (see Fig. 2).

Accompanying the dilution of sea water in the area during the flood season is the production of immense phytoplankton bloom (more than 10 million cells/litre) due to the fertilizing effect of the Nile flood water. This bloom is however, mostly confined to the upper 10 meter depth. Otherwise a minor maximum occur in January and February while minimum numbers were recorded usually in summer.

The results of these qualitative and quantitative studies of the neritic zooplankton organisms at Alexandria are treated under two separate articles.

Part I : entails the ecology and distribution of the most important organisms with special emphasis on the Copepoda.

Part II : deals with seasonal variations of the zooplankton community as a whole in the offshore and inshore stations. A critical discussion of the results is also given.

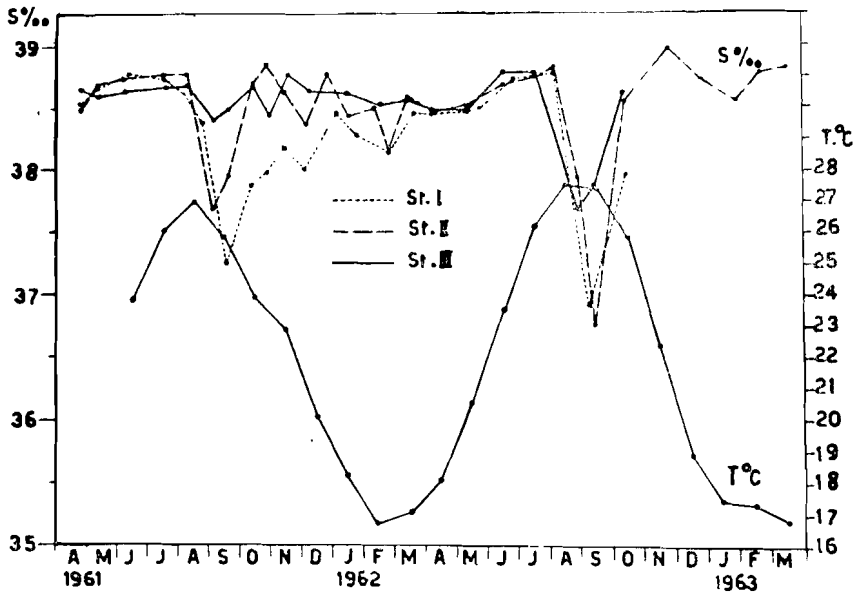

FIG. 2.—*Upper* : Seasonal variations of salinity at each of the offshore station based on the average values of the whole water column (0–30 m).

Lower : Temperature cycle in the area, based on the average values of the whole water column at the three offshore stations from June 1961 to March 1963.

A—Copepoda

All the Copepod species recorded in the area during this investigation are included in table (5). Throughout this investigation identifications of the different copepod species were carried out after Giesbrecht (1886). G.O. Sars (1895-1903) and Rose (1933). Of the 84 species recorded, only 18 form the greater bulk of the copepod community in the plankton either all the year round or only during part of the year. These important species are marked by (A) in the list and, their seasonal variations is treated in detail in this section.

Paracalanus parvus Claus

This is the most important pelagic copepod in the area, occurring in every sample collected during the period of investigation. It is a cosmopolitan species with a variable ecological occurrence, being recorded in both oceanic and neritic

zones. (Rae & Rees, 1947 Deevey, 1948; 1960; Sewell, 1948; Digby, 1950; etc..). It occurs generally as a surface or epipelagic form. However, it may occur also in considerably deep waters. For example, it was recorded by Farran (1926) at a depth of 1830 meters in the Bay of Biscay, and by Jespersen (1934) at 500-1670 meters in the Labrador Sea.

It has been reported to have a wide range of temperature tolerance, between —1.23°C and 28.0°C (Sewell, 1948; Deevey, 1960), or even 32.0°C (Woodmansee, 1958). It is also a euryhaline species with a rather wide salinity tolerance ranging from 19.33‰ to 40.0‰ (Bigelow. 1926) or from 14.8‰ to 35.1‰ (Woodmansee, 1958). The occurrence of the species in very great numbers in the Eastern Harbour (Station IV) may suggest that it prefers protected inshore waters.

Owing to the similarities in shape and structure of the developmental stages (nauplii and copepodites) of *Paracalanus* and *Clausocalanus* it was difficult to distinguish them while counting. Consequently, the seasonal variation of the adult individuals is treated separately while that of the developmental stages is based on the combined numbers of both. However, the relative abundance of adult individuals may refer to their species origin.

The seasonal abundance of the adult individuals of *Paracalanus parvus* in the three offshore stations, during the period of investigation is characterised by the occurrence of a number of peaks representing outbursts in the population of this species. It is obvious from the graph (Fig. 3), that the species passed the winter of 1962 with only a very few individuals. It even escaped the record in certain samples. Although the species was reported to tolerate a wide range of temperature, yet in our area the low winter temperature (15-16°C) seems to restrict its numbers. When the temperature of water began to rise by the advent of spring, the species propagated successfully and successive peaks followed one another in the interval of time from April to December, with a temperature range between 18.5°C - 28.7°C. In both years the species was generally more abundant during flood season with a maximum in October 1961 attaining 15500/m3 at station I.

With the exception of the flood season (September to October), the propagation of the species in 1962 was not as successful as in 1961.

On the basis of the occurrence of peaks of abundance for the species from April to December at a temperature range of 18.5°C - 28.7°C,5 generations of adult could thus be detected :

Adult	I	: Represented by the peak of	April.
„	II	: „ „ „	June
„	III	: „ „ „ „	August and early September.
„	IV	: „ „ „ „	October.:
„	V	: „ „ „ „ „	Decemper.

The few large size specimens of winter may represent the overwintering generation.

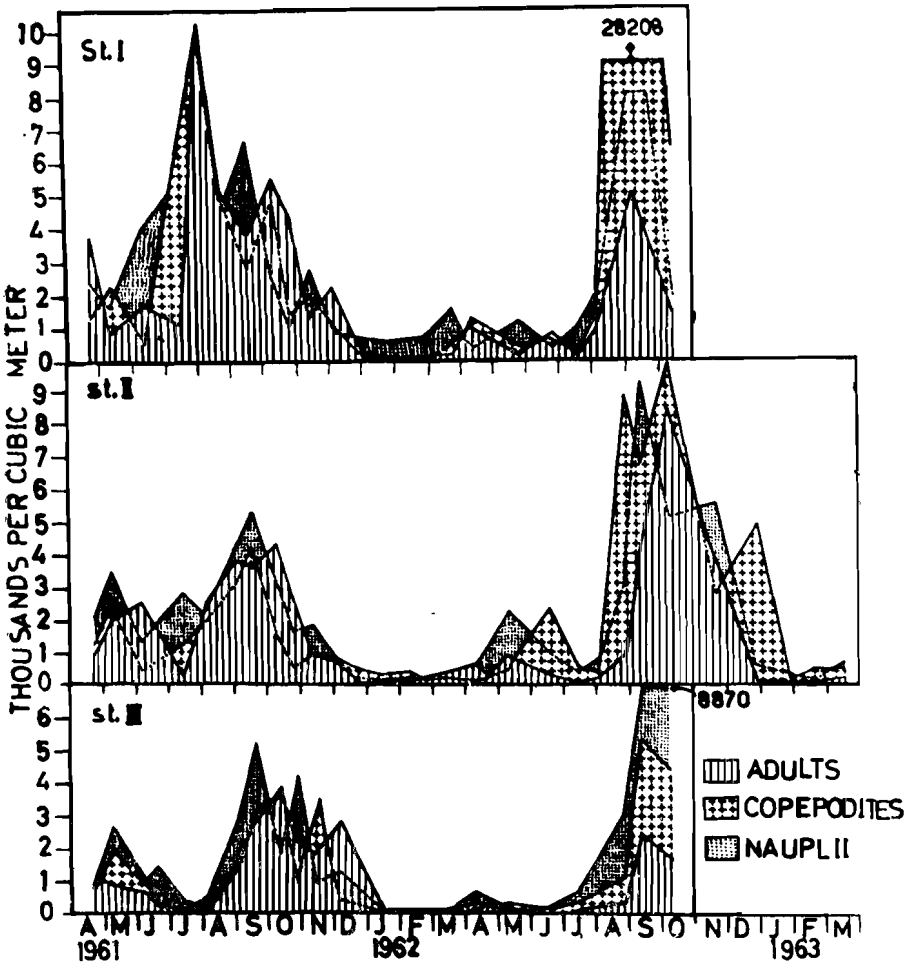

FIG. 3.—*Paracalanus parvus*, from the vertical hauls of the fine net at stations I, II and III. The graphs of copepodites and nauplii represent the combined numbers of both *Paracalanus* and *Clausocalanus* species.

Inthe inshore water at station IV, *Paracalanus parvus* was also present all the year round. Figure (4) shows the seasonal variation of the adults, copepodites and naupliar stages of this species. The condition of its occurrence at this station could be summed up in the following:

1.— The numbers recorded here, by far exceed those recorded in any of the offshore stations, this suggests an inshore preference which probably might be due to the greater abundance of the suitable nannoplanktonic food for this netritic species in this area.

2.— The production of the species at station IV seems to be continuous almost throughout the year.

3.— Although there are some obvious peaks in the graph of abundance of the species, yet it is difficult to determine the exact number of broods due to the overlapping of generations. El-Maghraby (1965) on the basis of length measurement of this species predicted at least 6 generations in the course of the year at Boughaz (station IV).

The following generations could be indicated from the peaks of abundance shown in figure (4) (which agree with the broods given by El-Maghraby (1965);

Adult I : Represented by the peaks from April to early May.

" II : Which may occur in late may or June (in June 1961, this peak was exceptionally very high, 54, 333/m^3 occurring at an optimum temperature of 25.5°C).

" III & IV : Represented by the large numbers of individuals that were maintained throughout the flood season (late August to October) at temperatures of 26.0°C/ 27.0°C.

" V : Represented by the fairly numerous population existing during the period November-December.

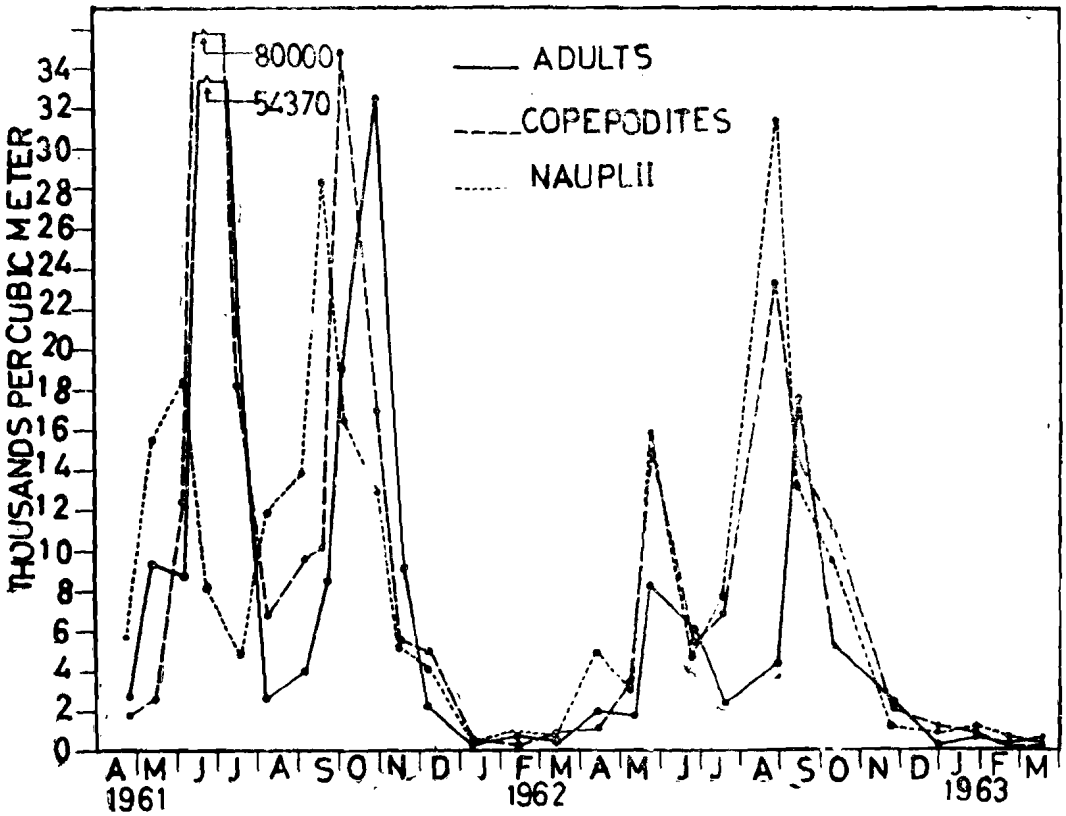

FIG. 4.—*Paracalanus parvus*, from the vertical hauls of the fine net at station IV. The graphs of Copepodites and naupii represent the combined numbers lf those *Paracalanus* and *Clausocalanus* species.

The large size individuals recorded during winter represent an overwintering population.

Clausocalanus arcuicornis Dana

Clausocalanus furcatus Brady

Clausocalanus arcuicornis is included among the fairly common copepods in the area, since it occurred in almost every plankton sample taken during the period of investigation. On the other hand, *Clausocalanus furcatus* is of but minor importance. Its density did not exceed 140 individuals/m3 during its maximum abundance in winter. Both species were counted together as it was not easy to differentiate between them while counting, but owing to the very few individuals by which *Clausocalanus furcatus* was represented, the seasonal variation shown in figure (8) represents fairly accurately that of *Clausocalanus arcuicornis*. A glance at the graph will show that the periodic occurrence of the latter species was nearly similar during both years.

Four peaks were detected from April to November. The first peak occurred in spring (mostly in April). The second was recorded in June, the third in late 4 summer (late August and September), and the last peak occurred in November. The maximum number recorded for the species in the offshore stations (2900/m3 was that at station I on August 24th 1961 moreover throughout the year the species was mostly represented at station I. As obvious from figure (8) at least 4 generations of *Clausocalanus arcuicornis* succeed one another in the course of the year; the possible time of appearance of the adults of these broods may be given as follows:

Adult	I	: Represented	by	the	spring maximum (may).
	II	„	„	„	peak of June.
„	III	„	„	„	late summer peak.
„	IV	„	„	„	peak of November.

Likewise the few specimens surviving in winter, represent the overwintering population.

In the inshore station IV (Eastern Harbour), *Clausocalanus arcuicornis* was also recorded all the year round, but its numbers were generally relatively higher than those recorded in the offshore stations. The maximum number of individuals of the species in the whole period of investigation (4500/m3) was recorded in this area in May. The peaks recorded for the species at station IV (Fig. 8) generally coincides in time with those recorded in the offshore stations.

Developmental stages of Paracalanus and Clausocalanus:

The seasonal variations of the developmental stages of *Paracalanus* and *Clausocalanus* are shown in figures (3 and 4). The following remarks are worth of mentioning:

1.— Small numbers of both nauplii and copepodite stages accompanied the few adult individuals of winter.

2.— As the periods of abundance of adults of both *Paracalanus* and *Clausocalanus* species are generally the same, several peaks of the adults coincide in time with the peaks of copepodites and nauplii. It is not easy to say whether those developmental stages belong to the brood of adults in question or not. Field studies do not reveal clearly this problem, since the condition is complicated by the continuous naupliar production, and hence overlapping and interference of the resulting broods take place.

3.— Other peaks of the developmental stages occur at the time when the numbers of adults were small. These may clearly represent the offspring of the dying population metamorphosing to give the adults of the succeeding brood.

4.— Maximum numbers (for both copepodite and nauplii) were recorded during the flood season accompanying the adult maximum. The number of these maxima were however, significantly higher in 1962 than in 1961.

5.— Of particular interest is the peak of nauplii (particularly those of *Paracalanus*) recorded on October 30th, 1961 at station III alone. This peak was more pronounced than those recorded in November at stations I and II. The result of its metamorphosis probably gave the peaks of copepodite and adult recorded respectively in November and early December. The numerous population of *Paracalanus* nauplii at station III was probably of inshore origin. Plankton samples taken on October 30th, from the inshore station V indicated the presence of a very large population of adult *Oithona nana*, *Euterpina acutifrons* and *Paracalanus nauplii*.

The inshore water influx at Station III in October 1961 was confirmed from salinity data.

Euterpina acutifrons Dana

This planktonic harpacticoid species is also one of the most important copepods in the area. It occurs in both the Mediterranean and Red Seas (Steuer, 1910; Gurney, 1927; Rose, 1933). Fox (1927) believes that it enters the Suez Canal from both sources.

In the area investigated, the species was always recorded throughout the period of investigation; its extreme abundance in stations IV and V may suggest that it prefers inshore waters.

The seasonal variations of the species (Fig.5) in the three offshore stations were reflected in the same way. The species passed the winter with very few, but large sized adults which even escaped the record in some samples. The number of adults increased considerably during the spring months, giving rise to a minor peak in April. The spring propagation was, however, more successful in 1961 than in 1962. The second peak in both years was detected during June and, again it was more pronounced in 1961. Although the third rise was obvious in both years during August, it occurred before the flood season in 1961, and at the beginning of the flood season in 1962.

Like the other most common copepods in the area, this species also maintained a large population throughout the flood season (from late August to October). The maximum abundance in both years were recorded during this period at station I (7,500 individuals /m3, on October 12th, 1961 and 12,350/m3 on September 9th, 1962).

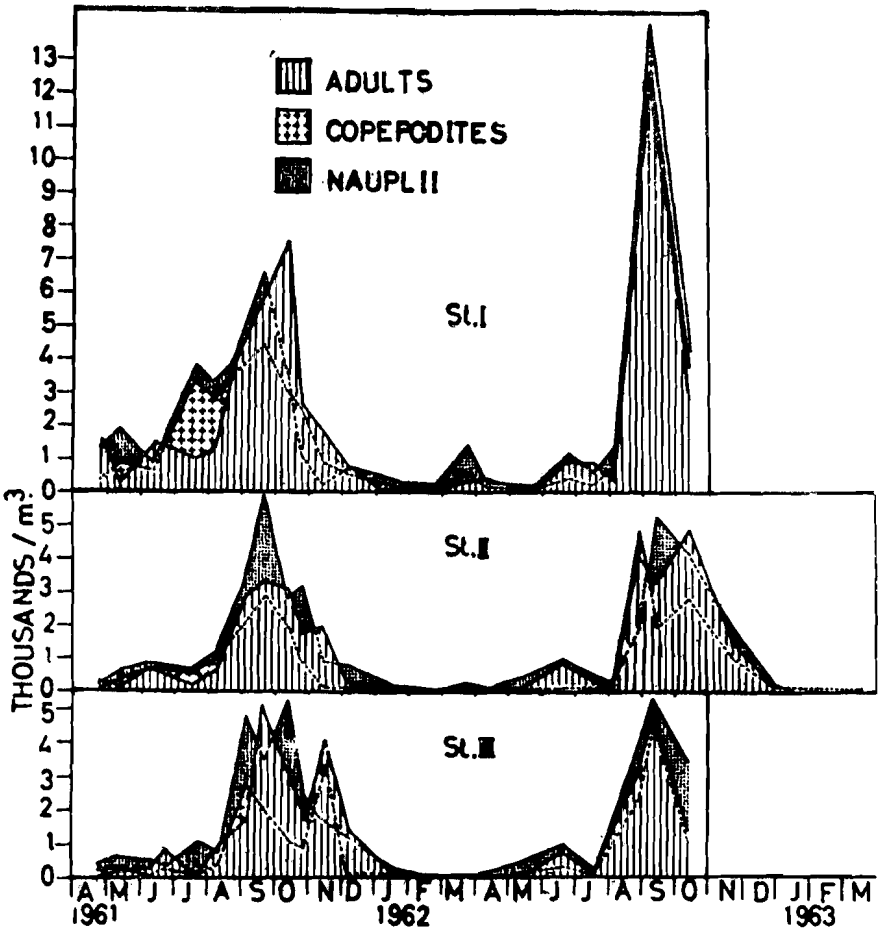

FIG. 5.—Seasonal variations of adults, copepodites, and naupliar stages of *Euterpina acutifrons* at each of the offshore stations, based on their occurrence in vertical hauls of the fine net, from April, 1961 to March, 1963.

From the seasonal variation of the species at the three offshore stations, it may be concluded that :

1.— The species thrives well and has its maximum abundance during autumn at an average temperature of 26.1°C.

2.— The occurrence of the species is generally more pronounced at station I where large numbers were always recorded.

Judged from the peaks of abundance shown in figure (5) at least 5 broods representing 5 successive generations were detected for the species in the area, these are as follows :

Adult	I	:	Represented	by	the	spring speak of April.
„	II	:	„	„	„	early summer peak of June.
„	III	:	„	„	„	late „ „ „ August
„	IV	:	„	„	„	early autumn „ „ September and October.
„	V	:	„	„	„	autumn peak in November.

The few individuals recorded in winter (December and January) represent the overwintering brood. El-Maghraby (1965) recorded 6 broods for this species in the course of the year, the times of occurrence of which are in fairly good accordance with those stated above.

In the insbore station IV, the occurrence of the species was much more pronounced than in the offshore stations. The seasonal variation of the species at this station is shown in figure (6). 6 peaks of adult abundance are obvious in the period from April to December 1961. The first, second and fourth of these, coincided with those recorded at the three offshore statiovs.

Develomental stage of Euterpina :

The seasonal variation and occurrence of developmental stages (nauplii and copepodites) of *Euterpina* is shown graphically in figure (5). It is obvious that their production was nearly continuous throughout the period of investigation. However, neither the number of these peaks nor the time of their occurrence was necessarily similar to those of adults. In several occasions they either directly preceded or followed the peaks of adults. This discrepancy in the time of maximum occurrence of the younger stages, was due to the relatively continuous breeding of this species, and consequently the overlap of the succeeding generations. However, the maximum production of developmental stages in both years of investigation occurred during the period of the Nile flood and was conincident also with the adult maximum.

The peaks of copepodites shown in figure (6) generally coincided with those of adults in the inshore stations.

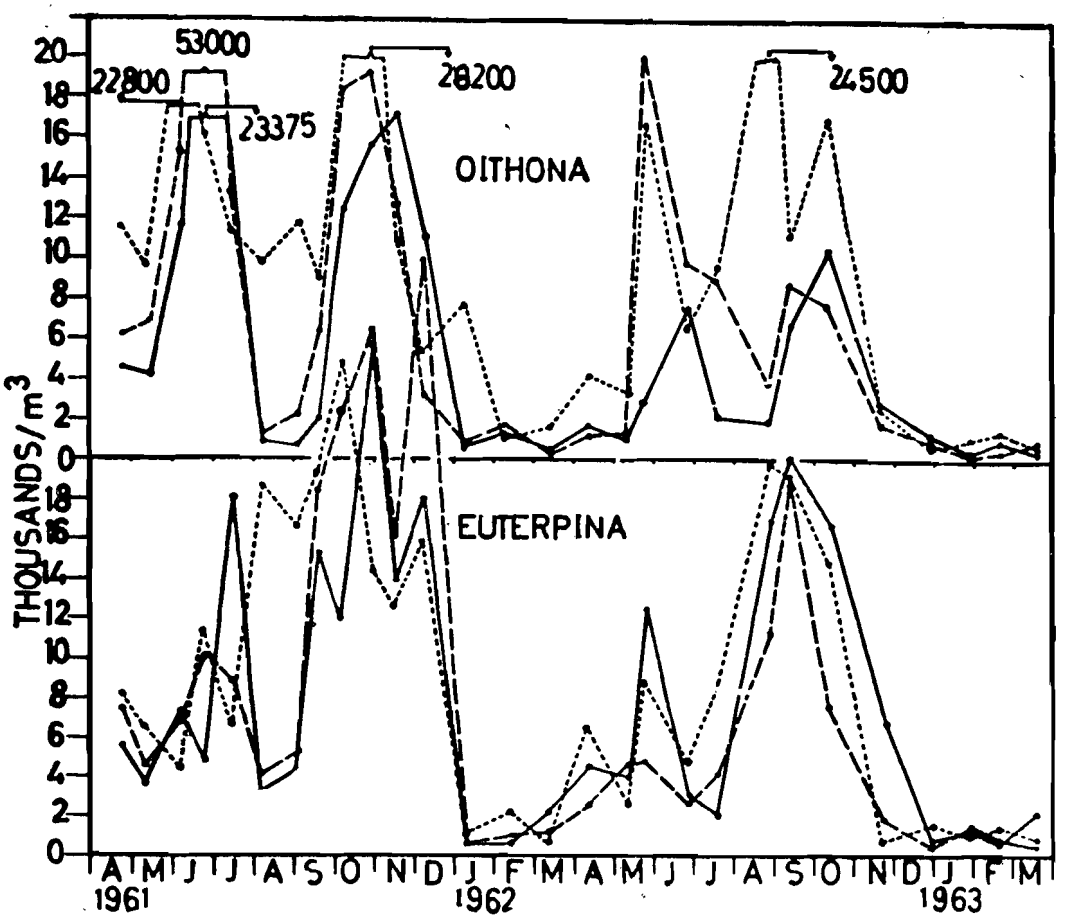

FIG. 6.—*Upper* : Sesonal variatiques of adults of *Oithona nana* (solid line) and nauplii (dotted line) and copepodites (dashed line) of *Oithona* spp.

Lower : Seasonal variations of *Euterpina acutifrons*; adults (solid line), copepodites (dashed line) and najupliar stages (dotted line) all numbers based on verttical hauls of the fine net at station IV.

Judging from these peaks shown in figure (6) it may be concluded that at least 6 broods representing 6 successive generations for the species in the inshore area (station IV) could be detected. The possiple sequences of these may be as follows :

Adult	I	: Represented	by	the	few individuals of March.
„	II		„		peak recorded in April.
„	III	„	„	„	of late May to early June.
„	IV & V	„	„	„	large population recorded during the flood season (September and October).
„	VI	„	„	„	by the peak of December recorded in both years, and this might represent the overwintering population.

Oithona nana Giesbrecht

This neritic species is the third in abundance among the copepod species of the area investigated. It is a southern warm water species, found in both the Mediterranean and Red Seas. In this investigation the species was recorded throughout the year at all stations.

Apart from minor rises, its occurrence in the offshore stations was rather rare in winter and early spring. The first pronounced peak occurred in either June or July.

From late August to December, 1961 the species was rather common at a stations with a maximum of 9800/m^3 at station II in October 1962. (Fig.7).

Judging from the peaks of abundance of the species in the area, 5 broods, representing five successive generations, could be detected for the species. The time of appearance of these coincides with that based on the length measurements recorded by El-Maghraby (1965).

Adult	I	: Rperesented by the peak recorded during April especially at station I.
„	II	: Represented by the peak of June recorded in both years.
„	III & IV	: The large population recorded from August to October may be due to these two generations.
„	V	: The peaks of November (station I) and December (station III) 1961), may represent this brood.

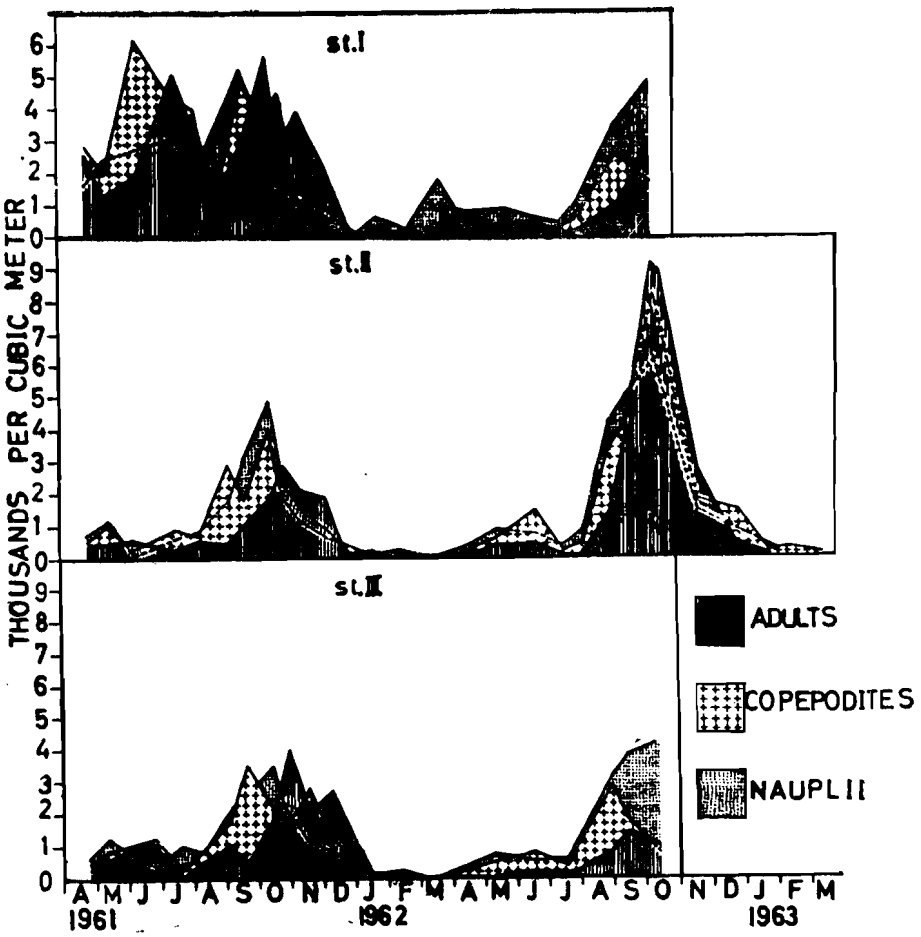

Fig. 7.—Seasonal variations of adults, copepodites and naupliar stages of *Oithona nana* at each of the offshore stations based on their occurrence in vertical hauls of the fine net from April, 1961 to March, 1963.

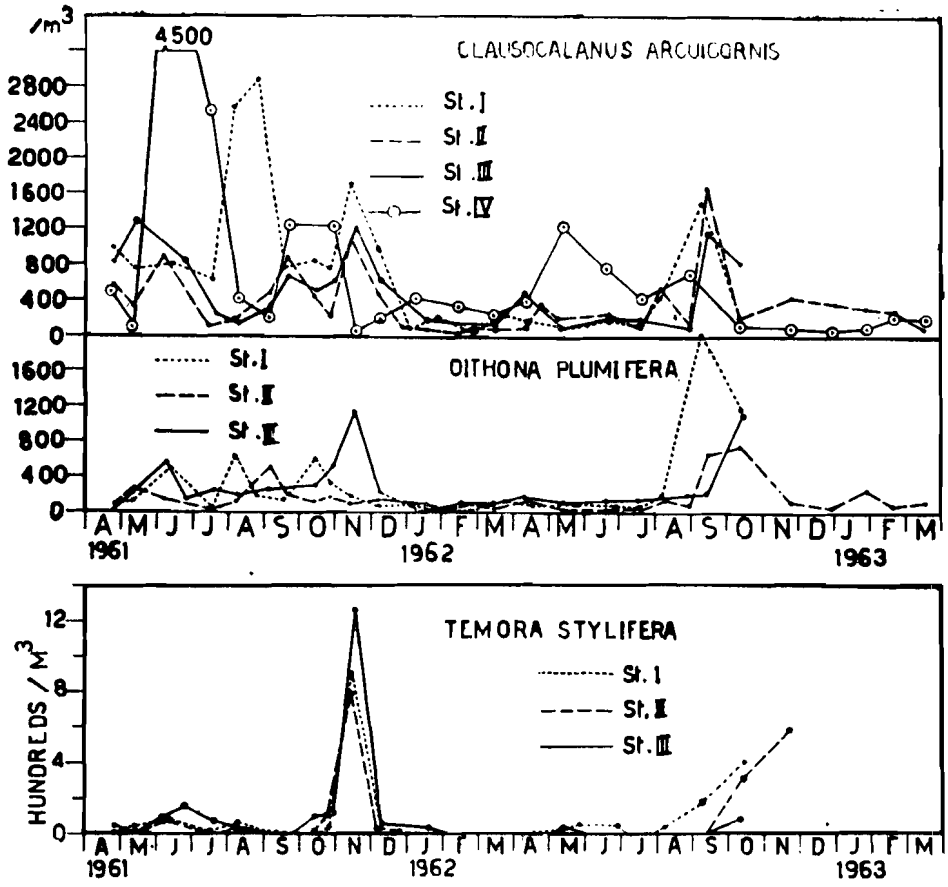

FIG. 8.—Seasonal variations of *Clausocalanus arcuicornis*, *Oithona plumifera* and *Temora stylifera* in the area from April, 1961 to March, 1963.

The minor population recorded during January (station I) and February (station II) 1961, was the overwintering individuals.

In the inshore station IV (Fig. 6) the species is much more numerous than in the offshore stations; two pronounced maxima were recorded for the adult species on each year, viz.: in early summer (June) and in autumn (October and November). The maximum number recorded for the species in 1961 was that of June (23400/m^3), the corresponding maximum in 1962 was much lower (10400/m^3) and recorded in October 1962. Other minor peaks were recorded in April 1961 and 1962 and in February 1962 and 1963 respectively. In other months the numbers were much lower but the species was generally rather frequent in summer.

Oithona plumifera Baird :

This copepod was recorded all the year round in the offshore stations. Its presence in inshore stations was however erratic; being only recorded in small numbers on a few occasions. This may suggest an offshore origin of this species. The species was also recorded by Gurney (1927) in the Gulf of Suez, and by MacDonald (1933) in the Suez Canal. The seasonal variation of this species in the area during the period of investigation (shown in Fig. 8) is very irregular. The occurrence of peaks is neither simultaneous in the three stations for the same year nor was it similar in both years. Maximum abundance was 1200 individuals/m^3 in November 1961 at station III.

Developmental stages of Oithona:

The seasonal variation of the developmental stages of *Oithona* species (copepodites and nauplii) is based on the combined numbers of copepodites and nauplii of *Oithona nana*, *Oithona plumifera* and *Oithona linearis*, as it was not easy to distinguish them while counting. However, although the adult specimens of *Oithona plumifera* were present nearly throughout the year, yet their numbers were much lower than those of *Oithona nana*. *Oithona linearis* was, on the other hand, too rare to be considered of importance. Consequently, the graph showing the seasonal variations of the developmental stages could be considered as fairly representing those of *Oithona nana*. In both the offshore and inshore stations the peaks of abundance of both copepodites and nauplii generally coincided with those of adults. (Figs. 6 & 7).

From the foregoing, it could be seen that the propagation of *Oithona nana* in the inshore water, at station IV, is much more pronounced than at any of the offshore stations.

Centropages kroyeri Giesbrecht.

This species has been recorded in the area nearly all the year round. Its greater abundance in the inshore stations during the period of its maximum occurrence also suggests its neritic character.

The seasonal variation of this copepod is shown in figures (9,10). This is based on the combined numbers of both adult and copepodite stages. This presentation has been convenient, since the fluctuations in abundance of both the copepodite stages and adults almost coincided in time. It appears from the graphs that the species passed the winter with a few individuals. The first peak was recorded in early spring (March or more commonly April). In May of both years (with the exception of the records of May 1962 at station II) the numbers of individuals decreased considerably. The exceptionally numerous population recorded at station II during May 1962 was mostly due to copepodites. In June 1961, a second, minor peak (mostly of adults) was recorded at station I. Otherwise, the population of *Centropages kroyeri* maintained an early summer minimum. The second maximum occurred in late summer (August and September). This maximum was most pronounced at station I, where 14136 individuals /m^3 were recorded on September 9th, 1962. In that summer, the maximum seems to start in July as shown for the year 1961, especially at stations II and III.

The small numbers of July and early August 1962 could not be taken as an indication of a small population of the species, but might be attributed to its bottom concentration and rare presence in the water column sampled after its downward vertical migration. This idea is supported by the fact that mid-night vertical hauls taken at stations I and II, in August 1962 yielded a rich population which dominated all other copepods present as shown from table (1).

TABLE 1.—NUMBER OF *Centropages kroyeri* (PER CUBIC METER) IN MIDDAY AND MIDNIGHT VERTICAL HAUL CATCHES TAKEN DURING AUGUST 1962

Station	I	II	Time of Sampling
August 4th	154	118	Midday
August 8th	2025	1820	Midnight

The scattering of the species at night in the whole water column sampled allowed the net to procure greater numbers. The summer rich population thus extends from July to September. Johnstone (1955) and Sewell (1948) demonstrated the tendency of diurnal vertical migration in other species of *Centropages*.

On the basis of length measurements, El-Maghraby (1965) was able to detect two broods prouduced during summer, the first was represented by a population occurring in July and August, while the second occurred in September. From October to the end of the year the species dwindled considerably being represented only by a few individuals; however, a minor rise (290 individuals/m^3) was detected

on November 1961 at station III, but this was composed mainly of copepodites. The adults developed during this time may form the over-wintering population. A glance at the graph of distribution of the species in the three offshore stations (Fig. 9) also indicates that the species, while most abundant at station I, gradually decreased in numbers towards the west (i.e. towards station III).

In the inshore station IV, the species was represented also throughout the whole year, but in comparatively higher numbers than in the offshore stations. Likewise, 4 peaks of abundance were recorded at this station in the course of the year.

As a whole, at least 4 successive generations could be predicted for this species throughout the year. These are represented as follows:

Adult I : Represented by the peaks recorded during spring (April or May).

„ II : The numerous population of July and early August may represent this generation.

„ III : The peaks of late August and September may be due to this brood.

„ IV : The specimens found during November and December may represent this population which survives the winter with very few individuals.

Isias clavipes Boeck:

The contribution of this copepod to the total zooplankton population in the area is of secondary importance, because of its small numbers and rather short duration. Its presence is, however, of interest from the biogeographical point of view. Rose (1929) has listed it among some eleven species which appear to be mainly confined to the Western Mediterranean and rarely taken in the Eastern Basin. Sewell (1948) considered *Isias clavipes* among those species which appear to have had their origin in the Atlantic Ocean and which have been swept into the Mediterranean by the inflowing Atlantic current through the Straits of Gibraltar. On the other hand, Rae and Rees (1947) considred the species among the resident plankton population of the North Sea waters. Williamson (1956) regarded it as an indicator of water entering the Irish Sea from the South.

The seasonal abundance of the species in the area is shown in figure (9), which is based on the numbers of both adults and copepodite stages. It is clear from this figure that the abundance of the species is of a relatively brief duration. The maximum abundance occurred predominantly in April in both years at all stations. During its peak the species was mostly represented at station III, where the highest numbers were recorded in both years (1000 and 1040 individuals/m^3 respectively in 1961 and 1962). In June and July the species dwindled considerably and sometimes even escaped record.

In August and September, the species appeared again in the area although in considerably smaller numbers. However, during this period it was mainly confined to station I, where its maximum (316/m^3) was recorded on August 6th, 1961.

The more pronounced peak of April occurred in both years at an average temperature of 18.2°C. The second minor peak of August occurred, on the other hand, at an average temperature of 27.5°C. Judging from the difference in both the extent of duration and magnitude of the two annual maxima, it is clear that the high temperature is not favourable for maintaining a rich population of this species.

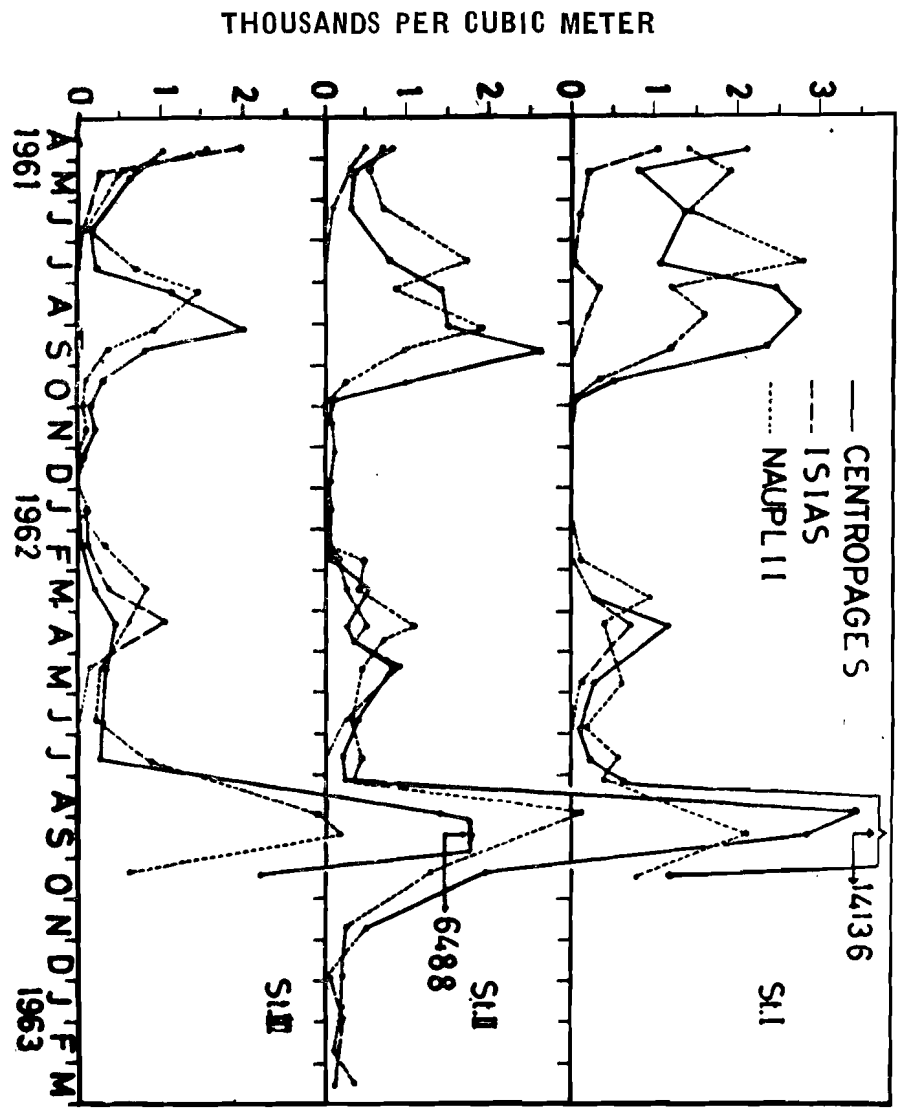

FIG. 9.—Seasonal variations of *Centropages kroyeri* (adult + copepodites) and *Isias clavipes* (adult + copepodites) and the naupliar stages of both species in the offshore stations from April, 1961 to March, 1963.

The occurrence of the species in the inshore region, i.e. station IV is shown in figure (10). It was also recorded in winter and spring. The April maximum here (i.e. 2210/m³ and 1100/m³ in 1961 and 1962 respectively) is comparaple to that of station III. During the summer the species was recorded at station IV only once being represented by a few individuals in September 1961.

At least three genrations could be predicted for this species as shown from the figure of its distribution, viz. :

Adult I : Represented by the few overwintering large sized individuals.

„ II : Represented by the spring population.

„ III : Represented by the summer population.

The nauplii of Centropages and Isias :

The nauplii of *Centropages kroyeri* might be mixed with those of *Isias clavipes*, assuming that the nauplii of the latter species (as a member of the family Centropagidae) resemble those of the genus *Centropages*. From the graphs of abundance of nauplii in stations I-IV, at least 4 peaks could be detected from February to September. (Figs. 9, 10)'

The first occurred in February or more commonly during March. The second occurred during April or May, i.e., following the April peak; the nauplii of this peak may be mostly those of *Centropages kroyeri*, since the population of *Isias clavipes* dwindled considerably in the following month. The third peak occurred in July, i.e. coincident with the beginning of the summer population of both *Centropages kroyeri* and *Isias clavipes*. The fourth peak which is the largest, occurred during the period of the Nile flood, viz. : late August-September. As the adult population of *Isias clavipes* was dwindling, the nauplii forming this peak might belong wholly to *Centropages kroyeri*.

Two minor rises were recorded at station IV in October and December 1961. The nauplii of the latter month give rise to the overwintering population.

Acartia spp.

Five species of the genus *Acartia* were represented in the area, namely : *Acartia negligens* Dana; *Acartia latisetosa* Kriczaguin; *Acartia clausi* Giesbrecht; *Acartia danae* Giesbrecht; *Acartia adriatica* Steuer.

The latter two species were found only on a few occasions in winter, represented either by single or rather few individuals (4–10/m³). The abundance of adults of the first three species is shown graphically in figure (10). The number of copepodites as well as that of nauplii represent those of the three species, since the structural differences of their developmental stages are so inconspicuous that they could not be easily differentiated while counting.

Acartia negligens :

This is the most important species of the genus *Acartia* in the area, especially in the offshore stations. In both years, the maximum numbers for the species were recorded in April at the three stations particularly at station I.

During its period of existence, the species seems to be mostly established to the East (i.e. station I) where the largest number had been recorded, viz. : 2100(m^3 in April 1961. In 1961 too, the number decreased gradually from May to early September, the adult individuals of the species were completely absent from late September to October. They appeared again in November but were represented by only small numbers in horizontal catches. The species passed the winter by very small numbers. In 1962, after the end of the spring peak, the numbers decreased considerably; and the species was completely absent in July, to have appeared again in August and persisted through September and October, but mostly in small numbers at stations I and II.

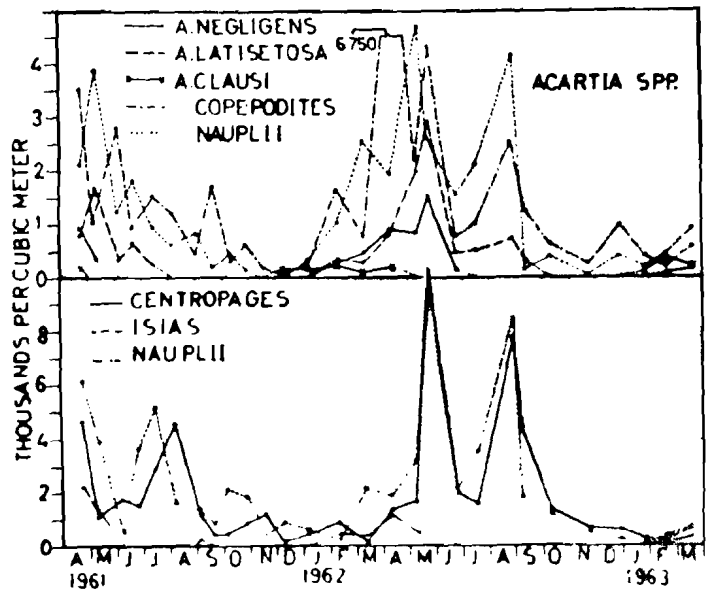

FIG. 10.—*Upper* : Seasonal variations of the adult of, *Acartia negligans*, A. *latisetosa*. A. *clausi* and the Copeodites and nauplii of *Acartia* species.

Lwoer ; Scosonal vairatians of *Centropages Kroyeri* (adult + copepodites), Isias clavipes (adult) and copepodites) and the naupliar stages of both species at station IV, from April 1961 to March 1963.

The seasonal variations of the species at station IV are almost similar to those in the offshore stations. The species persisted in the samples from January to June with a maximum of 900/m^3 in April, and 1450/m^3 in May 1962. Its temperature range during its period of existence seems to be 16.8°C-26.1°C with an optimum at 18.2°C. Three broods representing at least three generations could be detected for the species in our waters. This is based on the occurrence of peaks for the adults, viz. :

Adult I : Spring brood (April-May).

„ II : Late summer brood (September-October).

„ III : Autumn brood (November-December), this also represented the overwintering population.

Acartia latisetosa :

Unlike the forementioned species, this copepod is the most important species of the genus in the inshore waters. Sewell (1948), listed *Acartia latisetosa* among some of ten species which appear to have had their origin in the Mediterranean Sea and its offshoot the Black Sea. Monro Fox (1927) represented it from the Suez Canal and, as the species was not recorded from the Red Sea, he suggested that it has entered the Canal from the Northern end. The species seems to flourish also in waters of relatively low salinity, as in Lake Menzalah where it "occupies a prominent position in the plankton of the lake" (El-Maghraby *et al.*, 1963). In the brackish waters of the inland Lake Qaroun the species is considered as the most important planktonic organism (Nageeb, 1961).

The species was frequent at station IV during all seasons except in autumn. It shows two maxima, one in late spring (May), and the other in summer (August). The former is higher than the latter.

In the offshore stations the species was poorly represented. In 1961, it occurred from April to July with a maximum in May (180/m^3 at station I). In 1962, it appeared during April and May but in small numbers. It disappeared during June and July, then appeared again in August and September. It is to be noted that the species was completely absent from station III with the exeption of the records of April 1961. The species was also poorly represented in horizontal haul catches taken at station III during September 1962. This may be attributed to ts transport from stations I and II by the dilute surface westward current which iis frequently detected during the climax of the Nile flood.

Judging from the peaks of abundance of this species in the Eastern Harbour station IV) at least three broods representing three successive generations could be detected, viz. :

Adult I : January or February, this may also represent the overwintering population.

„ II : Represented by the spring brood of May.

„ III : Represented by the summer brood of August.

The relatively higher numbers and prolonged period of occurrence of this species at station IV may confirm its inshore habitat.

The average temperature range recorded for the species is 16.1°C-27.2°C with an optimum at 20.8°C.

Acartia clausi:

The ecological position of this species is uncertain. In Egypt, it is recorded from both the Mediterranean and Red Sea, as well as from the Suez Canal (Fox, 1927; Rose, 1933, and Sewell, 1948).

El-Maghraby *et al.* (1963) found it also in the brackish water lake Menzalah. Farran (1910) reports it as oceanic, but of common occurrence in enclosed sea areas. Johnstone *et al.* (1942) also listed it as North Atlantic oceanic species.

In Delaware Bay, Deevey (1948) reported that this species "apparently does not reproduce at temprature exceeding 20.0°C". This seems also true from our area, since the species has its peak when the water temperature is around 18.5°C but disappears completely when the temperature exceeds 23.0°C. Its temperature range is from 15.6°C to 22.6°C.

In our area the species was frequent (but never common) in inshore waters where it occurred from December to April with a rather pronounced maximum (180 - 425/m^3) in February, and a second but smaller one in late March and early April. It is almost rare in offshore stations.

Developmental stages of the genus Acartia:

From the figure of abundance of the copepodites and nauplii of the three species of *Acartia* (Fig. 10) it may be concluded that:

1.— Two maxima of both copepodites and nauplii occur in the course of the year, viz.: a spring maximum and a summer one. These coincide in time with the maximum abundance of adult specimens of both *A. latisetosa* and *A. negligens*.

2.— A continuous production of copepodites and nauplii occurs at stations II and III throughout most of the year. On the other hand, both adults and developmental stages were completely absent at station I from August to October, 1961.

3.— Generally the summer production of developmental stages as well as adults was more successful in 1962 than in 1961.

In the inshore station (station IV), although both nauplii and copepodite stages occur all the year round, yet 6 peaks could be detected for each throughout the year. The times of occurrence of these peaks are shown in table (2).

TABLE 2.— PEAKS OF NAUPLII AND COPEPODITES OF *Acartia* SPP. AT STATION IV

Number of Peak	Time	
	Nauplii	Copepodites
1	March	April
2	May	Late may or early June
3	Late June	July
4	Late August and September	Late August and September
5	October	December
6	Late December	February

It is evident that the peaks of nauplii proceed those of copepodites by an interval of time approximately one month, however, this interval is extended during late autumn and winter. This is probably due to the approoch of the winter quiescent phase in the propagation of these species. The copepodite peaks could thus be regarded as reflections of those of nauplii after their metamorphosis.

Referring these peaks of nauplii and copepodites to their species, on the basis of relative abundance and occurrence of adult specimens, it appears that :

1.—The first and second peaks may belong to the mixed population of the three species (*A. clausi*, *A. latisetosa* and *A. negligens*) which occur together at this time interval (January to May or June).

2.—The third, fourth and fifth peaks belong mainly to the mixed population of *A. latisetosa* and *A. negligens.*

3.—The sixth minor peak apparent in late December may belong to adult specimens of *A. clausi* as it was the only *Acartia* species present in this month.

Temora stylifera Dana.

This is both neritic and oceanic species of common occurrence in both the Mediterranean and Red Seas. It enters the Suez Canal from both sources (Fox, 1927; Sewell, 1948).

The graph of abundance of this species (Fig. 8) shows clearly that :

1.—Two peaks of abundance were detected during only two seasons of the year, the first in May and June (late spring), and the second in October and November (autumn).

2.—The species is mostly established to the east (station I) during its occurrence in the area.

3.—The species also seems to have a very prolific autumn presence off Abu Qir Bay (the nearest to station I), since it was found to form the main diet in the stomach contents of Sardines caught from that region during the autumn.

4.—The occurrence of the species in the area in both years showed irregularities both in its periodicity and spacial distribution. This seems to be a general ecological character of the genus. Ostenfeld (1931) emphasized the same irregularities in *Temora longicornis*. O.F. Muller.

5.—The species does not favour inshore waters where it has been rarely recorded.

Other copepods :

The following copepodes are numerlically of secondary or minor importance, however, some of them were on certain occasions more or less frequent, these are :

Oncaea venusta philippi; *Oncaea mediterranea* Claus; *Oncaea conifera* Giesbrecht.

Oncaea venusta was rather rare in winter and summer but fairly numerous during spring and autumn months. During both seasons it was more represented at station III at which the maximum (700/m^3) was recorded in October 30th, 1961. The occurrence of *O. mediterranea* in the offshore area nearly followed that of *O. venusta*, save that the former was more numerous in winter, while in other seasons *O. venusta* was numerically superior to *O. mediterranea*. In the inshore area, station IV, both pecies were recorded in winter and autumn but always in small numbers except in October 1962 when they were frequent. *O. conifera* was rare and occurred mostly singly in the offshore stations during winter.

It is to be noted that the prolonged period of occurrence of *Oncaea* spp. and their presence in relatively high numbers at station III, may suggest that they are more frequent to the West of Alexandria region.

Corycaeus clausi F. Dahl; *Corycaeus speciosus* Dana.

Of the 8 species belonging to this genus, so far recorded in this investigation, the above mentioned two species are the more important. In both years (1961 & 1962) *Corycaeus clausi* was nearly present throughout the year having two peaks of abundance, the first in June with a maximum of about 200/m3 in station II. The second peak occurred in October with a maximum of 120/m^3 recorded also from the same station.

In 1962, both peaks occurred respectively in June and November also at station II. Otherwise, the species was either represented by a few individuals or else absent. The presence of *Corycaeus speciosus* in the area was of a short duration, but in most cases it was associated with *Corycaeus clausi*. In 1961, a maximum of 240/m^3 was recorded in June at station III, and another one of about 200/m^3 occurred in October at station II. In 1962, both maxima occurred in May and October respectively. The highest number counted for this year was 150/m^3 on October 11th, at station II. During summer months the species was almost absent. Both species passed the winter in small numbers. In the inshore water (station IV) *Corycaeus clausi* was frequent during June and October. The other species of the genus recorded in the area were met with occasionally at this latter station.

Corycella rostrata Claus; *Corycella carinata* Giesbrecht.

Except for the summer months, *Corycella rostrata* was present in nearly all plankton samples taken during the rest of the year in the offshore stations. Throghout its period of existence the species showed two peaks. The first occurred in May or June at stations I and II with a maximum of 350/m^3 at station II. At station III, however, the species was represented by a few individuals during the same period.

The second peak occurred in October or November at all stations with nearly equal numbers. During winter the species was represented by small numbers in all stations. On the other hand, *Corycella carinata* was recorded in winter, though never in any appreciable numbers. It was almost absent in other seasons.

The absence of this latter species in the Eastern Harbour station IV) suggests that it does not thrive well in inshore waters.

Corycella rostrata, on the other hand, was present at station IV as well as in offshore stations. A maximum of 500/m^3 was recorded at station IV on December 7th, 1961.

Calocalanus pavo Dana.

This pelagic copepod has two periods of occurrence in the area. The first persisted from late December to April or early May. During this period the species was more represented in station II. The time of maximum occurrence of the species during winter and spring is however not well defined, thus higher numbers were recorded on February 26th, at station I (104/m^3), on March 14th, at station II (160/m^3) and on April 8th, at station III (75/m^3). During winter also

the species was met with in the inshore samples but always in smaller numbers. The second period is in summer from July to October, being represented in the offshore stations in nearly the same density as in spring.

Centropages violaceus Claus.

This species was reproted by Rose (1929) as a Western Mediterranean form. In our area it was recorded in small numbers in the winter and summer of 1962. In the latter season it occurred from late July to early October especially at stations I and II, both in horizontal and vertical hauls, with a maximum of 80/m^3 on August 4th, at station II. In winter the species occurred only at station I, from January to March though in much smaller numbers.

Labidocera brunescens Czerniavsky.

Although this copepod has been reported as a Mediterranean species by Rose (1929) and Sewell (1948), yet its presence in the area was not significant. It escaped the record during 1961. In 1962, it was represented during July and early August by small numbers in horizontal hauls in station I alone. In lake Menzalah, however, it is reproted by El-Maghraby *et al.* (1963) as an important summer species (from June to October) attaining its maximum abundance in July. The species thus seems to be more numerous in sea areas to the east of Alexandria.

B.—Other Permanent Zooplanktonts

In this section a general survey of the occurrence and seasonal variations of the different animal groups in the zooplankton is to be considered.

1. – *Tintinnids* :*

The tintinnid population recorded in the area investigated are characterised by the diversity of the species recorded, and the comparative scarcity in the number of individuals of most of them. This seems to be a character of the Mediterranean tintinnids as a whole (Jorgensen, 1924).

In the area investigated 99 tintinnid species and varieties were identified from both the net catches and the water samples collected from various depths.

Although the number of tintinnid species recorded in the area is relatively large yet, the greater bulk of the tintinnid population is formed by a relatively small number of neritic perennial species. Of these the following are the most important : *Favella markusovszki* (Dad.) Jorg.,, *Favella franciscana* Kof . & Campb., *Favella azorica* (Cleve) Jorg., *Tintinnopsis beroidea* Entz., *Tintinnopsis campanula* (Ehr.) Dad., *Helicostomella subulata* (Ehr.) Jorg. *Codonellopsis morchella* (Claus) Jorg., and *Coxliella annulata* (Dad.) Brandt.

* A detailed account on the ecology and distribution of tintinnids in the area investigated is given in a separate paper.

2.– *Radiolaria :*

So far, only 15 species of Radiolaria were identified in our area, they are in order of abundance :

Sphaerozoum punctatum Muller; *Cyphonium ceratospyris* Haeckel ; *Spongodictyon trigonizon* Haeckel ; *Heliosphaera echinoides Haeckel; Acrosphaera spinosa* Haeckel; *Lethomelissa* sp. *Staurosphaera jacobi* Haeckel; *Theoconus zancleus* Haeckel; *Lithostrobus conulus* Haeckel; *Eucyrtidium cienkowskii* Haeckel; *Sethocapsa pyriformis* Haeckel; *Spirocyrtis holospira Haeckel*; *Stylochlamydium asteriscus* Haeckel; *Lamprodiscus laevis* Hertw. and *Sethoformis* sp.

The first of these species occurred in nearly all plankton samples taken during the whole period of investigation. It was mostly represented at station III, being rare during summer, but reached its maximum abundance in winter, when it was very common (sometimes abundant) in horizontal catches taken by both nets. *Cyphonium and Spongodictyon* were frequent in the winter catches of the coarse net, both were also more frequent at station III. The other mentioned species were recorded by few specimens in winter only. In the inshore station V alone, *Lethomelissa* sp. and *Sethoformis* sp. were recorded in single specimens during February. *Sphaerozoum punctatum* was also of frequent occurrence at this station during winter and spring. The rest of the species were not recorded in the inshore stations.

3.—*Foraminifera*

Globigerina bulloides (d'Orb.). This species was frequently recorded in the offshore stations during summer months, especially in the coarse net catches. Several unidentified species of the genus *Globigerina* were also occasionally met with from April to November, especially in vertical net samples.

4.—*Cystoflagellata*

Noctiluca scintillans (Mac.). The presence of *Noctiluca* in the area was almost confined to the flood season (late August to October or November). The following table shows the numbers/ m^3 recorded for this species during the period in question.

TABLE 3.—Number per cubic meter of *Noctiluca scintillans*

Month / Station	1961				1962			
	Late Aug.	Sept.	Oct.	Nov.	Late Aug.	Sept.	Oct.	Nov.
I	1302	8200	4150	866	80	4500	800	—
II	—	3196	1433	—	420	800	580	—
III	—	5942	688	—	200	596	220	—
IV	—	18600	12200	300	3400	9200	6500	200

As clear from the table the species established itself in the area from the beginning of the flood season; it reached its maximum during the climax of the flood and diminished considerably by the end of November. On the whole, the numbers recorded in 1961 were much higher than those of 1962.

At station IV *Noctiluca* was numerically more abundant in both years than in offshore stations. Moreover at this station, the species had a second generation during spring with a minor peak in April (maximum 3000 specimens / m^3 recorded in April 1961). Judging from the magnitudes of its peaks of abundance, the optimum temperature and salinity for the species in the area appear to be 27.0-C and 36.6 ‰ respectively.

5.—*The medusae*

The Medusae were better represented in the catches of the coarse net. In the area investigated a few specimens were recorded in winter; from April to November Medusae were frequent and two periods of maxima were recorded, i.e. from late May to June and from early October to November. During both Maxima, these organisms dominated all other zooplankton species in the net samples. Of the Medusae present in the area, few were only identified, they are in order of acundance as follows : *Liriope tetraphylla* (Chamisson & Eysenhardt) Russel. *Pandea conica* (Quoy and Gaimard) Lesson; *Pantachogon haeckeli* Mass; *Phialidium hemisphaericum* (Linne.); *Octorchis gegenbauri* (Haeckel); *Rhopalonema sp.* (probably *R. funerarium* vanhoffen); *Gossea corynetes* (*Gosse*); *Mitrocoma cirrata* Haeckel; *Aurilia aurita* (Linnè.); and *Obelia* spp.

With the exception of *Obelia* spp. and *Liriope tetraphylla*, all the above mentioned species were recorded only from the offshore stations. In the inshore stations medusae of *Obelia* spp. were rather frequent in nearly all seasons. Periods of abundance were recorded during January, April, July and August to October. The maximum (1500 specimens /m^3 and 1460/m^3 were recorded in October 1961 and August 1962 respectively.

At the offshore stations, *Liriope tetraphylla* was by far the most common medusae during summer and autumn. It is a world wide warm-water oceanic species, being confined mainly to the warm water of the oceans between the North and South isotherms of about 20°C (Russell, 1953, after Thiel, 1936). It is of common occurrence in the Mediterranean (Kramp, 1924); and in the Suez Canal (MacDonald, 1933). Kramp (1924) identified three species pelonging to the genus *Liriope* viz., *L. eurybia Haeckel*, *L. exigua* Quey + Gaimard and *L. mucronata* Gegenbaur, but Russell (1953) included all of them under *Liriope tetraphylla* (Chamisson & Eysenhardt) which he believes to be the only species of the genus.

In this investigation the species dominated all other zooplankton organisms on two occasions, viz.: June and in October–November; both maxima occurred at an average temperature of 22.8°C to 25.8°C.

Pandea conica occurs from March to June or July and from October to Novemper, but always in few numbers, Maximum in June. According to Russell (1953) this species is widely distributed and of common occurrence in the Mediterraenan Sea (cf. also Kramp, 1924).

Pantachogon haeckeli was recorded in few numbers in winter. Its presence in the area was significant, since it was reported as a deep sea oceanic species (Russell, 1953 and Kramp, 1924); hence it may be included among the indicator species of the offshore 'influx' of the winter months.

The medusae of *Aurilia aurita* was recorded in winter at station III only, where several specimens could be seen floating on the sea surface. A single specimen was caught by a bucket while sampling on January 16th 1962. It is a neritic medusae, widely distributed along all the Mediterranean coasts, and large specimens were recorded in the Adriatic from February to April (Kramp, 1924).

6.— *Siphonophores*

Siphonophores too, were rather frequent in the coarse net samples of the offshore neritic stations during most of the year. Of the Calycophores, the following species were inentified in our area :
Muggiaea Kochi (Will.); *Chelophyes appendiculata* Eschscholtz; *Eudoxide spiralis* Bigelow; *Lensia multicristata* Moser; and *Lensia subtilis* Chun.

Chelophyes appendiculata was the most common of the order, being present all the year round with its maximum in summer and autumn.

Muggiaea Kochi was frequent during autumn and winter, it was also recorded in the Suez Canal (MacDonld, 1933). *Lensia subtilis* and *Eudoxoides spiralis* were rather frequent during winter and spring months, while *Lensia multicristata* was rare in winter.

7.— *Rotifers*

Most individuals of this group shrink considerably and loose their identity when preserved in formalin, and this does not facilitate their specific identification. Of the rotifer population present in the area, it was possible to identify only the following species :

Synchaeta vorax Riusselet; *Synchaeta bacilifera* Smirnov; *Synchaeta* spp.; *Trichocereca marina marina* Daday; *Brachionus calyciflorus* Pallas; *Brachionus plicatilis* Müller; *Brachionus* spp.; *Keratella testudo* (Ehrenebrg); *Keratella quadrata quadrata* Müller; *Keratella cochlearis cochlearis* (Gosse); *Keratella cruciformis cruciformis* (Thompson); and *Keratella* spp.

On the whole, rotifers were common in the plankton catches of the inshore stations (IV and V), especially during summer and autumn months. During winter and spring, although there was a variety of species, yet the numbers of individuals with the exception of March 1962 and January 1963 were very small.

In the following table (table 4) are included the total numbers/m^3 of the rotifer population at station IV (Eastern Harbour) during their period of abundance.

In the offshore stations rotifers are generdlly rare except during the flood season when they are more or less frequent A maximm of 200/m^3 was recorded at station I in October and November and.at station III in December 1962.

TABLE 4.—Total numbers/m³ of Rotifers recorued from station IV from June to December 1962.

Year	June	July	Aug,	Sept.	Oct.	Nov.	Dec,
1961	—	120	320	1200	1300	9000	2500
1962	500	1000	1950	2600	1200	650	120

Of particular interest is the occurrence of species of *Keratella* and *Brachionus* in the inshore water at station V (Western Harbour). Most of the species belonging to these genera are either fresh or brackish water (Berzin, 1960). They were more common during February and March at this station and some of them were recorded in summer. The origin of these species at station V is probably due to fresh or brackish water discharged in the vicinity of the area by the Mahmoudiya Canal and Mex Pumps. The two genera were also recorded from the brackish Delta Lakes (Hawary, 1960 – Maghraby *et al*, 1963). *Synchaeta* and *Trichocerca* species were of frequent occurrence in the whole area, particularly at station IV during the autumn and spring months.

8.—*Chaetognatha*

The identification of all *Sagitta* species encountered during this investigation was not possible, owing to the fact that the majority of the individuals present were juveniles; as a result reference is made only to the genus.

The genus *Sagitta* was recorded in nearly all samples taken during 1961 with two peaks of abundance, the first in June (Maximum 1875/m³ at station IV), the second in October (maximum 1500/m³ at station I). On the other hand, the genus was absent during 1962 from January to July with the exception of few specimens occasionally present during April and June, but from only August to November it was established in the area with fairly large numbers. The Maximum in this year occurred in October (2050/m³ at station III). Of the sagitta present, the following four species were only identified:
Sagitta bipunctata Quoy and Gaim.; *Sagitta serratodentata* Krohn; *Sagitta hexaptera* d'Orbigny; and *Sagitta enflata* Grassi.

The first two species occurred together from April to June 1961. In 1962 they were numerous during only October and November; both species probably form the greater part of the two peaks recorded for the genus in the area. *Sagitta* hexapter.. was frequent from June to october, while *Sagitta serratodentata* was rarely caught.

9.—*Cladocera :*

Species recorded :

Evadne nordmanni Loven; *Evadne spinifera* P.E. Muller ; *Evadne tergestina* Claus; *Penilia avirostris* Dana and *Podon Polyphemoides* Leuckart.

Of the genus *Evadne*, *E. nordmanni* was the most common; it occurred irregularly in the area from late March to October or November. In 1961, the maximum (423/m^3) was recorded in August, while in 1962 it occurred later in October (300/m^3); both annual maxima were recorded at station I. *E. spinifera* and *E. tergestina* are warm water forms, and according to Baker (1938) the latter species is more or less limited to equatorial regions. In the area investigated the presence of this species was confined to the summer months, and always represented by small numbers. On the other hand, *E. spinifera* was rather frequent from April to October. It also reached its maximum in summer. However, its presence in the area was very irregular. In 1961 this species was more frequent at station III with two Maxima, the first (273/m^3) occurred in July and the second (178/m^3) in early October. In 1962, on the other hand, this species was much less frequent in the whole area and displayed only one maximum (153/m^3) on July 17th at station 1.

Podon polyphemoides was present in most of the plankton catches taken from late spring to early autumn, especially in 1962. It reached its peak in August, the maximum (725/m^3) was recorded at station III in late August 1962. At the other stations the numbers of individuals were much smaller. It is to be mentioned that during its period of existence, the species was better represented at station III. In the Suez Canal this species was recorded by MacDonald (1933) but without reference to a date.

Penilia avirostris was represented by a few specimens (only 4/m^3) on April 2nd 1962, at station II.

At the inshore stations, *Podon polyphemoides* and *Evadne nordmanni* were only recorded. The former was rather frequent during April, May and August, while the latter was recorded in August and early September.

10.—*Ostracoda*

Three species belonging to the genus *Conchochea* were identified in the area investigated, each was represented by a few individuals only, viz.:

Conchoecia elegans Sars; *Conchoecia obtusata* Sars; and *Conchoecia haddoni* Brady and Normann.

11.—*Tunicates*

Pelagic tunicates occurred in the area almost all the year round. However, most of the specimens obtained were juveniles and since these animals shrink and crumble by preservation in formalion and sometimes torn by agitation while handling the samples, therefore only a few species could be identified. All of them belong to the class *Copelata.*

Family Oikopleuridae ;

Oikopleura longicauda Vogt; *Oikopleura dioica* Fol;. *Oikopleura albicans* Leuckart; *Oikopleura cophocerca* Gegenbaur; *Stegosoma magnum* Langerhans; *Pegalopleura haranti* Vernieres.

Family Fritillaridae :

Fritillaria formica Fol.; *Fritillaria pellucida* Busch.; *Fritillaria aequatorialis* Lohm.; *Fritillaria fraudax* Lob .; and *Appendicularia sicula* Fol.

Oikopleura longicauda and *Oikopleura dioica* were the most important of the tunicate population, especially in the offshore stations. Both species occurred together from April to November, with two maxima: the first in May or June and the second in September October. During the winter months *O. longicauda* was sometimes present in considerable numbers. In Algeria (Bernard, M. 1958), this species exhibited three periods of abundance i.e. winter (February), spring, (May-June) and autumn (October-Novemper); while *O. dioica* was common only in spring and autumn. This is nearly the condition in our waters. *O. diocia* is a cospolitan species though more abundant in rather colder waters (Thompson, 1948, P. 39), its temperature range from 3.2°C to 29.5°C and salinity 11.4‰ to 36.7‰

O. albicans was frequent in June. *Stegosoma magnum* together with *Pegalopleura haranti* were more frequent to the west (station III). From April to June, especially in 1962, *O. cophocerca* was more common in the Eastern Harbour, particularly in June. Members of the genus *Fritillaria* were frequent in the offshore stations in May, June and October as well as in January - February, especially in station II. They were more represented in the samples taken by the coarse net. *F. formica* was the most frequent of the genus. *Appendicularia sicula* was common in summer (June-July), especially at station III and station V. *Fritillaria aequatorialis* occurred with few numbers during early summer. This species was first recorded from the Mediterranean by Bernard, M. (1958) in the Bay of Algeria.

From the foregoing review, it is clear that most of the appendicularian species recorded in the area occur during the warm seasons of the year. The seasonal variation of all tunicates, based on their total numbers in the fine net samples, show that there are two peaks of abundance of tunicates in the course of the year. The first is in late spring to early summer and the second from late summer to early autumn.

It is interesting to note that the large numpers of these tunicates occurred at the inshore station IV where the absolute maxima of 7500 and 49300 specimens were recorded in June 1961 and late may 1962, at temperature of 25.5°C and 22.5°C respectively.

In the offshore stations the maxima occurred at an average temperature of 23.8°C and 25.4-C in June 1961 and in October 1962 respectively. On the other hand, several other outbursts were detected during Januray -Februray, especially in the catches of the coarse net. These occurred at an average temperature of 16.6°C to 18.2°C. At San Diego, Eseenberg (1922) found that the maximum

production of *Appendicularians* occurred at about 14.5°C and that the numbers diminished considerably at a temperature of 18.0°C. In the Bay of Algeria, (Bernard, M. (1958 found that the maximum occurred at a much higher temperature (20.0-C -26.0-C); she also reported that when the water temperature was below 13.0°C ; the *Appendicularians* were generally absent. In both localities (as. in our area) the dominant species are *O. longicauda* and *O. dioica* the tempeature recorded during maximum occurrence of *Appendicularians* in our waters agree well with the findings of Bernard (1958).

C. The Temporary Zooplankton

The plankton of the area investigated particularly of the inshore stations was at times rich in the larvae of a variety of benthic invertebrates. The specific identification of most of these larvae was not possible because of lack of the necessary literature. Moreover, to reveal the identity of these larvae through rearing them until metamorphosing to the adult stage is beyond the scope of this work. Consequently, most of the larvae encountered in the samples are only referred to their types.

It is however essential to give few remarks on the abundance and periodicity of these larval types in order of their importance.

The nauplii of cirripede have a permanent presence in the plankton of the area with numerous occurrence in winter and late summer. Their production in the inshore stations was more pronounced with avery marked winter maximum in which 48,000 individuals were recorded. These nauplii mostly belong to *Balanus amphetrite*, Darwin and *Balanus perforatas*, (Brugiuere), the two dominating cirripedes in the area (Broch, 1935). The occurrence of the Cypris larvae of these cirripede follow that of nauplii but their numbers are much fewer.

The veliger larvae of lamellibranchs and gastropods both had a long duration in the plankton; they were more numerous in the inshore station attaining maximum in late spring when respectively 22, 500 and 34,500/m^3 were recorded. The maxima of the veligers in the offshore stations were less pronounced and have not coincided with those of inshore stations for they were recorded in early autumn.

The presence of spionid larvae of polychaetes was also very pronounced in the inshore stations. They have a continuous production in the course of the year with three peaks occurring successively in spring, summer and autumn. The maximum of 12,000/m^3 was recorded in November. Several of these spionid belong to the genus *Polydora*. The presence of these larvae in the offshore stations is sporadic and less significant.

Both the echinopluteus and ophiopluteus larvae were fairly frequent in the area. A maximum of 1600/m^3 was recorded in autumn. Among those identified are the echinopluteus of *Paracentrotus lividus* Lamark *Echinocardium cordatum* Pennant, *Echinocyamus pusillus* Muller and the ophioplutii of *Ophiopsila aranca* Forbes *Ophiothrix fragilis* Abild. and *Ophiomyxa pentagona* Mull. and Trochel.

Stages of different types of crab zaea and mysis of shrimps are encountered during most of the year particularly in the inshore stations. The maximum occurred in June when 1450/m^3 were recorded. The zoea of *Neptunus pelagicus* (L.), *Cancer pagurus* Leach, *Macropodia longirostris* (Fabr.), *Porcellana longicornis* (Pannant) and *Porcellana platycheles* Penant were identified.

Fish eggs and larvae were represented throughout the year. The most common of these were those of *Engraules encrasicolus*, Linne. which had rather a long duration from April to December.

DISCUSSION

In the area investigated the copepods are by far the most important elements in the community, constituting an average of about 70% of the total population.

A glance at the list of copepods recorded in the area (Table 5) shows clearly that nearly all of them belong to the Mediterranean-Atlantic fauna, (quoting the work of Sewell, (1948) on their origin). Some of them are reported to belong to the bathypelagic fauna (below 200 meter depth); these are:

Calanus tenuicornis	*Euchirella rostrata*
Calanus robustior	*Euchaeta hebes*
Eucalanus attenuatus	*Euchaeta spinosa*
Eucalanus elongatus	*Phaenna spinifera*
Pseudocalanus elongatus	*Pleuromamma abdominalis*
Aetideus armatus	*Pleuromamma gracilis*
Euactideus giesbrechti	*Lucicutia simulans*
Undinopsis bradyi	*Heterorhobodus papilliger*
Chiridius poppei	*Haloptilus longicornis*

All of them are recorded in small numbers and their presence, besides other true oceanic forms (among tintinnids, Siphonophorus, etc...) in the area investigated was associated with offshore influxes, particularly during the winter, under the influence of strong westerly winds. Among the winter occurring copepods, few species were not recorded by Rose (1933) and Sewell (1948) in the Mediterranean Sea, as *Megacalanus longicornis, Gaidius tenuispinus* and *Euchirella maxima.* According to Rose and Sewell (l.c.) they belong to the North Atlantic bathypelagic fauna.

On the basis of the exchange of water between the Mediterranean Sea and the Atlantic Ocean through the Straits of Gibraltar, Sewell (l.c.) states that the surface living plankton can easily be carried from the Atlantic into the Mediterranean, but deep dwelling forms of the Atlantic Ocean cannot be swept into the Mediterranean unless either the adults, or more likely, their larval stages inhabit

the upper layers or at least can survive in it for a sufficient length of time to be transported by the surface current. Sewell (l.c.) reviewing the work on the exchange of fauna between the Mediterranean and the Atlantic Ocean through the Straits of Gibraltar concludes that "..... it would seem clear, therefore, that there is nothing inherently impossible or even improbable in the suggestion that the great majority of the deep dwelling species in the Mediterranean Sea have been carried in from the Atlantic Ocean and that this process may be going on at the present time".

Several other copepod species recorded in the area are reported to belong to the Atlantic epipelagic fauna. Rose (1929) stated that their presence is mostly confined to the western Mediterranean basin. These such as:

Isias clavipes	*Pseudocalanus elongatus*
Centropages violaceus	*Anomalocera patersoni*
Pontella lo biancoi	*Parapontella brevicornis*
Acartia danae	

However, some of these species, such as *Isias clavipes* and probably also *Centropages violaceus*, have established themselves in the eastern Mediterranean region, they are found at Alexandria in considerable quantities at certain seasons.

As regards the transport of planktonic copepods from the Red Sea into the Mediterranean, through the Suez Canal, the available data in the literature are not adequate enough for any conclusion on this matter; since several copepods recorded in our area have wide areas of distribution including the Mediterranean, the Atlantic Ocean and the Red Sea. According to Sewell (1948) most of the Indo-Pacific (to which the Red Sea belongs) and Atlantic species recorded in the Mediterranean Sea could have been swept into the latter sea by the inflowing Atlantic current through the Straits of Gibraltar. On the other hand, Fox (1927) considers that Temora stylifera, *Acartia clausi* and *Acartia latisetosa* have entered the Suez Canal from the Mediterranean Sea, while other species such as *Oithona nana*, *Paracalanus parvus* and *Euterpina acutifrons* have entered the Suez Canal from both ends. Nevertheless, Gurney (1927) is of the opinion that the occurrence of *Canthocalanus pauper* Giesbr. and *Temora discaudata* Giesbr. at Port Said seem to afford evidence of a northward migration through the Suez Canal. The latter two species are, however, not recorded in our area.

Sewell (1940, 1948) reviewing this subject, states that, "contrary to the case with the "weed-haunting" harpacticoid copepods of which about 15 Red Sea species have shown successful migration to the Mediterranean, there seems to be very little evidence of any large transference of plankton species from the Red Sed into the Mediterranean Sea through the Suez Canal, under present conditions, even where such a transport may have been accomplished, it might be masked by the presence, in the Mediterranean sea, of other individuals of the same species that have been swept in from the Atlantic Ocean through the Straits of Gibraltar".

Apart from the offshore winter occurring species, the copepod community in the area consists of the usual small species, which characterise the neritic environment. These species seem to be indigenous to the area. The number of these copepod species dominating the population in the area is, however, limited. The species recorded may either be almost permanently present, (either as adults or developmental stages) or exist only during a part of the year. It is possible to divide the more common copepods in the area into three groups :

1.—Permanent (throughout the year), e.g. *Paracalanus parvus, Oithona nana, Euterpina acutifrons* and *Clausocalanus arcuicornis.*

2.—Present during most of the year, e.g., *Centropages kroyeri, Acartia negligens* and *Acartia latisetosa.*

3.—Temporary, i.e. with a brief period of existence, e.g., *Isias clavipes, Acartia clausi, Temora stylifera, Oncaea* spp., *Corycaens* spp., and *Corycella* spp.

Inspite of the overlapping of some of the major peaks of the more common copepods in the area, a marked seasonal succession in the occurrence of their maxima could be detected as shown in Figure (11).

The density of each of these species in the area fluctuates not only from one month to another, but also from year to year. Thus, each species showed several peaks of abundance in the course of the year as shown in their graphs (Figs. 3-10). These peaks are mostly related to the succession of generations in their population.

On the whole, the "indigenous" speeies of copepods recorded in the area such au *Eutermina acutifrons, Oithona nana, Paracalanus parvus* and *Acartia latisetosa* have a clear tendency to an inshore preference, as demonstrated by the large numbers found in such stations. On the other hand, some other species showed obvious offshore preference, these such as *Isias clavipes, Temora stylifera, Oithona plumifera, Acartia negligens* and *Calocalanus pavo.* Moreover, some of these species exhibited marked spacial distribution in the area during their period of occurrence. For example, *Isias clavipes* is mostly represented at station III during its winter and spring propagation, on the other hand, its summer brood is mostly confined to the east (station I). Its western occurrence could, however, be accounted for as due to the west-east current running along the south coast of the Mediterranean, which is greatly aided by the winter prevailing westerly winds.

The summer population of *Isias clavipes* at station I could be regarded as representing a residue of the spring population that was able to propagate in this area probably for favourable conditions.

Several other copepod species are also mostly represented at station I, of these *Centropages violaceous, Acartia negligens* and *Labidocera brunescens* are worth mentioning; the latter is also reported as an important summer species in Lake Menzalah, (El-Maghraby *et al.* 1963).

As regards the factors affecting the distribution of the copepod species in the area, it is well known that a species range may de determined seasonally or geographically by one or more of a number of limiting factors such as competition with other species, abundance of suitable food, temperature, salinity, or other hydrographic factors. It is preferable thus to seek the factors affecting the distribution of the zooplankton in the area.

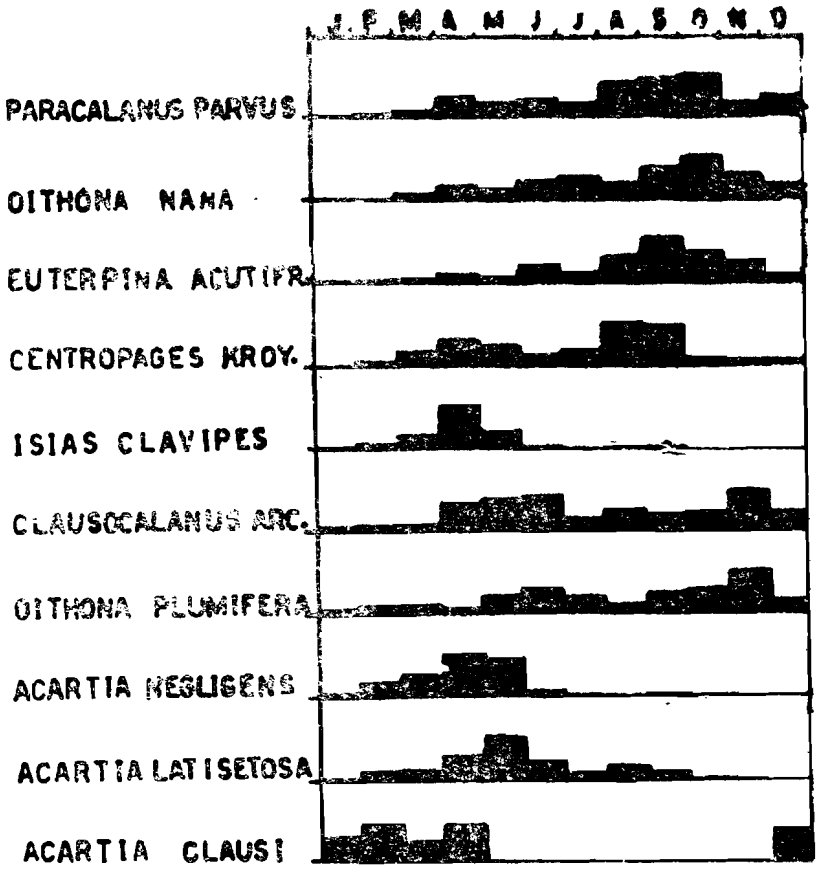

FIG. 11.—Succession of abundance of the important copepods in the area in the course of the year; based on their occurrence in vertical hauls of the fine net during the period of investigation.

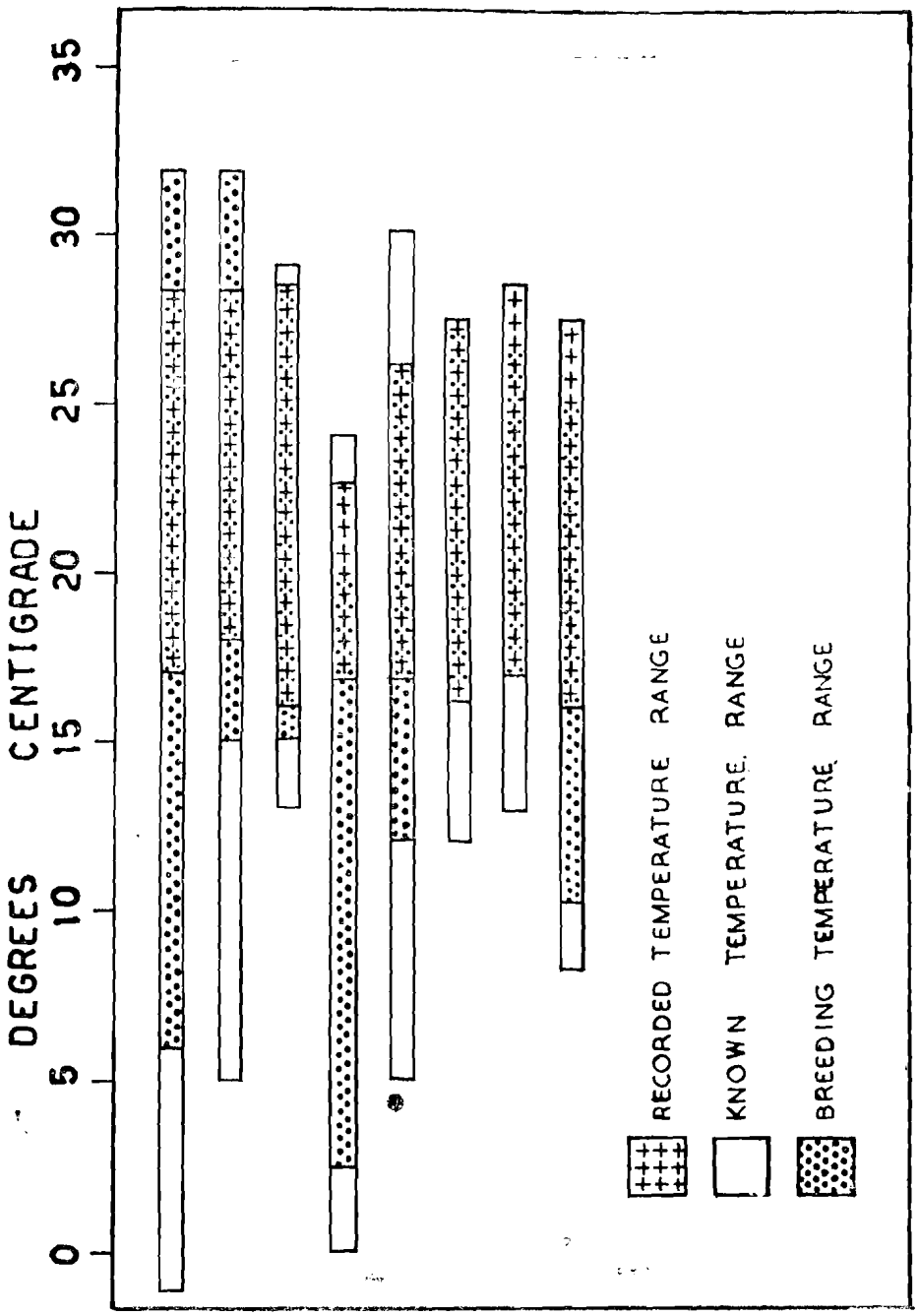

FIG. 12.—The temperature range recorded for the important copepods in the area and their known temperature and breeding ranges in other sea areas from above to below.

Paracalanus parvus, Euterpina acutifrons, Oithona nana, Acartia clausi, Acartia negligens, Acartia latisetosa, Cantropages kroyeri, Isias clavipes.

In marine habitats, it is geenrally recognised that the water temperature is one of the chief factors in regulating the distribution of copeopods, as well as most of the other organisms inhabiting the upper layers (Orton, 1920; Ekman, 1935; Sverdrup *et al.* 1942; Sewell, 1948 and Deevey, 1960). For each species there is a temperature range within which it is able to live, but there is a much smaller temperature range within which it can reproduce and still a smalller one "optimum" within which the species is at its maximum. The extreme as well as the breeding temperature range for some of the important copepod species recorded in the area are shown in Figure (12). The extreme temperature ranges recorded for some of them in other sea areas is also shown for comparison. For this purpose reference is made to several authors, e.g. Sewell 1948; Deevey 1948, 1960; Grice 1956, Conover 1956; Woodmansee 1958; etc.

It is obvious that the lower limit of the breeding temperature for the more important copepods recorded in our area is about 17°C. Few species such as *Acartia clausi* and *Isias clavipes* are probably able to breed at temperature slightly below 15.6°C which is the minimum water temberature recorded in our area. Both species are, however, not able to build a large winter population. The low winter temperature may apparently (at least partly) account for the winter minimum of the copepod population in the area.

The endemic copepod species which form the greater bulk of the zooplankton community in the area, may thus be classified as warm-water species; these such as : *Paracalanus parvus, Euterpina acutifrons, Oithona nana, Oithona plumifera, Acartia negligens, Clausocalanus arcuicornis, Centropages kroyeri* and *Calocalanus pavo.* This catigory agrees also with Marumo *et al.* (1960). These species are aslo common in the western Mediterranean basin and some, e.g. *Paracalanus parvus* and *Euterpina acutifrons* are common at times in northern temperate regions as in the English Channel (Ostenfeld, 1931) and even in the North Sea (Rea and Fraser, 1940; Rae and Rees, 1947). The maximum temperature tolerated by these species in northern regions is very near to (or even lower than) that recorded during the winter in Alexandria region. The scarcity of these species in winter in the area investigated, could be explained not only on the basis of temperature tolerance, but more likely also due to the existence in different sea regions of different "races or even forms" within each species which have different temperature requirements.

A common observation in the northern hemisphere is that at the northern limits of its range, a species appears during summer and autumn, and at its southern limits it occurs from winter to spring, whereconditions are optimal the year round it should occur throughout the year. As a species approaches the outer limits of its temperature range the length of its annual occurrence decreases to about half year or less (Deevey, 1960). Thus, *Isias clavipes* and *Acartia clausi* occur in several localities of the north temperate seas in summer and autumn, but their occurrence in the Mediterranean is restricted to winter and spring (Rose, 1927). In the area investigated, *Isias clavipes*, however, may occur in comparatively large numbers during the summer months.

TABLE 5.—SEASONAL ABUNDANCE OF THE COPEPOD SPECIES RECORDED IN THE AREA.

Abbreviations :

S = single specimens; + = rare ++ = frequent; +++ = common to abundant, A = important species.

p = pelagic; B = bathypelagic; ty = tychopelagic; o = oceanic

n = neritic; T = tropical S = sbutropical t = temperate;

w= warm water; c = cold water Co = cosmpopalitan.

x = species new to the Mediterranean region.

Species	Ecological Characters	Seasonal Frequency			
		Winter	Spring	Summer	Autumn
Acartia adriatica Steuer	P.o.t	+			
(A) *A. clausi* Giesb	P.n.t	++	++		
A. danae Giesb	P.o.t	+			
(A) *A. latisetosa* Kricz Dana	p.n.w	+	++	++	
(A) *A. negligens* Dana	p.n.o.w	S	++	++	+
Aetideus armatus Boeck	B.w.	S			
Amallothrix sp. (probably *A. optusiformis* Sars)	p.o	S			
Anomalocera patersoni Templ . .	p.o.n.w	S	+		S
Calanus gracilis Dana	p.o.w	+			
C. minor Claus	p.o.w	+	++		+
C. ropustior Giesb	B.w.	+			
C. tenuicornis Dana	B.t.w	+			
(A) *Calocalanus pavo* Dana	p.o.w	++	+	+	
Candacia bispinosa Claus	p.o.w	+			
C. simplex Giesb	p.o.w	+			
(A) *Canuella perplexa* Scott	ty.h.t	+	++	+	++
(A) *Centropages kroyeri* Giesp	p.n.t	+	+++	++	++
(A) *C. violaceus* Claus	p.o	+	+	++	+
Chiridius poppei Giesb	B.S	+			
(A) *Clausocalanus arcuicornis* Dana . .	p.o.n Co	+	+++	++	++
C. furcatus Brady	p.o.n.t	++			
Copilia mediterranean Claus . . .	p.n.T	+			
C. vitrea Haeckel	p.o.T	+	+		

TABLE (5) *continued*

Species	Ecological Characters	Seasonal Frequeney			
		Winter	Spring	Summer	Autumn
(A) *Corycaeus clausi* F. Dahl	p.n.w		+	++	++
C. flaccus Giesb	p.o.w	+	+		
C. furcifer Claus	p.o.s	+	+		
C. giesbrechti F. Dahl	p.o.w	+	+		+
C. latus Dana	p.o.w	+	+		
C. limbatus Brady	p.o.w	+	+		
(A) *C. speciosus* Dana	p.n.w	+	++	+	
C. typicus Kroyer	p.n.w	+	+		+
Corycella carinata Giesb	p.o.T	+			
(A) *C. rostrata* Claus	p.n.T	+	++	+	++
Cymbasoma longispinosum Bourne	p.n.w.	+			
C. reticulatum Giesb	p.n.w	+			
Euaetideus Giesbrechti Cleve	B.T.s	+			
Eucalanus attenuatus Dana	B.w	+			
E. elongatus Dana	B.t	+			
Euchaeta hebes	B.w.s	+	+		
Euchaeta marina Presl	p.o.w	+	+		
E. spinosa Giesb	B.s.w	+			
x *Euchirella maxima* Wolfenden	B.s.w	+			
E. rostrata Claus	B.s.w.	+			
(A) *Euterpina acutifrons* Dana	p.n.t.w	+	+++	+++	+++
x *Gaidius tenuispinus* Sars	B.w	+			
Haloptilus longicornis Claus	B.t.w	+	+		
Heterorhabdus papilliger Claus	B.t.w	+	+		
(A) *Isias clavipes* Boeck	p.n.o	+	++	++	++
Labidocera wallastoni Lubbock	p.o.n	+	+		
L. brunescens Czern	p.n			+	
Lubbockia squillimana Claus	p.o.t	+			
Lucicutia flavicornis Claus	p.o.w	++			
L. simulans Sars	B.t.w	+			
Macrosetella gracilis Dana	p.n.T.s	++	+		
(A) *Mecynocera clausi* Thomps	p.o.n.w	++	++		+
x *Megacalanus longicornis* Sars	B.t.w	+			
Microsetella norvegica Boeck	p.Co.	++	+		+
M. rosea Dana	p.t.w	++	+		
Oncaea conifera Giesb	p.o.t.s	+			

TABLE (5) *continued*

Species	Ecological Characters	Seasonal Frequency			
		Winter	Spring	Summer	Autumn
(A) *O. mediterranea* Claus	p.n.o.T.w	++	++		
(A) *O. venusta* Claus	p.n.o.t.w	++	++		+
Oithona linearis Giesb	p.n.w	+	++		+
(A) *O. nana* Giesb	p.n.w.t	++	+++	+++	+++
O. plumifera Baird	p.o.t.w	++	++	+	++
(A) *Paracalanus aculeatus* Giesb	p.n.s.w				++
P. nanus Sars	p.n.t.w	+	+		
(A) *P. parvus* Claus	p.n.o.C	++	+++	+++	+++
P. pygmaeus Claus	p.n.t.w	+	++		++
Parapantella brevicornis Lubbock	p.o.n.t		+	+	
Phaenna spinifera Claus	B.t.w	S			
Pleuromamma abdominalis Lubbock	B.t.w	++	+		
P. gracilis Claus	B.t.w	S	+		
Pontella lo biancoi Canu	p.o.t	+	+		+
Pseudocalanus elongatus Boeck	B.t	+			
Sappherina angusta Dana	p.o.s.w	+			
S. intestinata Giesb	p.o.T.s	+	+		
S. iris Dana	p.o.T.s	+			
S. maculosa Giesb	p.o.T.s.w	+			
S. nigromaculata Claus	p.o.n.w	+		+	
Sappherina ovatolanceolata Dana	p.o.T.s	+			
Scolecithrix Danae Lubbock	p.o.w	++	+		
(A) *Temora stylifera* Dana	p.n.o.t.w		++		++
Thalestris sp.	Benthic	S		S	
Undinopsis bradyi Sars	B.t.w	+			

SUMMARY

The neritic zooplankton of the south eastern Mediterranean at Alexandria has been described from vertical and horizontal plankton hauls, sampled in the area for two successive years (April, 1961-March, 1963). The seasonal variations of the important species particularly the copepods has been outlined in relation to some hydrographic factors.

Of the Copepods altogether 84 species has been identified, most of them belong to the neritic temperate and warm water fauna; the greater bulk of the population was dominated by few species of small copepods such as *Paracalanus parvus*,

Euterpina acutifrons, Oithona nana, O. plumifera, Centropages kroyeri, Isias clavipes, Clausocalanus arcuicornis and *Acartia* spp. The seasonal variations of these species have been traced from both offshore and inshore stations. Most of them (all stages included) have at least two annual maxima, their seasonal periodicity is more or less regular and the temperature seems to be the determining factor in this regard. The autumnal phytoplankton bloom occuring at a relatively high temperature favoured the development of a numerous population of several of the small copepod species in the area. The succession and the number of generations of the dominant copepods was traced from the occurrence of their peaks. The temperature range and optimum range of these species are also given. Several oceanic offshore as well as deep water copepods have been recorded in the area particularly from the offshore stations. These are temporary visitors occurring in winter and are regarded as indicators of offshore water influxes.

The distribution and seasonal variations of the other permanent zooplankters in the area are also briefly considered. Of the tintinnids 99 species belonging to 27 genera were identified, most of them are new records to the area.

Appendiculates were more numerous from April to November with *Oikopleura dioica* and *O. longicauda* the most important.

The medusae were common in the coarse net catches during May-June and from October to November, *Liriope tetraphylla* and obelia spp. were the more common.

The occurrence of the different planktonic larval stages in the area is birefly outlined. These were more numerous in the inshore stations particularly at station IV where benthic animals are abundant.

REFERENCES

BARKER, H.A. 1935.—The culture and physiolagy of marine dinoflgellates. Archiv. Microbiol., Bd. 6, 157-181.

BERNARD, M, 1958.—Systematique et distribution saisonniere des tuniciers pelagiques d'Alger. Rapp. et Proc.-Verb., 14 (N.S.), 211-231.

BERZINS, B. (1960).—Rotatoria. Cons. Inter. pour l'Expl. de la Mer. Zooplankton sheet (84-87)

BIGELOW, H.B., 1926.—Plankton of the offshore waters of the Gulf of Marine. Bull. U.S. Bur. Fish., 40, 11, 1-507.

BRANDT, K., (1906-7).—Die Tintinnodeen der plankton Expedition. Ergebnisse d. plankton-Exped. d. Humboldt-Stiftung, Bd. III L a.

BROCH, H., (1935).—The Fishery Grounds near Alexandria. Crirripedes. Fisheries Rese ach Directorate. Notes and Memoires No. 10, Cairo, Egypt.

CONOVER, R.J., 1956.—Oceanography of Long Island Sound, 1952 1954. VI. Biology of *Acartia clausi* and *Acartia tonsa*. Bull. Bingham Oceanogr. Coll. 15, 156-233.

CONOVER, R.J., (1960).—The feedng, behaviour and respiration of some marine planktonic crustacea. Biol. Bull. Woods Hole, 119, 399–415.

CONOVER, S.A.M., (1956).—Oceanography of Long Island Sound, 1952–1954. IV. Phytoplankton. Ibid, 15, 62–112.

DEEVEY, G.B., 1948.—The zooplankton of Tisbury Great Pond. Bull. Bingham Oceanogr. Coll, 12, 1–44.

DEEVEY, G.B., 1956.—Oceanography of long island sound, 1952–1954. V. Zooplankton. Iibd, 15 113–155.

DEEVEY, G.B., 1960.—Plankton studies. Ibid, 17 (2).

DIGBY, S.B., 1950. —The biology of the small planktonic copepods of Plymouth, J. mar. biol. Ass., U.K., 29, 393–438.

EKMAN, S., 1935.—Zoogeography of the Sea. Sidgwick and Jackson Ltd. London, 417 pp.

EL-MAGHRABY, A.M., WAHBY, S.D. AND SHAHEEN, A.H., 1963.—The ecology of zooplankton in lake Menzalah. Alex. Inst. Hydrob. Notes and Mem. No. 70, Egypt.

EL-MAGHRABY, A.M., 1964.—The developmental stages and occurrence of the copepod *Euterpina acutifrons* Dana, in the marine environment of Alexandria, U.A.R. Ann. & Mag. Nat. History Ser. 17, 7, 223–233.

EL-MAGHRABY, A.M. , 1965.—The seasonal variations in length of some marine planktonic copepods from the eastern Mediterranean at Alexandria. Crustaceana, 8 1, 37-47.

EL-SABY, M.K., 1937.—A chemical study of the Egyptian Sardinella. Notes and Memoires No. 29, Alex. Inst. Hyudrob., Cairo, Egypt.

ESSEMBERG, A., 1936.—Seasonal distribution of the Appendicularians in the region of San Diego (California) ; Ecology, V. 3, 55, 64.

FARRAN, G.P., 1910–11.—Copepoda. Bull. Trim. Cons. Int. Expl. Mer., I & II, 60–105.

FARRAN, G.P., 1926.—Biscayan plankton collected during a cruise of H.M.S. "Research" 1900, Part XIV. The Copepoda. J. Linn. Soc. London, Zool. Vol. 36.

FARRAN, G.P., 1949.—The sasonal and vertical distribution of Copepoda. Great Barrier Reef Expedition, Sci. Reports. B.M. (N.H.) 2, 291-312.

FOX, H.M. 1926.—General part. Zool. Res. Cambridge Exped. Trans. Zool. 50, London.

FRASER, J.H., 1947.—Fishes d'Identification du Zooplankton, Nos. 9 and 10. Thaliacea I and II Cons. Int. Expl. Mer. Copenhagen.

GIESBRECHT, W., 1892.—Systemtik und faunistik der pelagischen copepoden des Golfes von Neapel (Fauna und Flora des Golfes von Neapel, 19).

GIESBREDHT, W., 1896.—Uber pelagische copepoden des Rothen Meeres. Zool. Jahrsb. Bd IX.

GRAN, M.H., 1931.—On the conditions for the reproduction of plankton in the sea. Rapp. Proc. Verb. Inst. Cons. Expl. Mer., 75, 37–46.

GRUVEL, A., 1931.—Les Etats de Syrie. in Bibl, Faube Colon. Françaises, Paris.

GURNEY, R., 1927.—Cambridge Expedition to the Suez Canal, 1924. Copepoda and Cladocera of the Plankton. Trans. Zool. Sgc. Soc. Lon.

JESPERSEN, P., 1924.—On the quantity of macroplankton in the Mediterranean and Atlantic. Int. Rev. ges. Hydrobiol.Hydrogr. 12, 102–115.

JOHNSTON, R., 1955.—Biologically active compounds in the sea. J. mar. biol. Ass. U.K., 34 385–195.

JORGENSEN, E.G., 1924.—Mediterranean Tintinndae. Rep. Danish Oceanogr. Exped. Medit., 2 J. 3.

KOFOID, C.A. AND CAMPBELL, A., 1929.—A conspectus of the marine and fresh water ciliata belonging to the suborder Tritinnoinea, with descriptions of new species particularly from the Agassiz Expedition to the easterern tropical Pacific. Univ. Calif. Publ. Zool. Vol. 34, p. 1–403.

MACDONALD, R., 1933.—An examination of plankton hauls made in the Suez Canal during 1928. Fish. Res. Direct. Coastguard & Fish. Res. Egypt, Notes and Memoires No. 3.

MARGALEFF, R., 1955.—Variaciones interanuales en el fitoplankton des Castellon. II. Reunbion Sobre productivedad y pesquerias, 48–51.

MARUMO, R.; KITOU, M. AND ASOOKAS, 1960.—Plankton in the Northwestern Pacific Ocean in summer of 1958. The Oceanogr. Magazine Vol. 12. No. 1 Japan Meteor. Agency.

MASSUTI, M. AND MARGALEFF, R., 1950.—Introductin al estudio del plancton Marino. Patronato Juan de la cierna de investigacion Technica. Dec. de Bisgl. Mar. Barcelone.

MORTENSEN, TH. AND STEUER, A., 1937.—The Fishery Grounds near Alexandria XIII. Echinoderma. In Notes and Memoires Nr. 21, cairo.

ORTON, J.H., 1920.—Sea temperature, breeding and distribution in marine animals. J. biol. Ass., 12: 339-366.

OSTENFELD, C.V., 1931.—Resumé des observations sur la plankton des mers explorées parle Conseil pendant les Années 1902–1908. Cons. Perm. Int. Expl. Mer. Bull. Trim., pl. 4.

RAE, K.M. AND Fraser, J.H., 1941.—The copepoda of the southern North Sea, 1932–37. Hull Bull. Mar. Ecol., No. 4, pp. 171–238.

RAE, K.M. AND REES, C.B., 1947.—The Copepods in the North Sea. Hull. Bull. Mar. Ecol., II, pp. 95–134.

REES, C.B., 1950.—The identification and classification of Lamellibranch larvae. Hull Bull. Mar. Ecol., Vol. III, No. 19.

ROSE, M., 1924–1925.—Les Copepodes pelagiques de la Mer de Monaco pendant les années 1907–14. Bull. Inst. Oceanogr. Monaco, Nos. 447–449–456, 459, 460.

ROSE, M., 1927.—Sur la présence de l'*Acartia adriatica dans* la baie de Alger. Bull. Soc. Hist. Nat. Afrique du Nord, t. 18.

ROSE, M., 1929.—Copepodes Pelagiques .... etc. Res. Camp. Sc. du Prince Albert de Monaco F. 78.

ROSE, M., 1933.—Faune de France, Copepodes pelagiques — Office Central de Faunistique. Paul Lechevalier, Paris.

RUSSELL, F.S., 1953.—The Medusae of the British Isles. Camb. Univ. Press.

SEIWELL, R.B.S., 1929.—Georgraphic and Oceanographic Research in Indian Waters. V. Mem Asia. Soc. Bengal, 9, 207-356.

SEIWELL, R.B.S., 1948.—The free swimming planktonic copepoda, Geographical distribution. John Murray Exped. 933-34, 8, 321-592. Scientific Reports, British Mus.seum (N.).

STEUER, A., 1910.—Planktonkunde. Leipzig. Berlin.

STEUER, A., 1935.—The Fishery Grounds near Alexandria; 1-Preliminary Report. Fish. Res. Direct. Notes abd Memoires No. 8, Cairo.

STEUER, A., 1939.—The Fishery Gounds near Alexandria : XIX-Mollusca. Notes and Memoires No. 33. Fisheries Research Dirctorate. Cairo, Egypt.

SVERDRUP, H.U., JOHNSON, M.D. AND FLEMING, R.H. (1942).—The Oceans, their physics and chemistry, and general biolggy. Prentic Hall., N.Y., 1087 pp.

THOMPSON, H., 1948.—Pelagic tunicates of Australia. Comm. Counc. Sci. Ind, Res., Australia.

THOMPSON, I.C. AND SCOTT., A., 1903.—Report on the Copepoda. Cylon Pearl Fisheries · Supplemental Report 1 (7).

THORSON, G., 1946.—Reproduction and larval development of Danish Marine Bottom invertebrates. Medd. Komm. Denmarks-Fish. Fisk. Havund Ser. Plankton, Bind 4, No 1, pp. 523.

TOTTON, A K. AND FRASER, J.H., 1955.—Siphonophora, S.O. Calicopharae : Publ. Circ Cons. Int. Explor. Mer Fiche d'Ident. Zoopl. 55-60.

TREGOUBOFF C. AND ROSE, M., 1957—Manuel de plonktonologie Mediterraneane, Centre National de Recherche Scientifique, Paris.

WALTER-KLIE 1943.—Copepoda — I. S. O-Harpacticoida. Publ. Circon. Cons. Int. Expl Mer., Fishes d'Ident. Zoopl. No. 4.

WHITEHOUSE, R.H., 1933.—Report on fish eggs and larvae taken during 1931. Fish. Res. Direct. Notes and Mem. No. 4, Cairo, Egypt.

WILSON, D.P., 1928.—The larvae of *Polydora ciliata* and *Polydora hepleura*. J. Mar. Biol. Ass., U.K., XV, pp. 567-603.

WOODMANSEE, R.A., 1958.—The seasonal distribution of the zonplankton off Chicken Key in Biscayne Bay, Florida. Ecology 39 ; (2), pp. 247-262.