

A CONTRIBUTION TO THE KNOWLEDGE OF THE THALIACEAN FAUNAS
OF THE EASTERN MEDITERRANEAN AND THE RED SEA *

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ABSTRACT

In the sector of the Mediterranean east of the 22nd meridian, five species of Salpidae (*Thalia democratica*, *Salpa fusiformis*, *Ihleia punctata*, *Pegea confoederata* and *Cyclosalpa pinnata polae*) and five species of Doliolidae (*Doliolum denticulatum*, *Doliolum nationalis*, *Doliolina* sp., *Doliolina intermedium* (?) and *Dolioletta* sp.) were caught during a series of cruises. At the same time, four species of Salpidae (*Thalia democratica*, *Salpa cylindrica*, *Brooksia rostrata* and *Ritteriella amboinensis*) and two species of Doliolidae (*Doliolina mülleri krohni* and *Doliolum denticulatum*) were recorded in the Gulf of Elat (Gulf of 'Aqaba). Two further species, *Salpa maxima* and *Dolioletta gegenbauri tritonis*, previously recorded from this area, were not found again in these last catches. Pyrosomidae are missing in both areas. The two faunas are very different, having in common only a few widely distributed species.

INTRODUCTION

The thaliacean fauna of the eastern Mediterranean remains relatively little known. First data were given by Sigl (1912a, b; 1913) working on material collected between 1890 and 1894; she described the form *polae* of *Cyclosalpa pinnata*, numerous specimens of which were caught in several stations off the coasts of the Middle East countries. Also recorded from the same region were *Doliolina mülleri* (nurses) and *Salpa fusiformis*. Since that time, only four more papers dealing with the distribution of the Thaliacea in this area have been published. Godeaux (1963) noticed the presence, along the Israel coast, of *Thalia democratica*, *Doliolina mülleri*, *Doliolum denticulatum* and *Dolioletta gegenbauri*. *Thalia democratica* was again found by Kimor and Berdugo (1967). More recently, Lakkis (1971) confirmed the presence of *Thalia democratica*, *Salpa fusiformis* and *Doliolum* sp. in the Lebanese coastal waters. In the north Aegean Sea, Kiortsis (1969) observed *Thalia democratica*, sometimes in large swarms and, more rarely, *Salpa fusiformis*, *S. maxima* and *Doliolum nationalis*.

During the years 1968 and 1969 several cruises were undertaken and plankton

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collected in the Mediterranean east of the 22nd meridian as part of the Hebrew University-Smithsonian Institution Joint Program "Biota of the Red Sea and the Eastern Mediterranean". Neritic waters of the continental shelf of Israel were also sampled several times, between 1967 and 1969.

The thaliacean fauna of the Red Sea, more precisely of the northern part (Gulf of Elat (Gulf of 'Aqaba), and Gulf of Suez), has been investigated many times during the past 40 years and is better known than that of the eastern Mediterranean. More information is also available on the bathymetric distribution of these animals. The data were exhaustively summarized by Halim (1969). Among the Thaliacea the following have been successively recorded: the salps *Thalia democratica* (Apstein, 1906; Furnest, 1958; Godeaux, 1960; Halim, 1969; Fenaux and Godeaux, 1970), *Salpa maxima* (Van Name, 1952; Godeaux, 1960), *Salpa cylindrica* (Sewell, 1953; Godeaux, 1960), *Brooksia rostrata* and *Ritteriella amboinensis* (Godeaux, 1960; Fenaux and Godeaux, 1970; Meurice, 1970) and the Doliolids *Doliolina mülleri krohni*, *D. intermedium*, *Doliolum denticulatum*, *D. nationalis* and *Doliolletta gegenbauri tritonis* (Neumann, 1906; Godeaux, 1960; Fenaux and Godeaux, 1970). Plankton relations of the Red Sea and Arabian Sea were discussed by Kimor (in press). Differences between the thaliacean faunas of the two regions considered in this paper were stressed by Godeaux (1973).

From December 1969 to March 1970 a few hauls, either horizontal or vertical, were performed in the Gulf of Elat (Gulf of 'Aqaba), in the neighbourhood of the Marine Biology Laboratory of Elat. Another small collection from the same area (May 1971, vertical hauls) was kindly entrusted to the author by Dr. R. Fenaux (Villefranche-sur-Mer).

METHODS*

The samples were collected with a W.P. II plankton net. The horizontal hauls were carried out for ten-minute periods at a speed of 2-3 knots; the vertical hauls were taken from different depths (200-0 or 50-0 m) according to the depth of the bottom at the site of the station. Dr. Fenaux used a W.P. II closing plankton net for his vertical hauls.

The neritic waters of the continental shelf of Israel were sampled at profiles perpendicular to the coast line, at set stations of 10, 25 and 75 fathoms.

Samples were preserved in Formalin, and the Thaliacea were sorted before dividing into aliquots.

Owing to the small size of the nets (inner aperture, 57 cm; length, 261 cm; mesh aperture width, 200 μ) the larger Thaliacea probably escaped, explaining the presence of only small specimens of Salpidae in the catches.

*For a summary of the data on plankton samples see Por et al. (1972).

RESULTS

The species recorded in this paper are listed below in tabulated form.

A. Mediterranean Sea	B. Red Sea (Gulf of Elat)
SALPIDAE	
<i>Thalia democratica</i> (Forskål) (P.S.-P.G.)**	<i>Thalia democratica</i> (Forskål) (P.S.-P.G.)
<i>Salpa fusiformis</i> Cuvier (P.S.-P.G.)	—
—	<i>Salpa cylindrica</i> Cuvier (P.G.)
* <i>Ihlea punctata</i> (Forskål) (asymmetrical Fowler) (P.G.)	—
<i>Pegea confoederata bicaudata</i> (Quoy and Gaimard) (P.G.)	—
<i>Cyclosalpa pinnata polae</i> Sigl. (P.G.)	—
—	<i>Brooksia rostrata</i> (Traustedt) (P.G.)
—	<i>Ritteriella amboinensis</i> (Apstein) (P.S.-P.G.)
DOLIOLIDAE	
<i>Doliolum denticulatum</i> Quoy and Gaimard (PZ.-GZ.)	<i>Doliolum denticulatum</i> Quoy and Gaimard (N.-PZ.-GZ.)
* <i>Doliolum nationalis</i> Borgert (PZ.)	—
<i>Doliolina mülleri</i> (Krohn) (N.)	<i>Doliolina mülleri</i> (Krohn) or <i>D. krohni</i> (Herdman) (O.-N.)
* <i>Doliolina intermedium</i> (Neumann) (N.)	<i>Doliolina krohni</i> (Herdman) (GZ.)
<i>Dolioletta gegenbauri</i> (Uljanin) (N.)	—
PYROSOMIDAE	
none	none

*New findings.

**P.S.: proles solitaria, P.G.: proles gregata, O.: oozoid, N.: nurse, P.Z.: phorozooid, G.Z.: gonozooid.

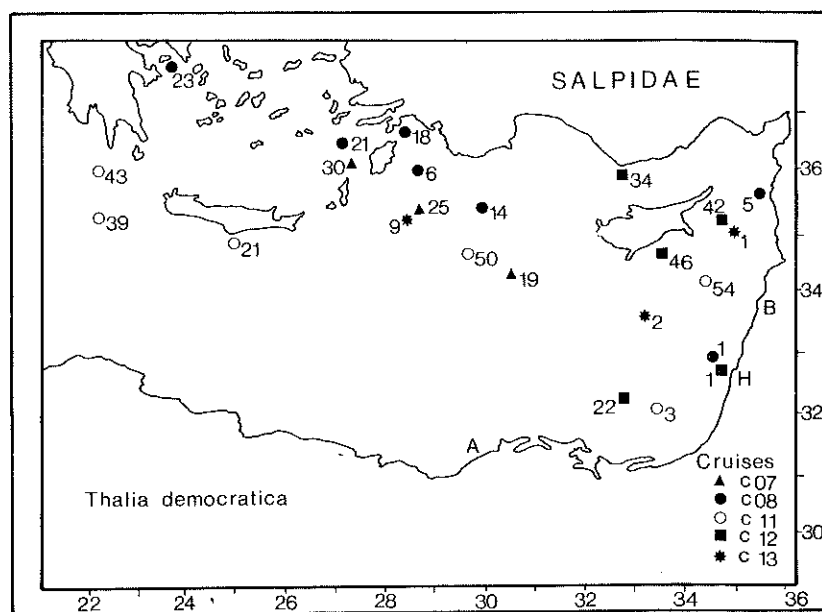
A. Mediterranean Sea

1) *Salpidae*

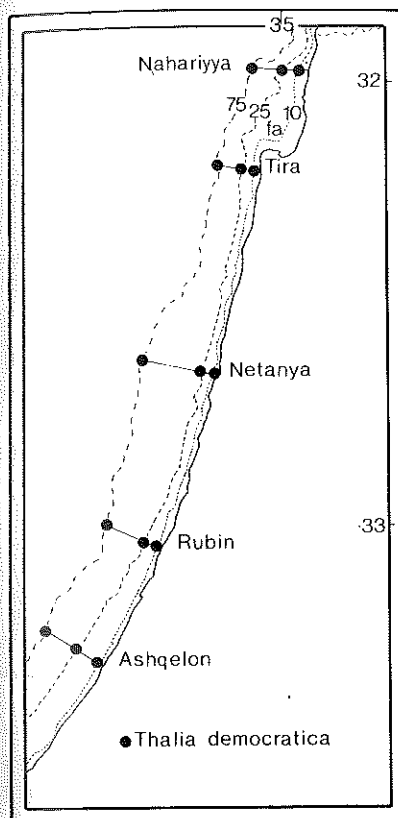
a) *Thalia democratica* (both P.S. (oozooids) and P.G. (blastozooids)) was often recorded during the cruises; it was present in 24 catches out of a total of 33 (31 stations) in the open sea (Map 1) and in 20 of the 21 samplings taken in the neritic waters of Israel from Ashqelon to Nahariyya (Map 2). The specimens were caught at the surface (horizontal hauls) or in the 200 m upper layer (vertical hauls).

Thalia democratica was present during the whole year off the coast of Israel (see also Godeaux, 1963 and Lakkis, 1971). In the open sea this salp was mainly encountered in the northern, as well as in the eastern, part of the sector. The stations were either in the neritic zone or over greater depths; the temperature was between 14.81°C (C-07, 11.II.68) and 22.40°C (C-08, 4.VI.68) and salinity between 38.61‰ and 39.20‰. Conclusions are nevertheless difficult to reach since the catches were made discontinuously over one and a half years.

b) *Salpa fusiformis* was never caught in the coastal waters but was recorded from 15 stations (16 catches) of the eastern Mediterranean (Map 3) all above great depths (deeper than 100 and often 1000 fathoms). They were only found in samples during winter (C-07, C-11 and C-12) when the surface temperature was low (14.81°C to 19.36°C) and salinity between 38.73‰ and 39.13‰. However, Lakkis (1971) recorded the presence of this salp in June, above depths of 100 m or less and in waters where the temperature was more than 25°C. All our samples taken during the late



Map 1. Catches of *Thalia democratica* in the eastern Mediterranean during the different cruises.

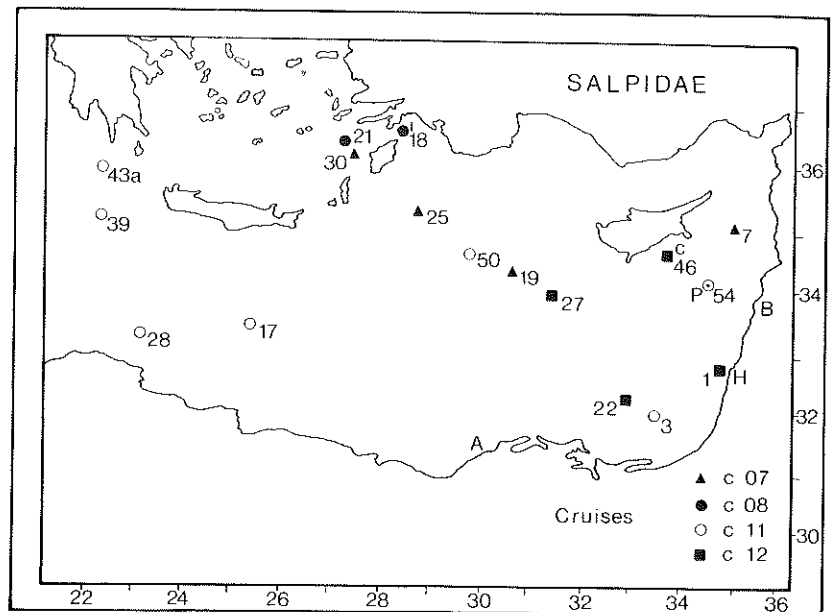


Map 2. Catches of *Thalia democratica* along the coast of Israel. 10, 25 and 75 fa. = lines of increasing depths.

spring, summer and autumn were devoid of this species. At Villefranche-sur-Mer, *Salpa fusiformis* was found to occur in the upper layers during the cold period where temperature, varying between 14°C in December and 16.5°C in May, seemed to be the controlling factor (Braconnot, 1963); in such a case, the eastern populations were the more tolerant.

c) *Ihleia punctata (asymmetrica)* was recorded for the first time from the area (Map 3). Seven blastozooids, in bad condition, were caught at the surface at a station located between Rhodes and the Turkish coast (4.VI.68, $36^{\circ}30' \text{N}$ and $28^{\circ}13' \text{E}$, temperature = 22.74°C , salinity = 38.94‰). *Ihleia punctata* is a very tolerant species, known from the north Atlantic as well as the tropical Atlantic; it is missing in the Indian Ocean.

d) *Pegea confoederata bicaudata* was recognized in the sector (Map 3) southeast of Cyprus (a single 3 cm long blastozooid; 28.XII.68, horizontal hauling, $34^{\circ}10' \text{N}$ and $34^{\circ}29' \text{E}$, temperature = 20.14°C , salinity = 39.20‰). It is the first record since Forskål (1775) found it in the Greek Archipelago, some two centuries ago. This salp lives in tropical and temperate waters and is rather commonly found in the three main oceans.



Map. 3. Catches of *Salpa fusiformis* in the eastern Mediterranean during the different cruises. C, I and \odot P are the positions of the catches of *Cyclosalpa pinnata polae*, *Illea punctata (asymmetrica)* and *Pegea confoederata* respectively.

e) *Cyclosalpa pinnata polae* was taken again from the eastern Mediterranean after more than half a century (Map 3). Five blastozooids (l = 1 cm), with the characteristic pattern of the body musculature, were collected at night from station 46 of cruise C-12, southeast of Cyprus (9.III.69, $34^{\circ}35' N$ and $33^{\circ}35' E$, temperature = $17.09^{\circ}C$, salinity = 38.89‰ , depth of bottom = 780 m). This species has a wide distribution.

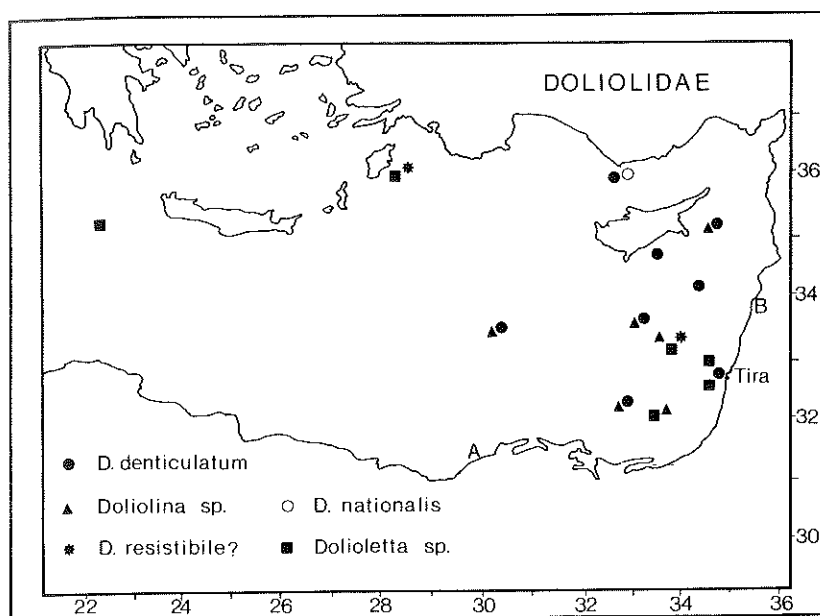
For these last three species, the scarcity of material prevents the drawing of any conclusion. (For details on distribution see Godeaux and Goffinet, 1968.)

2) Doliolidae

Five species were identified in the samples (Map 4) but three of them were only present as old nurses, devoid of their viscera. Determination of these unfortunately remains uncertain (cryptic species, Godeaux, 1961).

a) *Doliolum denticulatum* was represented by nurses, phorozooids and gonozooids in seven samples from cruises C-08, C-11, C-12 and C-13, and in a single sample from the neritic zone off Tira (one phorozooid above the 25 fathom line, 10.XI.68). The catches were more numerous during cruise C-12 (February-March 1969), but as no samples were obtained during the summer months, it is therefore impossible to draw any conclusions concerning the annual cycle of this species.

b) *Doliolum nationalis* has been recorded for the first time from the area. A small phorozooid was caught at the surface of the sea with some 20 phorozooids and gonozooids of *D. denticulatum*, at station 34 of cruise C-12 (depth of bot-



Map. 4. Catches of the different species of Doliolidae in the eastern Mediterranean during the different cruises.

tom = 810 m), between Cyprus and Turkey (28.II.69, temperature = 15.97°C, salinity = 38.93‰). *Doliolum nationalis* is sometimes very common in the western Mediterranean (Godeaux, 1961; Braconnot, 1963) and is known from the north Aegean Sea (Kiortsis, 1969). The reasons for its absence in the eastern Mediterranean are unclear: it is a neritic species, able to live in coastal waters with relatively high temperature and salinity.

c) Specimens belonging to the genus *Doliolina* were present at six stations as old nurses, belonging probably to the species *mülleri* or *mülleri krohni*. No blastozoid (phoro- or gonozoid) was found to support an opinion. All the nurses were small, often lacking the statocyst, with a single pair of anterior nerves and the fourth and fifth muscles slightly broader than the third. Even in our previous investigations (Godeaux, 1963), we found that only a few nurses were present during the whole year in the upper layer (200 m to surface, Godeaux, 1963 and this paper).

d) Two nurses with narrow muscular rings and intervals twice as broad, the nervous ganglion lying very close to the fifth muscle, the statocyst wanting, the heart and the stolon in the fifth intermuscular interval, could be identified tentatively as *Doliolum intermedium* (according to Garstang, 1933). This species has never been recorded from the Mediterranean, but Neumann (1906) described gonozoids of *Doliolum intermedium* from the Red Sea. Nevertheless, it must be kept in mind that *Dolioloïdes rarum* is known from the Mediterranean and that its nurse was never identified with certainty. The possibility of a passage through the Suez Canal still remains open.

e) The genus *Dolioletta* was also represented by nurses, as already mentioned (Godeaux, 1960). A few animals were caught at six stations. These nurses are able to reach a larger size than *Doliolina*: the body is firmer, with the third muscle slightly broader than the fourth which is itself broader than the fifth. The statocyst is usually present. As previously stated for the genus *Doliolina*, accurate identification of the specimens is not possible while at least three species and subspecies of the genus *Dolioletta* (*D. gegenbauri* (Uljanin), *D. gegenbauri tritonis* (Herdman) and *D. mirabilis* (Korotneff)) occur in the western sector and may extend into the eastern one.

3) Pyrosomidae

These animals were not observed even as tetrazooid colonies. No record is available in the literature. Possibly prospecting of the waters below 400 or 500 m, with an Isaacs Kidd trawl, would yield positive results.

B. Red Sea (Gulf of Elat)

1) Salpidae

a) *Thalia democratica* was rather commonly found in the catches from the Gulf (see Furnestin, 1958; Godeaux, 1960; Fenaux and Godeaux, 1970), but always in small numbers and during the "cooler" months (surface temperature $\leq 24^{\circ}\text{C}$, Oren, 1962). All the records are from November to April (e.g. Tiefsee-Expedition in April 1899, in the southern part of the Red Sea, Apstein, 1906). Moreover, all the catches were taken at the surface of the sea or in the 50 m upper layer. Nevertheless, a thick sound-scattering layer, constituted by chains of this salp, was observed by Halim (1969) at a depth of 400 m, just south of the Gulf of Suez, where salinity is above 40‰ but temperature between 21 and 22°C.

Thalia democratica is widespread and is met with in almost every temperate or warm sea or ocean; it is also present along the occidental coast of Israel. The Red Sea form may belong to the subspecies *orientalis* described by Tokioka (1937), but our specimens are too few to allow significant counts of the muscle fibres.

b) *Brooksia rostrata*, first caught in 1949 (Godeaux, 1960) has been found several times in the plankton of the Gulf, despite the small size and fragility of the body. This species is by no means common. Both P.S. and P.G. were collected in November 1969 and P.G. again in May 1971. From the point of view of bathymetric distribution, the aggregate zooids were always encountered in the 50 m upper layer while the oozoids were caught deeper, between 200 m and the sea level (Godeaux, 1960; Fenaux and Godeaux, 1970).

c) *Salpa cylindrica* has sometimes been caught in the Gulf. We can only record a single specimen (15.IX.70). The scarcity of this species could be explained, as already mentioned, by the size of the nets and their meshes which are less suitable for catching relatively large sized animals.

Salpa cylindrica is a warm-water species, commonly found in most intertropical areas; its presence in the Gulf of Elat confirms the torrid character of the sector. This

salp has also been recorded from the Persian Gulf and the Gulf of Aden where temperature and salinity reach high values (Godeaux, unpublished).

d) *Ritteriella amboinensis* (both P.S. and P.G.) is very common especially in winter. Its blastozoid is very similar to that of *Salpa maxima* (Meurice, 1970), but can be distinguished by the disposition of the trunk muscles (especially the first two) and the number of their fibres. *Ritteriella amboinensis* was often collected in the vertical haulings between 500 m and the surface. The oozoids are relatively more common in the deeper layer (from 500 to 100 m) and the blastozoids in the upper layer (from 200 m to the surface).

This salp is reported from the warm parts of the main oceans, but it is always caught in small numbers and its ecology therefore remains relatively little known (for summary of information, see Meurice, 1970).

2) Doliolidae

Two genera, *Doliolina* and *Doliolum*, are present in the collections.

a) *Doliolina* is represented by oozoids and nurses of small size. The oozoids bear a U-shaped and somewhat declined digestive tract and an endostyle beginning at the level of muscle II and slightly overlapping muscle V. A statocyst is present at this stage. The length of the animal does not exceed 1.5 mm. The oozoids probably belong to the species *Doliolina mülleri* and its variety *krohni*. The nurses (1<10 mm) have the fourth muscle slightly broader than the third and the fifth, and a single pair of anterior nerves. The statocyst is usually missing, being dropped at the time the viscera are undergoing degeneration. Often the position of the former endostyle is located by a ventral line of small heaps (? macrophages) scattered between muscles II and V.

Summing up all the observations, it appears that oozoids and nurses of the genus *Doliolina* were always collected with closing nets between 200 m and the surface, and from November to May. Information is lacking for the May to November hot period (mean temperature of the surface of the sea is above 24°C, Oren, 1962).

The collections considered here did not yield any blastozoids (owing to their small size, they probably escaped the sorting) although we previously recorded the presence of both phorozoids and gonozoids of *Doliolina mülleri krohni* (1<1 mm), recognizable by their long endostyle and the position of the gonads (Fenaux and Godeaux, 1970).

b) The genus *Doliolum* is represented by nurses, phorozoids and gonozoids (and possibly trophozoids) of *Doliolum denticulatum*. No *Doliolum nationalis* was observed. Nurses are easily identified by their muscular cuirass uniting muscle II to muscle VIII; the body is firm and barrel-shaped. Blastozoids are distinguished by the horizontal arch-shaped alimentary tract and the ventral insertion of the branchial lamella at the level of the third muscle.

Doliolum denticulatum may occur locally in great numbers: a single vertical haul (S.V.71), between 50 m depth and the surface, yielded 40 nurses and some 330

phorozooids, among which 80% of the individuals were small-sized and therefore rather freshly liberated from the nurses. It may be concluded from our fragmentary data that nurses and phorozooids are present from December to May in the 200 m upper layer, while the gonozooids are only found from December to March. Again, information on the warm period is lacking.

3) *Pyrosomidae*

These animals were missing and no species has ever been found in the Red Sea despite the fact that several species of *Pyrosomidae* have been reported from the Arabian Sea and the Indian Ocean (Sewell, 1953), although always from great depths (the sill at the southern entrance of the Red Sea does not exceed 100 m, Halim, 1969:231).

CONCLUSIONS

During the last quarter of the century, five species of *Salpidae* and five of *Doliolidae* have been recorded from the eastern part of the Mediterranean while the presence of five species of *Salpidae* and four of *Doliolidae* has been recognized in the Gulf of Elat. The two faunas appear sharply separate from each other since they have in common only a few species of worldwide occurrence, *Thalia democratica*, *Doliolum denticulatum*, *Dolioletta gegenbauri* and its sub-species *D. tritonis*. There is no conclusive proof of any exchange of *Thaliacea* between the two areas.

In the Mediterranean sector, *Ihleia punctata*, *Doliolum nationalis* and *Doliolina intermedium* (?) are newly recorded; *Pegea confoederata* was found once some two centuries ago and *Cyclosalpa pinnata polae* described from the area at the beginning of the century. The presence of *Thalia democratica*, *Salpa fusiformis*, *Doliolina mülleri*, *Doliolum denticulatum* and *Dolioletta gegenbauri* has been noticed several times. *Salpa maxima*, although present in the Adriatic and Aegean seas (Sigl, 1913; Kiortsis, 1969), was never found off the Levantine coasts.

All the species of the samples from the Gulf of Elat have been reported several times from the sector. However, *Salpa maxima* (and its form *tuberculata*) observed by Van Name (1952) and the author (Godeaux, 1960) has not been found again during the last decade; specimens from Van Name's collections, kindly forwarded by Dr. Ailsa Clark, undoubtedly belonged to the species *Salpa maxima* as proved by the number of muscle fibres and arrangement of the trunk muscles. Moreover, the species *Dolioletta gegenbauri tritonis* is also missing; it has been previously observed in samplings done in May 1949 and January-February 1958 (Godeaux, 1960), i.e., during the same season as the collection investigated in this paper. Unlike the case of *Salpa maxima*, the absence of this species cannot be explained by the size of the nets. Another species, *Doliolina intermedium*, described by Neumann (1906) from the main basin, has never been found in the Gulf of Elat.

No species seems to be endemic to the Mediterranean or to the Red Sea. The fauna of the eastern Mediterranean shows an affinity to that of the eastern Atlantic Ocean, but appears poorer than the fauna of the western sector, e.g., *Salpa maxima*, *Iasis*

zonaria and Pyrosomidae are all absent. The fauna of the Red Sea supports similar conclusions: it has affinities to that of the tropical Indian Ocean but again seems poorer, e.g., *Metcalfina hexagona* and Pyrosomidae are lacking. Compared with the conditions prevailing in the neighbouring sectors, environmental conditions in the eastern Mediterranean as well as in the Red Sea (and more precisely in the Gulf of Elat) are peculiarly severe. However, further data would be necessary before drawing conclusions concerning any tendency to endemism.

Owing to the discontinuity of the catches and the lack of information concerning the summer period, it is not yet possible to give an account of the biological cycle of the species encountered. It is urged that more frequent sampling be done throughout the year in both areas.

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