

Thaliacea
Red Sea Vertical distribution
Gulf of Aden
Thaliacés
Mer Rouge Distribution verticale
Golfe d'Aden

Distribution of Thaliacea on a transect from the Gulf of Aden to the central Red Sea during the winter monsoon (March 1979)

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ABSTRACT

Ten vertical samplings were carried out at five different stations. Eight species of Salps and six species of Doliolids were collected and their distribution examined. No Pyrosoma was caught. Catches below 100 m were not very numerous.

Several species of Salps and Doliolids known from the northern Red Sea and its appendages were present in the catches: *Brooksia rostrata*, *Ritteriella amboinensis*, *Iasis zonaria*, *Thalia cicar*, *Salpa cylindrica*, *Doliolina indicum*, *D. muelleri*, *D. krohni*, *Doliolum nationalis* and *D. denticulatum*.

Doliolina indicum, common in the northern part of the Sea and in the Gulf of Aqaba, was the most frequently caught species of Doliolid.

Pegea confoederata, a new record, was locally very abundant.

The standing stock of Thaliacea was very low, except at the N'Djebel Tair and Commission Plain stations.

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RÉSUMÉ

Répartition des thaliacés le long d'une radiale entre le Golfe d'Aden et le centre de la Mer Rouge durant la mousson d'hiver (mars 1979)

Dix échantillonnages verticaux ont été opérés en cinq stations. Huit espèces de salpes et six espèces de doliolés ont été récoltées et leur répartition examinée. Aucun pyrosome n'a été capturé. Les récoltes en dessous de 100 m ont été peu nombreuses.

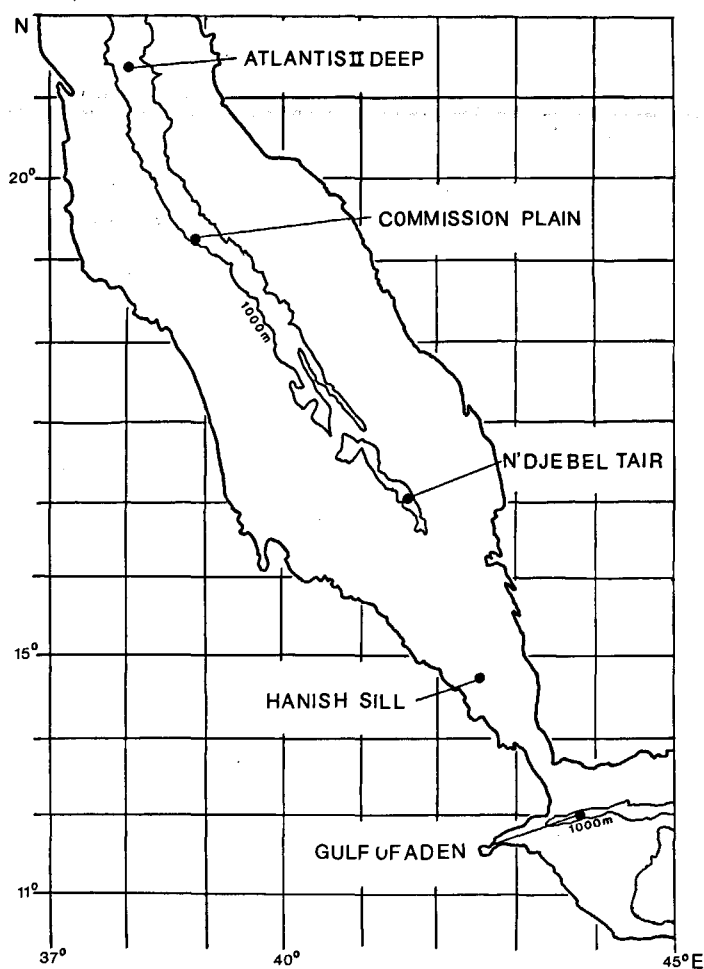
Plusieurs espèces de salpes et de doliolés connues du nord de la Mer Rouge et de ses dépendances étaient représentées dans les récoltes : *Brooksia rostrata*, *Ritteriella amboinensis*, *Iasis zonaria*, *Thalia cicar*, *Salpa cylindrica*, *Doliolina indicum*, *D. muelleri*, *D. krohni*, *Doliolum nationalis* et *D. denticulatum*.

Doliolina indicum, commun dans le nord de la Mer Rouge et dans le Golfe d'Aqaba, a été l'espèce de doliolé la plus souvent capturée.

Pegea confoederata, espèce nouvelle pour la Mer Rouge, était localement très abondante.

La densité en thaliacés était très faible excepté aux stations de N'Djebel Tair et de Commission Plain.

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Figure

Sites of investigations in the Gulf of Aden and the Red Sea during March 1979 (after Beckmann, 1984).

Localisation des stations opérées dans le Golfe d'Aden et en Mer Rouge en mars 1979 (d'après Beckmann, 1984).

INTRODUCTION

Information on the thaliacean fauna of the southern part of the Red Sea is scarce. In the three hauls carried out by the Tiefsee Expedition (1898-1899) in the Red Sea, Apstein (1905) and Neumann (1906) recorded the presence of a few species: *Salpa mucronata* (*Thalia democratica*), *Doliolum* (*Doliolina*) *intermedium*, *Doliolum nationalis* and *Doliolum denticulatum* and of some

undetermined species. Nearer, at a station close to the Strait of Bab-el-Mandab, large numbers of oozoids of *Salpa cylindrica* were collected in the upper 100 m layer by the John Murray Expedition (Sewell, 1953).

The northern part of the Red Sea, including the Gulf of Aqaba (Elat), and the Gulf of Aden, are comparatively better known. The Gulf of Aqaba was explored intensively during the Data Collecting Programme in the Gulf of Elat (DCPE, 1974-1977) and many oceanographic cruises have passed through the Gulf of Aden (Godeaux, 1985).

The occurrence of eleven species of Salpidae and of five species of Doliolidae has been recorded from the northern part of the Red Sea, while eleven species of Salpidae, four species of Doliolidae and two species of Pyrosomatidae have been observed in the Gulf of Aden and in the neighbouring areas of the western Indian Ocean. These species are not completely identical; only six species of Salpidae are known to be common to both regions.

The objectives of the present study are the systematics of the Thaliacea and their distribution in a still poorly known part of the Red Sea.

MATERIAL AND METHODS

From 16 to 26 March 1979, during the winter monsoon, the R.V. "Valdivia" operated a transect from the Gulf of Aden through the southern Red Sea to about 21°N (Meseda 2 programme: Metalliferous Sediments Atlantis II Deep). Zooplankton was collected at five different stations (see locations on Fig. 1) with a total of ten samplings (Tab. 1). A multiple opening and closing net (mouth opening 0.5 × 0.5 m) device equipped with five nets of 300 µm mesh size, was used for vertical tows. By closing one net, the next one automatically opens. A detailed description of the device and discussion of its sampling characteristics were provided by Weikert and John (1981). The samplings considered here were taken at 50 m intervals from the surface down to 450 m (for details, see Beckmann, 1984).

The sorted material was kindly supplied by Dr W. Beckmann (Universität Hamburg). On a total of 125 hauls carried out during the cruise, only 49 samples contained Thaliacea. The station in the Gulf of Aden is used as a reference station.

Table 1

Station list (after Beckmann, 1984).

Liste des stations (d'après Beckmann, 1984).

| N° | Location | North latitude | East longitude | Date | Sampling time of profiles | Sampling range (m) | Water depth total (m) |
|----|------------------|----------------|----------------|---------|----------------------------|--------------------|-----------------------|
| 5 | Gulf of Aden | 12°00.6' | 43°48.2' | 16/3 | 16.24-17.17 | 0-1050 | 1200 |
| 14 | Hanish Sill | 13°44.5' | 42°31.7' | 17/3 | 20.29-20.34 20.51-20.56 | 0-130 0-130 | 137 |
| 17 | N'Djebel Tair | 16°00.6' | 41°38.2' | 18/3 | 15.00-16.37 | 0-1050 | 1673 |
| 21 | | 16°01.3' | 41°37.3' | | 23.18-23.57 | 0-450 | |
| 30 | | 16°01.2' | 41°37.2' | 19/3 | 15.47-17.14 | 450-1450 | |
| 41 | Commission Plain | 19°14.9' | 38°53.8' | 21/3 | 13.55-18.00 | 0-1250 | 1912 |
| 44 | | 19°14.8' | 38°52.7' | 22-23/3 | 23.09-02.08 | 0-1250 | |
| 49 | | 19°13.9' | 38°54.1' | 23/3 | 11.38-14.50 | 0-1250 | |
| 52 | Atlantis II Deep | 21°22.0' | 38°03.9' | 24/3 | 12.51-16.27 | 0-1250 | 2122 |
| 60 | | 21°20.5' | 38°04.9' | 25-26/3 | 23.59-02.35 | 0-1450 | |

Determinations were mainly obtained after Metcalf (Salpidae) and Neumann and Garstang (Doliolidae).

RESULTS

Biogeographical data

Salpidae and Doliolidae were the only Thaliacea present in the collection, Pyrosomatidae were again completely lacking.

Most of the Thaliacea were taken in the epipelagic zone, from 100 m deep to the surface; the upper mesopelagic layer (from 250 up to 100 m) proved very poor. Station 30 (see Tab. 1), sampled from 450 m downward to 1450 m, did not yield any Thaliacea.

The epipelagic is separated from the mesopelagic zone by a rather sharp thermohalocline whose position depends of the station considered. Surface water is warmer ($t \geq 26^\circ\text{C}$) and well oxygenated, and has a relatively low salinity (36 to 38) compared with the deeper water ($t < 22^\circ\text{C}$, $S < 41$ and low oxygen concentrations) from 200 m down to 1000 m (for more details, see Beckmann, 1984).

Salpidae

The occurrence of eight species was recorded with a great variability in the numbers of specimens. No Cycloalps was observed.

Brooksia rostrata (Traustedt) is represented by a single oozoid and six blastozoids from the superficial 15 m at the station operated above the Hanish Sill. All these specimens were small. The species was previously recorded from the northern basin and its two appendages, in the upper layer above 200 m depth (Furnestin, 1958; Godeaux, 1960; 1973; 1974; Fenaux, Godeaux, 1970). It was also found in the Gulf of Aden in the upper 50 m above depths of 1000 m (Godeaux, 1972).

Brooksia rostrata is a species able to withstand a rather broad range of salinities but not low temperatures, judging from its tropical distribution in the Indian and Atlantic Oceans alike.

Ritteriella amboinensis (Apstein), was reported from four stations, but only 4 oozoids and 5 blastozoids were observed in the samplings. Three oozoids (18-23 mm in length) were taken at station 41 (Commission Plain) but at three different depths, respectively between 50 m and the surface, 100 and 50 m and 320 and 300 m; the fourth individual (24 mm in length) was caught at station 49 (also Commission Plain) between 400 and 350 m. It was caught between 500 and 200 m in the Gulf of Aqaba where the thermohalocline is absent at late autumn (Fenaux, Godeaux, 1970).

The five small blastozoids (3 mm in length) were caught in the Gulf of Aden in the upper 15 m.

Ritteriella amboinensis, a tropical salp, must be considered as very rare in the open ocean, where the catches only concern a few specimens. This seems to be a species selected by the severe ecological conditions existing in a warm hypersaline sea.

Iasis zonaria (Pallas), first observed in the northern basin (Godeaux, 1974) and later in the Gulf of Aqaba (Godeaux, 1978), is by no means a common species. Nevertheless, in addition to two oozoids (Commission Plain), 61 blastozoids were collected at several points: station 17 (N'Djebel Tair): 10 blastozoids (50-0 m depth); stations 44 and 49 (Commission Plain): respectively 18 blastozoids (50-0 m depth) and 31 blastozoids (100-50 m depth); and station 60 (Atlantis II Deep): 2 blastozoids (50-0 m depth).

With the exception of a young oozoid ($L = 7$ mm), *Iasis zonaria* was absent from the mesopelagic zone. A great part of the catches were also made below 50 m or even deeper in the northern part of the Red Sea, in front of the straits of Tiran and in the Gulf of Aqaba.

Most probably the two main lots of blastozoids were freed by disruption of chains during the handling of the samples owing to the size and the numbers of muscle fibres of the individuals (station 44, 0.7-0.8 cm in length, mean fibres number $x_{18} = 105.61$ [101-115] $\sigma = 4.20$ and station 49, 0.9 cm in length and $x_{31} = 117.03$ [110-126] $\sigma = 4.94$). For 122 blastozoids from the Gulf of Aqaba, the mean fibres number was $x_{122} = 117.7$ [98-137] $\sigma = 8.82$; 89 individuals have here their fibres numbers within $x \pm \sigma$.

Iasis zonaria is more eurythermous than the two preceding species, having been found throughout the Mediterranean and in the Atlantic Ocean up to 40°N . It was taken in the Gulf of Aden and the Gulf of Oman (Godeaux, 1972).

Thalia cicar van Soest, another commoner tropical salp, present at every station of the Sea (mainly at N'Djebel Tair), was collected in the upper 100 m (length < 7 mm).

Moreover, most of the catches (75%) were taken in the 50 m upper layer. *Thalia cicar* is a stenothermous species, limited to the warmer areas of both the Indian and Atlantic Oceans.

Thalia rhomboides (Quoy and Gaimard), a purely indo-pacific species, is only represented by 3 small oozoids collected in the Gulf of Aden, between 50 m and the surface.

This species was reported as well from the northern basin and the Gulf of Aqaba as from the Gulf of Aden, the Arabian Sea and the Straits of Hormuz (Godeaux, 1979 and unpublished data).

Thalia orientalis Tokioka is represented by a single oozoid, caught at station 44 between 50 m and the surface and easily identified thanks to its two long posterior appendages and the absence of the two small lateroposterior tunical outgrowths; these are obvious on the two other species of the genus observed in the collection. This constitutes the first record from the Red Sea despite the occurrence of the species in the whole Arabian Sea and the Gulf of Aden (Godeaux, 1979 and unpublished data). *Thalia orientalis*, a rather recent invader of the Mediterranean, is probably unable to withstand for long the hard ecological conditions prevailing in the Red Sea.

Salpa cylindrica Cuvier, the commonest and most typical tropical salp, is poorly represented here with three oozoids (<5 mm in length) caught between 100 and 150 m depth in the Gulf of Aden, and two oozoids (<7 mm in length) from the upper 15 m above the Hanish Sill. So few catches seem unexplainable, as this species was previously observed in large numbers not only in the area (Sewell, 1953) but also further to the north (Godeaux, 1974) and in the Gulf of Aden (Godeaux, Meurice, 1978).

Pegea confoederata (Forskål) is indisputably the best represented species yielded by the expedition. This rather large salp was present in great numbers at stations 41 and 44 (Commission Plain). According to Beckmann (1984) as many as 2 660 salps/100 m³ were counted in the upper 50 m layer; one day later, despite dispersal of the swarm, some 260 specimens/100 m³ were found again in the same layer.

Some 400 blastozoids (up to 5 cm in length), but less than 40 oozoids (up to 4 cm in length), were recorded in the samples subjected to study. Some embryos were also found at station 21. These blastozoids are rather small specimens as they usually reach more than 10 cm in length. The blastozoids were often carrying embryos developed enough as to allow the estimation of their muscle fibres. The mean values are respectively for 45 oozoids and embryos: $x_{45} = 121.52$ (extreme values: 96 and 152) with $\sigma = 10.39$ and for 47 blastozoids: $x_{47} = 210.70$ (extreme values: 155 and 265) with $\sigma = 22.89$. According to the conclusions of van Soest (1974) and Madin and Harbison (1978), the specimens belong to the species *P. confoederata*. The related species *P. bicaudata* can be discarded as all the blastozoids examined lack the two posterior tail-like processes.

This is the first record of the species in the area. *Pegea confoederata* was still entirely unknown in the Red Sea, but several records have been reported from the tropical Indian Ocean, from the Gulf of Oman and the Arabian Sea (Sewell, 1953), and from the vicinity of Bab-el-Mandab (van Soest, 1974). Sewell (p. 41) noted "this salp was remarkably common in the surface water in the region of the Gulf of Aden, the South Arabian coast and in the Gulf of Oman, between 3rd September 1933, and 25th November".

The blastozoids are very young and the oozoids are released at a length of 2.5 cm (as attested by the gut content). The oozoids are considered rarer than the blastozoids and in Metcalf's opinion (1918), they live in deeper waters in the open ocean, being brought to the surface by an upwelling of these waters.

The gut content of several blastozoids was examined. Beside unidentified remains, Coccolithophoridae, frustules of Diatoms (including large species: *Planktoniella sol*, *Corethron pelagicum*), tests of *Globigerina* sp., shells of Pteropods and even exoskeletons of cyclopoid Copepods were present.

Doliolidae

Six species were present in the samples. Their occurrence at the different stations exhibits a large variability.

No larvae were captured. The oozoids and blastozoids were very small (less than 25 mm in length). The size of the nurses was larger (up to 9 mm).

Doliolina indicum (Neumann) was very common; it was taken at almost all the stations in the upper 100 m and mainly between 100 and 50 m. The richest stations were in the Gulf of Aden and above N'Djebel Tair, Commission Plain and Atlantis II Deep. The nurses can be identified thanks to their slender shape and their narrow muscle rings separated by intermuscular spaces 2 to 3 times broader. The tiny phorozoids and the gonozoids bear characteristic clusters of melanocytes on both sides of the digestive slope and have five pairs of branchial slits, the testis of mature gonozoids extends horizontally on the left side between the 2nd and 3rd muscles. No oozoid could be identified with certainty as belonging to that species of the genus *Doliolina*.

Doliolina indicum was also caught at rather great depths, down to 300 m, but mainly as nurses. This form cannot feed on particulate organic matter, but may be able to absorb dissolved organic substances through its integuments.

Doliolina indicum must be considered as highly characteristic of the Red Sea, as it is commonly found everywhere. It is also known from the Indian Ocean (Neumann, 1906; Sewell, 1953; Godeaux, Meurice, 1978).

Doliolina indicum is closely related to the group *Doliolina intermedium*/*Doliolina resistibile*. Although *D. intermedium* was observed in the Red Sea by Neumann (1906), it is an Atlantic species known from the Azores-Madeira area and from the Mediterranean. *D. resistibile* is an austral species (Garstang, 1933).

Doliolina muelleri Krohn and *D. krohni* Herdman were identified at the different stations in the epipelagic layer but mainly as nurses devoid of viscera. Only a few phorozoids and gonozoids were collected, some of them attributed to the species *D. krohni* owing to the greater number of branchial slits. Some 15 oozoids were also examined but it is impossible at present to decide whether they belong to *D. muelleri-krohni* or to *D. indicum* (cryptic species, Godeaux, 1961). The problem does not exist with the nurses which exhibit quite different appearances.

Doliolina muelleri and *D. krohni* were mainly present in the upper 50 m, where more than the three-fifths of the total catches of the epipelagic layer were taken. From 100 m to 250 m deep, only two phorozoids were collected in the Gulf of Aden. Likewise two nurses were caught respectively between depths of 300-250 m and 450-400 m at the Commission Plain stations.

Doliolum nationalis Borgert is represented by a few phorozoids and gonozoids, all caught, except for one phorozoid (Gulf of Aden) and one gonozoid (N'Djebel Tair), in the first 50 m.

Doliolum nationalis is a neritic species very common in the Gulf of Suez, but completely lacking in the Gulf of Aqaba; it is generally caught only rarely in the open sea (Godeaux, 1973; 1974).

Doliolum denticulatum Quoy and Gaimard accompanies *D. nationalis* but is better represented, from the surface down to 300 m. Among the catches, some 73 oozoids and 30 nurses may belong either to one or to the other species (cryptic species, Godeaux, 1961). A large part of the phorozoids and of the gonozoids were caught in the upper 50 m layer at all the stations, the remnant being collected in the lower epipelagic zone. Only two phorozoids and three gonozoids, a negligible percentage, were observed between 300 and 100 m.

Dolioletta gegenbauri Uljanin and *D. tritonis* Herdman are poorly represented, beside 3 oozoids and 44 nurses, by 5 phorozoids of *D. gegenbauri* and 1 phorozoid and 3 gonozoids of *D. tritonis*, the distinction being based on the position of the ventral end of the gill lamella more or less close to muscle IV. Again the oozoids and the nurses of these species cannot be separated, but most probably *D. tritonis* is not a good species (Godeaux, 1962). Practically all the catches were obtained on both sides of Bab-el-Mandab in the epipelagic layer. *Dolioletta* sp. was rarely observed in the region where the catches seem to be exceptional (Godeaux in the Gulf of Aqaba, 1960).

In conclusion, the catches of the Doliolids were especially important in the upper 50 m at N'Djebel Tair, Commission Plain and Atlantis II Deep areas. On average, the catches were twice as important in the upper half as in the lower of the epipelagic layer.

The catches in the mesopelagic layer (100 m down to 450 m) only constituted a feeble percentage of the specimens collected by the Expedition (Tab. 3).

STANDING STOCK

The total number of the catches is very low and abnormally so at certain stations. The Thaliacea, part of the gelatinous zooplankton, live in more or less dense and large swarms, scattered throughout the epipelagic layer. Especially as far as the Salps are concerned, both the size of the nets and the method of vertical haulings do not seem very adequate for the purpose, and consequently cause a great irregularity in the catches. This is surely the case of the reference station operated in the Gulf of Aden, an area especially known for its diversity of species (Tab. 2).

The same conclusion may apply to station 52 in the vicinity of Atlantis II Deep. With the exception of *Pegea confoederata*, the great majority of the Salps was of a small size (length <10 mm). Conversely, results with Doliolids appear more homogeneous.

Calculations of the number of specimens collected over an area of 1 m² (Tab. 3) from the surface down to 450 m confirm the very poor abundance of Thaliacea in relation to the total plankton: in average 1.73%. However at the Commission Plain stations, the percentages of Thaliacea in the three samplings are higher, being respectively 6.20, 4.21 and 2.60% of the entire local populations. Nine species were recorded. In a former exploration of the area of Atlantis II Deep (Weikert, 1982), Thaliacea accounted for 4.1% of the mesoplankton collected in the upper 100 m (epipelagic zone) in similar conditions of hauling.

Table 2
Distribution of the Thaliacea in the Red Sea and the neighbouring seas.
Répartition des thaliacés en Mer Rouge et dans les mers avoisinantes.

| Thaliacea | Red Sea | | Gulf of Elat | Gulf of Aden | Arabian Sea |
|--------------------------------|---------|----|--------------|--------------|-------------|
| | N | S | | | |
| <i>Cyclosalpa sewelli</i> | | | | + | + |
| <i>Cyclosalpa floridana</i> | + | | | | |
| <i>Cyclosalpa bakeri</i> | + | | + | | |
| <i>Brooksia rostrata</i> | + | ● | + | + | |
| <i>Ritteriella amboinensis</i> | + | ● | + | + | + |
| <i>Ritteriella picteti</i> | | | | + | |
| <i>Metcalfina hexagona</i> | | | | + | + |
| <i>Iasis zonaria</i> | + | ● | + | + | + |
| <i>Thalia orientalis</i> | | ● | | + | + |
| <i>Thalia rhomboides</i> | + | | + | + | + |
| <i>Thalia cicar</i> | + | ● | + | + | + |
| <i>Pegea confoederata</i> | | ● | | + | + |
| <i>Salpa maxima</i> | + | | + | | + |
| <i>Salpa cylindrica</i> | + | +● | + | + | + |
| <i>Doliolina muelleri</i> | + | ● | + | | + |
| <i>Doliolina krohni</i> | | | | | |
| <i>Doliolina intermedium</i> | | ? | | | |
| <i>Doliolina indicum</i> | + | ● | + | + | + |
| <i>Doliolum nationalis</i> | + | +● | | + | + |
| <i>Doliolum denticulatum</i> | + | ● | + | + | + |
| <i>Dolioletta gegenbauri</i> | | ● | + | + | + |
| <i>Dolioletta tritonis</i> | | | | + | + |
| <i>Pyrosoma spinosum</i> | | | | + | + |
| <i>Pyrosoma agassizi</i> | | | | + | |

(This study and after Godeaux 1985; cette étude et d'après Godeaux 1985.)
● species collected by the R.V. Valdivia; ● espèces récoltées par le N.O. Valdivia.

Table 3

Thaliacea standing stock below 1 m² at different locations in the Gulf of Aden and the Red Sea during March 1979.
Densité en Thaliacés par m² aux différentes stations du Golfe d'Aden et de la Mer Rouge durant le mois de mars 1979.

| Species | Depth Range (m) | Gulf of Aden | Hanish Sill | | N'Djebel Tair | | Commission Plain | | | Atlantis II Deep | |
|---|--------------------|--------------|-------------|--------|---------------|--------|------------------|-----------|--------|------------------|--------|
| | | D | N | N | D | N | D | N | D | D | N |
| SALPIDAE : | | | | | | | | | | | |
| <i>Brooksia rostrata</i> | 0-50 | | | 35 | | | | | | | |
| <i>Ritteriella amboinensis</i> | 0-50 | | | 25 | | | | | | | 5 |
| | 50-100 | | | | | | | | | | 5 |
| | 100-250 | | | | | | | | | | |
| | 250-400 | | | | | | | 5 | | 5 | |
| <i>Iasis zonaria</i> | 0-50 | | | | | 50 | | | 95 | | 10 |
| | 50-100 | | | | | | | | | 155 | |
| | 100-250 | | | | | | | 5 | | | |
| <i>Thalia orientalis</i> | 0-50 | | | | | | | | 5 | | |
| <i>Thalia rhomboides</i> | 0-50 | 15 | | | | | | | | | |
| <i>Thalia cicar</i> | 0-50 | | 15 | 255 | 85 | 950 | 90 | 120 | 85 | 5 | 70 |
| | 50-100 | | | | | | 25 | 10 | 375 | | |
| <i>Pegea confoederata</i> | 0-50 | | | | | 150 | 1150 | 690 | 180 | | |
| | 50-100 | | | | | 80 | 80 | 50 | 5 | | |
| | 100-250 | | | | | | | 25 | 10 | | |
| | 250-450 | | | | | | 10 | | 5 | | |
| <i>Salpa cylindrica</i> | 0-50 | | | 10 | | | | | | | |
| | 50-100 | | | | | | | | | | |
| | 100-250 | 15 | | | | | | | | | |
| Total/station | | 30 | 15 | 325 | 85 | 1230 | 1365 | 1000 | 815 | 5 | 90 |
| Total Salpidae | 4960 | | | | | | | | | | |
| DOLIOLIDAE : | | | | | | | | | | | |
| <i>Doliolina indicum</i> | 0-50 | 5 | 5 | 10 | | 200 | 20 | 100 | 15 | 25 | 20 |
| | 50-100 | 355 | 10 | | | | 210 | 135 | 45 | 415 | 85 |
| | 100-250 | 50 | | | | | | 15 | 25 | | 10 |
| | 250-300 | | | | | | | | 5 | | |
| <i>Doliolina muelleri</i> + <i>D. krohni</i> | 0-50 | 65 | 5 | 10 | 35 | 200 | 30 | 25 | 10 | 20 | 55 |
| | 50-100 | 70 | 5 | | 60 | 15 | 30 | 35 | 15 | 30 | 30 |
| | 100-250 | 10 | | | | | | | | | |
| | 250-450 | | | | | | 5 | 5 | | | |
| <i>Doliolum nationalis</i> | 0-50 | 10 | 20 | 40 | 35 | 200 | | | | | |
| | 50-100 | | | | | | | | | | |
| | 100-250 | 5 | | | | | | | | | |
| | 250-300 | | | | 5 | | | | | | |
| <i>Doliolum denticulatum</i> | 0-50 | | 70 | 75 | 15 | 200 | 25 | 20 | 170 | 45 | 390 |
| | 50-100 | 60 | | | | | 170 | 70 | 170 | 90 | 30 |
| | 100-250 | 10 | | | | | | | 10 | | 5 |
| | 250-300 | | | | | | | | 5 | 5 | |
| <i>Dolioletta gegenbauri</i> + <i>D. tritonis</i> | 0-50 | 30 | 35 | 45 | | | | | | 5 | |
| | 50-100 | 50 | 5 | 15 | | | | 10 | | | |
| | 100-250 | 10 | | | | | | | | | |
| Total/station | | 730 | 155 | 195 | 150 | 815 | 490 | 415 | 470 | 635 | 625 |
| Total Doliolidae | 4690 | | | | | | | | | | |
| Total Thaliacea | 9640 | 760 | 170 | 520 | 235 | 2045 | 1855 | 1415 | 1285 | 640 | 715 |
| | | 7 species | 9 species | | 7 species | | | 9 species | | 7 species | |
| Total Mesoplankton (Beckmann 1984) | 557.400 (0-1450 m) | 79.000 | 77.600 | 75.900 | 83.400 | 59.800 | 29.900 | 33.600 | 49.500 | 37.100 | 32.500 |
| Percentage Thaliacea | 1.73 (mean) | 0.96 | 0.22 | 0.69 | 0.28 | 3.42 | 6.20 | 4.21 | 2.60 | 1.72 | 2.20 |

D: day = jour, N: night = nuit.

The distribution of the Doliolids, numerous in the Gulf of Aden and in the vicinity of Commission Plain and Atlantis II Deep, proves different from that of the Salpids. The best results concerning the latter were obtained at the Commission Plain and N'Djebel Tair stations (during the night). But as already stressed, owing to the method used for the gathering, the absence of specimens has little meaning.

CONCLUSIONS

The Thaliacean populations of the southern part of the Red Sea can be considered from a double point of view:

a) composition with regard to the populations of both the northern part of the Sea and the Gulf of Aden;

b) vertical and horizontal distributions in relation to the position of the prospected stations and the moment of collection.

Despite the small number of stations operated, the Meseda II Expedition yielded eight species of Salpidae and six species of Doliolidae. In half of the haulings, Salpidae were poorly represented. The commonest species in the northern part are often found again in the southern part of the Red Sea (Tab. 2).

The Pyrosomas are missing in the collection despite the occurrence of two species in the Gulf of Aden: *Pyrosoma* (*Pyrostremma*) *spinosum* Herdman (Sewell, 1953) and *P. agassizi* Ritter (Godeaux, Meurice, 1978). Possibly the Hanish Sill is an insurmountable barrier. Cyclosalps were also absent although two species were observed in the past in the northern basin: *Cyclosalpa floridana* Apstein, *C. bakeri* Ritter, and one more in the Gulf of Aden: *C. sewelli* Metcalf (Godeaux, 1972; 1974; 1978). *Salpa maxima* Forskål, *Salpa maxima tuberculata* Metcalf and *Thalia rhomboides* known from the Gulf of Aqaba are lacking (Van Name, 1952; van Soest, 1974; Godeaux, 1978).

A few more species living in the Gulf of Aden were not caught by the Expedition and as a matter of fact have never been observed in the Red Sea: *Metcalfina hexagona* (Quoy and Gaimard), a true indopacific species recorded from several areas of the western Indian Ocean (Sewell, 1953; Godeaux, 1972; Godeaux, Meurice, 1978) and *Ritteriella retracta* (Ritter) occasionally found off the coasts of Somaliland and in the Gulf of Aden (Meurice, 1974; Godeaux, Meurice, 1978, as *Ritteriella picteti* Apstein).

Pegea confoederata, locally abundant, and *Thalia orientalis*, new for the fauna of the Red Sea, may be temporary invaders. This could also be the case for *Dolioletta gegenbauri tritonis* known solely from an old record in the Gulf of Aqaba (Godeaux, 1960). These animals could have been driven by the northwesterly winds blowing during the winter monsoon.

In short, the populations of Thaliacea in the southern part of the Red Sea appear composed of two parts, one common to the whole Sea, the other only present in the south (and in the neighbouring Gulf of Aden). More information is needed to improve this conclusion and to testify to the exercise of a hindering role by the sill.

As far as we can conclude from the fragmentary data available, Doliolidae are very abundant in the Gulf of Aden and rather abundant at the most northern stations explored. On the contrary, Salpidae are best represented in the median stations and almost absent elsewhere.

All the species were collected in the upper part of the epipelagic zone (0-50 m) but two of them were better

represented in the lower part of that zone (50-100 m): *Iasis zonaria* (40% of the catches) and *Doliolina indicum* (70% of the catches). The frequency of the species seems independent of the importance of the captures.

A diel migration is only apparent at some stations (e.g. *Doliolum denticulatum* at N'Djebel Tair), but is generally weak or doubtful and evidently limited to the epipelagic zone.

The upper mesopelagic zone (100-250 m) is poor although the presence of eight species was noted; below (250-450 m), five species were still present with a few individuals (e.g. *Ritteriella amboinensis*) but these catches may result from a possible contamination by surface animals during the raising of the net, at least where tiny animals are concerned.

The decrease of the catches follows the slope of the curves of temperature and oxygen concentrations (Beckmann, 1984). The optima are $T \geq 25^\circ\text{C}$ and $\text{O}_2 \geq 2$ ml/l.

Thanks to their mucous trap, Thaliacea feed on microplankton: hence their distribution is bound to those of the phytoplankton and of the nutrients. Number of species can coexist, from the tiny *Doliolina indicum* to the giant *Pegea confoederata*, as they graze on preys of different sizes.

Despite the relatively small number of the Thaliacea, their role in the food web is not negligible. As young animals, members of several families of hyperiid Amphipods (Vibiliidae, Lycaeidae, Phronimidae) are parasites of the Thaliacea (Salps and Pyrosomas), devouring their prey only upon reaching the adult stage (Madin, Harbison, 1977; Laval, 1980). The Thaliacea are also attacked by corycaeid Copepods (*Copilia* ♀, *Sapphirina* ♀), and Mollusks (*Ocythoe tuberculata* ♂) and occasionally eaten by fishes and other marine Vertebrates (Godeaux, 1977).

But as Thaliacea are very active filters, with a fast transit of the gut (living cells can be observed in the feces), most of the energy of their preys is lost for the planktonic food chain. Their rapidly sinking fecal pellets play a great part in the enrichment in particulate organic matter (POM) of the lower layers of the seas (Wiebe *et al.*, 1979; Iseki, 1981; Silver, Bruland, 1981; Bruland, Silver, 1981; Madin, 1982; Deibel, 1985).

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