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THE THALIACEAN FAUNAS OF THE MEDITERRANEAN AND THE RED SEA.

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ABSTRACT

The thaliacean faunas of the Mediterranean and of the Red Sea have been compared from the point of view of origin and composition.

In the Mediterranean, the species are either very or moderately eurytherm, and true intertropical species are completely lacking, even in the eastern basin where rather severe climatic conditions prevail.

In the Red Sea, which opens into the warmest region of the Indian Ocean, most species are tropical.

The only species common to both seas have a world-wide distribution.

The Suez Canal, which connects the Red Sea and the Levant basin of the Mediterranean, might allow in the future the invasion of the latter by indo-pacific species.

The Mediterranean and the Red Sea have several characteristics in common : both are stretched and relatively narrow seas, connected to the neighbouring Ocean through a shallow strait. Moreover, they are located, either partly or wholly, in arid areas and are evaporation basins owing to a shortage in fresh water supply.

The Mediterranean has a length of some 4000 km; it is connected to the Atlantic Ocean through the Gibraltar sill (sill depth 320 m, width 25 km) in latitude 36°N. The entering Atlantic water has a surface salinity  $S \geq 36\%$  and a temperature  $T = \pm 13^{\circ}\text{C}$ . The air temperature in the area off Gibraltar varies between 15 and 20°C. The Mediterranean is divided into two basins, separated from each other by a ridge extending from Tunisia to Sicily. These two basins have a quite different physiomy.

The Mediterranean is a remnant of the former Mesogean but its fauna is relatively young owing to the severe dry periods undergone in the past; the repopulation started from the eastern Atlantic Ocean (lusitanian to senegalian affinities) from Pliocene onwards.

The Red Sea belongs to the east african Rift. Its length is of about 2000 km and its depth locally exceeds 2000 m. Its northern part ends into two small appendages : the gulf of Suez (neritic area, depth  $\leq 60$  m) and the gulf of Elat (oceanic area, depth reaching 1200 m) which is separated from the main basin by the strait of Tiran. In its southern part, the Red Sea presents a ridge, the Hanish Sill (100 m deep) in latitude 13°44,5'N. The straits of Bab el Mandab connect the Red Sea and the gulf of Aden in latitude 12°40'N. The Indian surface sea water flowing into the Red Sea has a salinity  $S = 36\%$  and a temperature  $T = 30 \pm 2^{\circ}\text{C}$ , according to the season of the year, but the water concentrates very fast (up to 40% and more) owing to the intense evaporation : a haline frontier can be detected around 18-20°N with a decrease of different taxa. On the contrary, the temperature decreases northwards and therefore the denser waters sink. The Red Sea was invaded by an Indo-pacific fauna during the Pliocene.

Since 1869, both seas have been bound together by the Suez Canal. With the disappearance of the main obstacles (summer Nile floods and high salinities of the Bitter Lakes), the erythrean fauna (fishes, mollusks, crustacea, even phytoplankton and jelly fishes) is invading more and more intensively the Levant basin (Por).

TABLE 1

Thaliacea	Tropical Atlantic Ocean	Canary Islands	Madeira Azores	Western Mediterranean	Eastern Mediterranean
<i>Cyclosalpa pinnata</i>	+	+	+	+	+
<i>C. polae</i>	+	+	+	?	+
<i>C. affinis</i>	+	+	+	+	
<i>C. floridana</i>	+				
<i>C. bakeri</i>	+				
<i>C. virgula</i>	+			+	+
<i>Brooksia rostrata</i>	+	+	+		?
<i>Ihlea asymmetrica</i>	+	+	+	+	+
<i>Salpa maxima</i>	+	+	+	+	+
<i>Salpa fusiformis</i>	+	+	+	+	+
<i>Salpa cylindrica</i>	+	+			
<i>Iasis zonaria</i>	+	+	+	+	+
<i>Thalia democratica</i>	+	+	+	+	+
<i>Thalia orientalis</i>	+	+	+	+	+
<i>Thalia cicar</i>	+				
<i>Thetys vagina</i>	+		+	+	
<i>Pegea confoederata</i>	+	+	+	+	+
<i>Traustedtia multitentaculata</i>	+		+		
<i>Doliolina muelleri</i>	+		+	+	+
<i>Doliolina intermedium</i>	+		+		+
<i>Doliolum denticulatum</i>	+	+	+	+	+
<i>D. nationalis</i>	+		+	+	+
<i>Dolioletta gegenbauri</i>	+		+	+	+
<i>Pyrosoma agassizi</i>			+		
<i>P. spinosum</i>		+	+		
<i>P. atlanticum</i>	+	+	+	+	+
<i>P. aherniosum</i>	+	+			

(Compiled from literature data : 1, 4, 6, 9, 12, 13, 14, 16, 17, 19, '22, 23, 25, 26, 27, 28, 29, 30).

The thaliacean fauna of the western Mediterranean is very diversified and includes Salpidae, Doliolidae and Pyrosomatidae. (Table 1). These animals feed mainly on phytoplankton and microzooplankton (coccolithophorids, diatoms, dinoflagellates, radiolaria); therefore they are directly dependent of the primary production.

The Salpidae are either very or moderately eurytherm ones. *Cyclosalpa pinnata* (Forsk.), *Ihleia asymmetrica* (Fowler), *Salpa maxima* Forsk., *Salpa fusiformis* Cuv., *Iasis zonaria* (Pallas) and *Thalia democratica* (Forsk.) are known in the lusitanian basin; some of these species are carried to Ireland or beyond the British Isles, sometimes to Norway (Bergen) or even to western Iceland (*Salpa fusiformis*) by the North Atlantic Drift (Barnes, Hunt). The same species are also recorded from the tropical Atlantic Ocean.

*Cyclosalpa affinis* (Chamisso) and *Cyclosalpa virgula* (Vogt), *Thetys vagina* Tilesius, *Pegea confederata* (Forsk.) and *P. bicaudata* (Quoy and Gaimard) have accidentally been collected in different parts of the western basin.

The sternoherm Salpidae present in the tropical Atlantic Ocean are completely missing : *Thalia cicar* van Soest does not extend beyond the Cape Verde Islands (15°N), *Salpa cylindrica* Cuv. barely reaches the Canary Islands (30°N). Although *Brooksia rostrata* (Traustedt) and *Traustedtia multitentaculata* (Quoy and Gaimard) have been collected between the Marocco Coast and the Islands of Madeira and Azores (Godeaux and Goffinet, 1968; Godeaux, 1977), they have not been recorded from the Mediterranean (except a doubtful reference concerning *Brooksia rostrata* in Adria, Sigl). On the contrary, *Thalia orientalis* Tokioka, a moderately eurytherm species found as well in tropical areas as off Madeira and Azores (Godeaux, 1973a), may have entered the Mediterranean during the fifties. This species is now collected from Gibraltar to Egypt and forms swarms in the central part of the Sea. The first catches are dated 1954 and have been progressively confirmed from the different parts of the Sea (Fig. 1).

Some samples contain specimens bearing a pair of hemocoelian balancerlike latero-posterior outgrowths. First observed near the Azores, these specimens have now been identified in different stations of the central Mediterranean (Godeaux, 1984a).

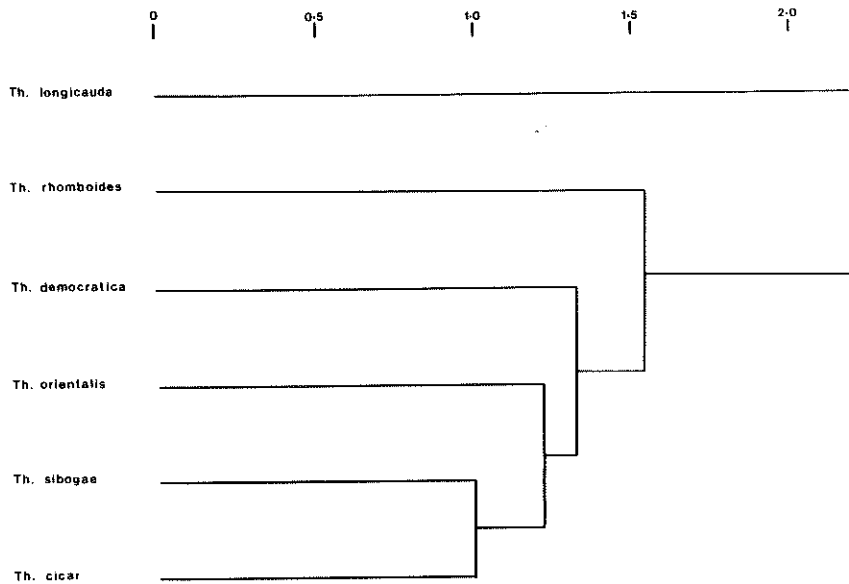


Fig. 1 : Cladogram of the genus *Thalia* (oozooids) (analysed characters : body size, number and grouping of muscle fibres, atrial palps, test projections, test echinations, distribution). (After P. Dauby, unpublished).

The eastern Mediterranean, being less rich in nutrients, is known to have a primary production half as important as that of the western basin. Evaporation is important and the salinity rises above 39‰ in front of Israel and Lebanon. From a general point of view, the fauna is impoverished. Nevertheless numerous species of Salpidae have been recorded, but often in a reduced number of specimens. *Cyclosalpa polae* Sigl described by Sigl (1912-1913) from Adria and Levant basin seems to be characteristic of that part of the Mediterranean (although recently recorded off Naples, van Soest, 1974a). This Salp lives in the three main Oceans, between 40°N and 40°S, except in the Red Sea. *Thalia democratica*, *Thalia orientalis* and *Salpa fusiformis* are widespread, *Salpa maxima* (first record by Forskål, 1775) is frequent in Ionian Sea and Adria. The other species are only known by a few specimens : a single blastozoid of *Pegea confederata* (described from the area by Forskål) has been rather recently found south of Cyprus and so have seven blastozoids of *Ihlea asymmetrica* off Rhodes (Godeaux, 1973a). *Cyclosalpa pinnata* and locally *Iasis zonaria* are also known.

Juvenile colonies (up to 10 cm long) of *Pyrosoma atlanticum* P., the sole mediterranean *Pyrosoma* species, have been caught mostly between 100 and 125 m deep in several hauls performed between Crete and Malta. The presence of tetrazoid colonies attests that mature colonies ( $\geq 12$  cm) could be found in the same zone. *P. atlanticum* is also known from Adria, yet not from the Levantine waters. In the Atlantic Ocean facing Gibraltar, numerous colonies of *Pyrosoma agassizi* and of *P. spinosum* have been caught several times (Godeaux, 1973a, van Soest, 1981) but apparently have never succeeded in entering the Mediterranean.

Most Doliolidae present in both basins are worldwide distributed species : *Doliolina muelleri*, *Doliolina krohni*, *Doliolum denticulatum* Quoy and Gaimard, *Doliolum nationalis* Borg., *Dolioletta gegenbauri* (Ulj.). The samples from the eastern Mediterranean are again poorer; the genera *Doliolina* and *Dolioletta* are often represented by nurses. Beside these species, nurses with narrow muscular rings separated by two to three times wider intervals have been repeatedly collected; they seem to belong to *Doliolina intermedium* (Neum.), species known from the Madeira area (Godeaux, 1973a).

The fauna of the Red Sea (Table 2) comprises worldwide distributed species : *Doliolina krohni*, *Doliolum denticulatum* (main basin and gulf of Elat), *Doliolum nationalis* (gulf of Suez), *Salpa maxima* var. *tuberculata* (van Soest 1974b) and *Iasis zonaria*. The other species are tropical species, missing in the Mediterranean : *Thalia cicar* (quite similar to the specimens from the tropical Atlantic Ocean, Godeaux 1979b), *Thalia rhomboïdes* Quoy and Gaimard (an indopacific species), *Salpa cylindrica* (main basin), *Brooksia rostrata* and *Ritteriella amboinensis* (both quite common in the gulf of Elat). *Pegea confederata* lives in the gulf of Aden and in the south of the Red Sea, extending to 20°N. *Metcalfina hexagona*, a deep water inhabiting species, although observed in the gulf of Aden, does not pass the Straits of Bab el Mandab.

The Pyrosomatidae are completely lacking. Among the Doliolidae, *Doliolina indicum* is the sole Indian species, vicariant of the mediterranean species *Doliolina intermedium* which belongs to the same subgroup. Nurses, phorozoids and gonozoids of *D. indicum* have been described (Godeaux, 1984b).

From the comparison of the Red Sea specimens of *Doliolum denticulatum* and *Doliolum nationalis* with specimens from other places, it can be stressed that the Red Sea animals are dwarf consequence of the severe local ecological conditions. The phorozoid and the gonozoid of *Doliolum denticulatum* respectively reach a length of 3 or 4 mm, instead of 10 mm in mediterranean specimens.

The Mediterranean and the Red Sea have been independantly repopulated by immigrants from different origins. The latitude of the straits and the climatic conditions prevailing in the Oceans in front of the entrances account for the faunistic differences. In the Red Sea, a tropical climate exists from one end to the other, explaining the presence of true tropical species up to 30°N. In the Mediterranean, the Levant basin undergoes a similar climate, but the tropical species have no possibility of colonizing it, except through the Suez Canal. Such an invasion could be effective in the future with consequently a slow uniformization of both faunas.

TABLE 2

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

(Compiled from literature data : 2, 3, 5, 7, 8, 10, 11, 12, 14, 15, 18, 20, 21, 25, 27, 28, 29, 30).



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