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THALIACEA AND CLADOCERA AT BOTH ENDS OF THE SUEZ CANAL

J.E.A. GODEAUX

Marine Biology, University of Liège, B-4020 Liège (Belgium)

ABSTRACT

Thaliacea, Cladocera, Eastern Mediterranean, Northern Red Sea.
The populations of Thaliacea and Cladocera present at both ends of the Suez Canal are defined and the possibilities of a northerly migration through the canal are examined.

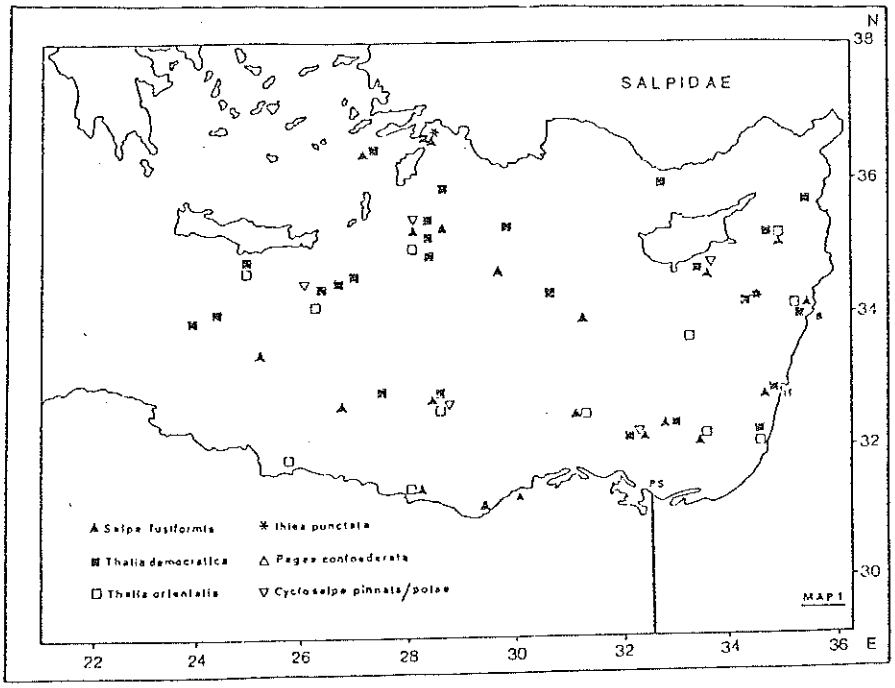
INTRODUCTION

The Mediterranean, a 4000 km long sea, opens into the temperate Atlantic Ocean by 36°N through the Straits of Gibraltar. Eastwards its oriental basin undergoes progressively harder ecological conditions and the levantine area, beyond 25°E, is located in a subtropical arid region. Evaporation is high during the warm season (May to October); salinity off the Palestinian coast is permanently above 39‰ (annual mean : 39.2‰, Lakkis, 1988) since the completion of the Aswan Dam stopped the annual floods of the Nile. The same range of salinities is observed down to 200 m. Surface temperatures vary from 16° to 30°C (Oren, 1957). Fauna is basically eurythermal and euryhaline.
The 2000 km long Red Sea opens into the Indian Ocean by 13°N through Bab-el-Mandab, thus in the subequatorial zone. The Red Sea stretches into a desert arid region where freshwater supply is lacking . In consequence of the intense evaporation, salinity rises from 36‰ in the Gulf of Aden to 41‰ and even more in the Gulf of Suez,when the great Bitter Lake still exercised its influence on this area during the summer. Surface temperatures oscillate between 16° and 30°C according to the season of the year. Fauna displays indopacific tropical characters with some endemic species or subspecies in the northern part.
The Suez canal is a 162 km long, 17 m deep and 200 m broad (maximum) causeway binding two marine areas where ecological conditions appear very similar, at least in the upper layers. A current flows through the Canal,northely and strong in winter, weak or even reversed in summer (Morcos and Messieh, 1973). The canal crosses the Bitter Lakes (36 km altogether) characterized by their high salinity (> 45‰) due both to the dissolution of the salt bed and to the intense evaporation. At the opening of the causeway in 1869, salinity reached 168,8‰ but fell down to 60‰ in two decades; it is slowly decreasing since the beginning of

this century. The lakes act as a barrier (now weakening) or a sieve toward migrant species.
Since the arrival in Port Said by the end of last century, of the swimming crab Neptunus (Portunus) pelagicus, the migration of species from the Red Sea to the Eastern Mediterranean progressively hastened, especially for three or four decades (Por, 1978). Migrants are mainly either active swimmers (e.g. fishes) or passively transported animals (e.g. Mollusks, Ascidians). Things are less clear with regard to the holoplankton as only microalgae, protozoans, medusae and some copepods have passed through the canal (Dowidar, 1976; Halim, 1963, 1965; Kimor, 1972, 1983, 1988). There are no reports until now concerning the heteropod and pteropod Mollusks, Euphausiacae and Thaliacea (for comments see Por, 1978).

OBSERVATIONS

The present paper is devoted to Thaliacea and Cladocera with comparison of the faunas present on both ends of the Suez Canal and discussion about a possible migration.
The thaliacean fauna of the Levantine Basin is rather wellknown thanks to the investigations undertaken since the end of World War and which complete the observations done by A. Sigl (1913). Numerous species have been collected more or less frequently (Godeaux, 1987, 1988).
a) Pyrosomatida. Immature colonies of Pyrosoma atlanticum have been caught, mainly between 70 and 150 m deep, at the western confines of the Basin. There are chances for future catches of the species in the far eastern Mediterranean.
b) Salpidae (map 1).
The commonest species are Salpa fusiformis, Thalia democratica and Thalia orientalis, having been reported from numerous stations, throughout the Basin. Salpa fusiformis and Thalia democratica display a large vertical distribution, from the surface down to 700 m. Thalia orientalis, which seems to have invaded the Mediterranean from the Atlantic Ocean at the beginning of the fifties, was observed off the coasts of Egypt (Godeaux, 1974) and Lebanon (Lakkis, personal communication) and south of Crete and Cyprus, in more or less great numbers, from the surface down to 150 m deep.
A few more but rarely collected species of Salpidae are also known from the basin : Cyclosalpa pinnata et C. polae (Sigl), Ihlea punctata (asymmetrica) and Pegea confoederata (Godeaux, 1973). Curiously enough, Salpa maxima, although recorded from the Central mediterranean and from the Adria, is absent.
Five species of Cladocera are known from the Levantine Basin : Podon polyphemoides, P. intermedius, P. nordmanni, Evadne spinifera, E. tergestina (Kimor, 1983; Lakkis, 1971).
c) Doliolidae (map2).
Doliolina muelleri, D. krohni and D. intermedium are mainly known as nurses. Thanks to a full-grown oozooid and a gonozooid caught off the Egyptian coast, the presence of the two first species is proved. But no blastozooid of D. intermedium has been taken until now; just a few nurses were collected in scattered stations. This species is not yet recorded from the western basin.
Doliolum denticulatum, an oceanic species, is known as nurses, phorozooids and gonozooids largely present in the samplings (sometimes


SALPIDAE
Salpa fusiformis
Ihlea punctata
Thalia democratica
Pegea confoederata
Thalia orientalis
Cyclosalpa pinnata/polae
MAP 1
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36
34
32
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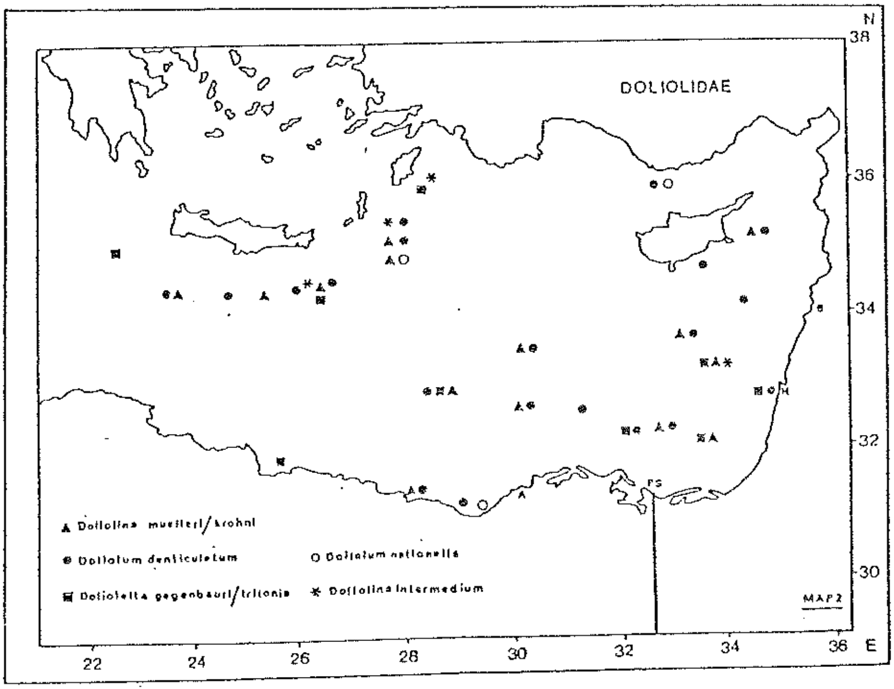
DOLIOLIDAE
Doliolina muelleri/krohni
Doliolum denticulatum
Doliolum nationalis
Dolioletta gegenbauri/tritonis
Doliolina intermedium
MAP 2
N
38
36
34
32
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32
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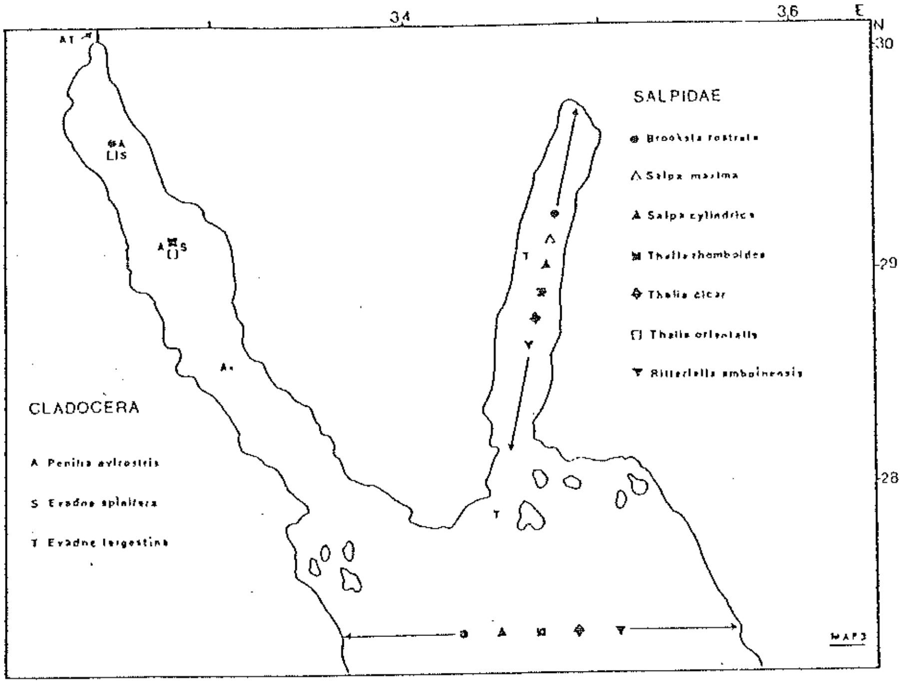
E

several hundred specimens in a single haul).
Doliolum nationalis, a related neritic species, is much less abundant and was only observed in a very few stations. Only phorozooids have been identified up to now. Nevertheless, it must be pointed out that it is not possible yet to separate the nurses of these two species of Doliolum (cryptic species, Godeaux, 1961).
Dolioletta gegenbauri and its closely related species D. tritonis are also known as nurses and cannot be separated (cryptic species).
The majority of the species caught in the Levantine Basin are ubiquitous and they cannot be usefull. The very few species which could be used as indicators of a possible passage from the Mediterranean to the Red Sea (antilessepsian migrations) are : Pyrosoma atlanticum, Cyclosalpa pinnata, C.polae, Salpa fusiformis, Ihlea punctata and Doliolina intermedium (as blastozooids only). The sternothermal, tropical species are missing to the Mediterranean as a whole : Brooksia rostrata, Salpa cylindrica, Thalia cicar, Ritteriella amboinensis and Traustedtia multitentaculata; most of them do not pass the Tropic of Cancer.
The thaliacean fauna of the Red Sea remained less known for long; just a few species were recorded in the past : Salpa cylindrica, S. maxima, S. tuberculata, Thalia democratica (?), Doliolina intermedium (?), Doliolum denticulatum, D. nationalis. More recent investigations proved that this fauna is in fact diversified and that almost all the species recorded in the main basin are also known from the Gulf of Aqaba.
The Tiran Straits (250 m deep) do not hinder the immigration of the epipelagic species (Godeaux, 1973).
Comparatively the Gulf of Suez is less explored; its plankton looks poor.
Brooksia rostrata, Thalia cicar, Ritteriella amboinensis, Salpa cylindrica are the commonest salps (map 3). R.amboinensis, a very rare salp in the open Ocean, seems to be a species selected by the severe ecological conditions existing in a warm hypersaline sea. Thalia rhomboides, Pegea confoederata and Iasis zonaria are also common. Thalia rhomboides and Pegea confoederata form large swarms. Cyclosalpa bakeri, Thalia orientalis, Cyclosalpa affinis are very rare. Salpa maxima and S. tuberculata were only found in the Gulf of Aqaba up to now.
Among the Doliolidae (map 4), Doliolina indicum is the most characteristic species. Are also found Doliolina muelleri, D. krohni and Doliolum denticulatum (as oozooids , nurses and blastozooids), Doliolum nationalis (phorozooids with some gonozooids), Dolioletta gegenbauri and D. tritonis (as nurses; gonozooids of D. tritonis are known from the Gulf of Aqaba). Doliolum nationalis was never found in the Gulf.
All these species are epipelagic, but also invade the upper mesopelagic layer (down to 200 m); with the exception of Ritteriella amboinensis caught as deep as 600 m in the Gulf of Aqaba, catches are scarce in the depth.
A few species of Thaliacea are reported from the Gulf of Suez (only 3 stations operated in 1959, Godeaux, 1974).
Brooksia rostrata (1 blastozooid), Thalia rhomboides (1 oozooid) and curiously enough Thalia orientalis (1 oozooid and a few blastozooids) are the sole salps observed.
Beside Doliolum denticulatum present in the southern part of the Gulf, numerous phorozooids of D. nationalis have been caught in all the area.
Doliolum nationalis is accompanied by two species of Cladocera : Evadne spinifera and Penilia avirostris. A more oceanic species is present in summer in the Gulf of Aqaba and was also discovered in the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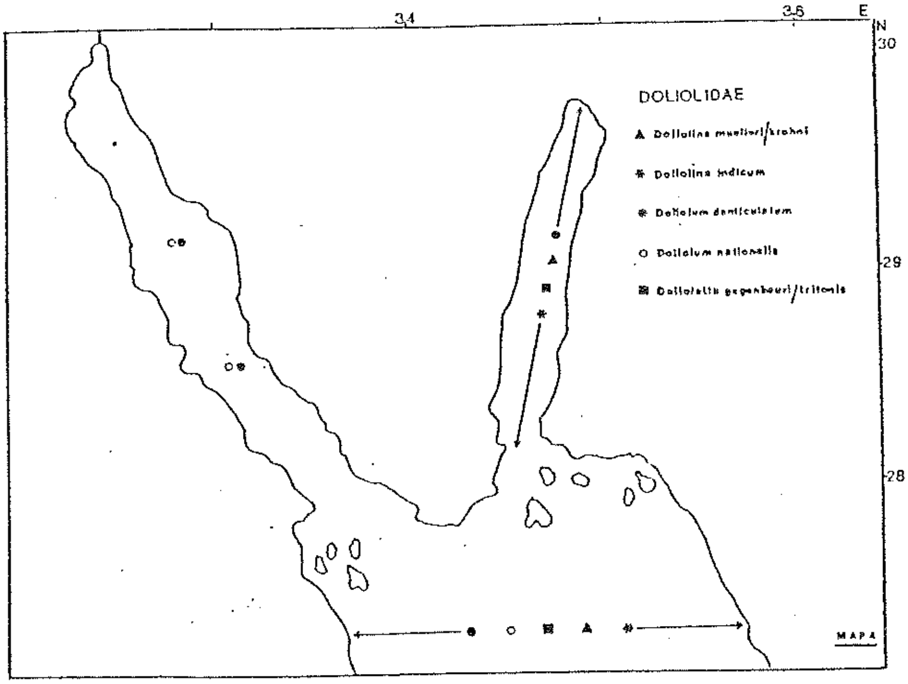
SALPIDAE
CLADOCERA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DOLIOLIDAE

Suez Canal : Evadne tergestina (with Penilia avirostris beyond the Bitter Lakes; Munro Fox,1926).

DISCUSSION and CONCLUSIONS

Up to now, any proof of a migration of Thaliacea species through the Suez Canal is missing. One reason is the want of information on the plankton present either at both ends of the Canal or in the Canal itself. Owing to the high biological pressure made by large populations of a species (eg. Doliolum nationalis) present in the Gulf of Suez, a more or less rapid step by step invasion of the Suez Canal must be expected as possible.
Some epipelagic species (Sagitta neglecta, S. enflata) are reported by Burfield (1926) from both parts of the Canal.
Concerning the Tunicates, numerous species of Ascidians (mainly of Red Sea origin) were collected throughout the length of the Canal (Harant, 1926); at least four of them were reported more recently as settled on the western Israelian coast (Pérès, 1955). Beside the Ascidians, Oikopleura longicauda, a cosmopolitan species, was found in the southern part of the canal and noteworthy at Kabret between the Bitter Lakes.
The factors ruling the migration of a species through the Suez Canal are : salinity, temperature, duration of the travel.
Salinity : the barrier is made by the Bitter Lakes whose salinity still remains higher than that in the Gulf of Suez. Nevertheless numerous species are established in the Bitter Lakes and even overran their limits. Some animals like the Cladocera are able to withstand a broad range of salinities thanks to their neck organ, a typical salt gland involved in ion transport (Meurice and Goffinet, 1983; Meurice, unpublished). It is the reason why Penilia avirostris, a neritic species, and Evadne sp. are found as well in diluted as in concentrated sea water.
Tunicates do not possess a similar organ although their blood composition differs somewhat from the composition of the surrounding sea water. The species found in the Red Sea are known from the Indian Ocean, where different ecological conditions (salinity, temperature) prevail according to the area considered; it is the case for Brooksia rostrata. The Thaliacea living in the Red Sea appear well adapted to this environment; for instance Ritteriella amboinensis is even more frequently caught in this area than elsewhere.
Therefore a slight rise of salinity would not be a sufficient obstacle to migration.
The possible indicators of Lessepsian migration are Brooksia rostrata, Ritteriella amboinensis, Salpa cylindrica, Doliolina indicum and Doliolum nationalis.
Temperature : The relatively low temperatures recorded in winter, when the northerly current is stronger, could be less favourable, although the differences of temperature at both ends of the canal are not great. But the pulsation rate of the trunk muscles will be depressed.
Duration of the migration : If we suppose a mean speed of a knot, theoretically a passive buoy will take about nine days to pass the Canal, say more than the duration of the biological cycle of a Thaliacea whose growth rate is faster. Moreover El-Sharkawy and El Din (1983) claimed the residence time of water in the Great Bitter Lake is about

five months, with a rise of salinity due to evaporation. Then colonization of the Canal by Tunicates must proceed step by step as it the case for the other planktonic organisms. A possible barrier to migration is also the pollution at the southern entrance of the Canal and could be the main reason for a non-migration of delicate animals.
It is obvious that a continuous survey of the fauna of the Canal must be urgently organized in order to detect any invasion of the area by new organisms.

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