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BRYOZOAN FAUNAS AND THE MESSINIAN SALINITY CRISIS

by

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Introduction. In the Mediterranean, the end of the Miocene is notably characterized by widespread deposition of evaporites (ROUCHY, 1982). The so-called "Messinian salinity crisis" has given rise to numerous controversies concerning the causes and amplitude of this sedimentological phenomenon and its biodynamical effects on the Mediterranean floras and faunas at the Miocene/Pliocene boundary. As a matter of fact, rich marine faunas are found in Tortonian to Lower Messinian (preevaporitic) formations whereas a gap is inferred during the deposition of evaporites, followed by reappearance of marine faunas in the lower Pliocene.

Based on these facts, two main hypotheses have been advanced. Some believe that marine floras and faunas were decimated because of the increase in salinity and subsequent drying up of the Mediterranean in the late Messinian. Reimmigration from the Atlantic came afterwards during the Pliocene transgression (HSÜ et al., 1973; CITA, 1976; RUGGIERI and SPROVIERI, 1976). Others are of the opinion that most of the taxa persisted, at least in some basins, due to an uninterrupted connection between the Mediterranean sea and the Atlantic ocean (GAUDANT, 1978; DAVID & POUYET, 1985).

From this point of view some groups have already been studied more or less in detail (RUGGIERI et al., 1969; BENSON, 1976a; CITA, 1976; GAUDANT, 1978). Conclusions drawn from these works supported one or the other of the hypotheses mentioned before. From an analysis of Messinian fossil deposits, we present here observations on how, and if, bryozoan faunas were affected by the massive deposition of salt and gypsum in the Mediterranean at the end of the Miocene.

Messinian bryozoan fauna

Although bryozoans have been found in various Messinian levels, the only deposits studied as yet (Fig. 1) are those of the western parts of the Mesogean realm: Spain, Morocco (EL HAJJAJI, 1982) and Algeria (MOISSETTE, 1984) where more than 200 species of cyclostome and cheilostome bryozoans were identified. From a stratigraphic point of view, most of the deposits studied may be attributed to the Early or Middle Messinian, although some of them may possibly be coeval with evaporite deposition (Late Messinian).

In this paper, we shall confine ourselves to the study solely of the cheilostome bryozoans whose species are better known and more significant. However, a complete understanding of the Messinian bryozoan faunas will have to include, finally, also the Cyclostomata.

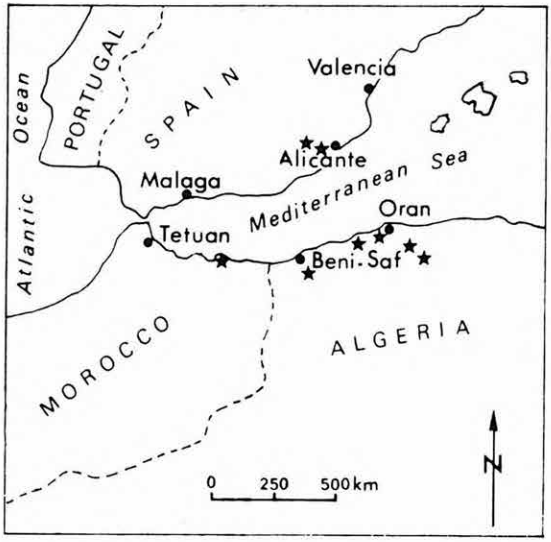

Fig. 1. Geographic distribution of Messinian bryozoan deposits in the Alboran basin (western Mediterranean)

Analysis of the cheilostome faunas

Among the 154 species of cheilostome bryozoans found in the three countries concerned in this study, some are new to science, others were left in open nomenclature. For statistical purposes, only those species already described or new species discovered in at least two countries will be taken into further account. Thus, we only use 122 taxa for our comparisons (Fig. 2).

To establish whether Messinian species ranged into Pliocene, existing literature on Mediterranean Pliocene bryozoans faunas from Italy (CIPOLLA, 1921; POLUZZI, 1971 and 1975), Spain (POUYET, 1976) and Tunisia (BUGE, 1956) was used but no account was taken in Fig. 2 of the species appearing in the Pliocene.

A relatively high number of species (83=68%) are common to the Messinian and the Pliocene (groups 2, 3, 5 and 6). Some of them (26=21%) appeared in the Messinian (or earlier?) and were also found in the lower or upper Pliocene and even in the Pleistocene (group 5) or the Recent (group 6). Among the Messinian (or lower) to Recent species (groups 2, 3, 5 and 6), Mediterranean endemics represent almost 17%. These species are therefore restricted to the Mediterranean basin and could not have been reintroduced from the Atlantic in the Early Pliocene, after the salinity crisis. This percentage could be much higher if we had included taxa that are known in the fossil stage only in the Mediterranean sea but that are found nowadays in the "near Atlantic", beyond the Straits of Gibraltar (Morocco, Portugal, Madeira ...). Their centre of distribution is in the Mediterranean and they are assumed to have migrated to the Atlantic after the Miocene or the Pliocene. Besides, these endemic species in the broader sense are often not distinguished by biologists (GAUTIER, 1962; HARMELIN, 1969; HAYWARD, 1974) from the "real" endemics.

In the Recent cheilostome bryozoan faunas of the Mediterranean, the percentage of endemic species ranges between 32 (western Mediterranean: GAUTIER, 1962) and 44 (eastern Mediterranean: HARMELIN, 1969), whereas in our Messinian faunas, this percentage amounts to 35. This fairly pronounced endemism bears testimony to a prolonged isolation, especially from the Atlantic ocean. However, only 1 *sensu stricto* and 7 *sensu lato* endemic species are known from the Messinian to the Recent. The others disappeared in the interval and were replaced by remnants of Atlantic immigrants and species evolving in situ from indegenous stocks.

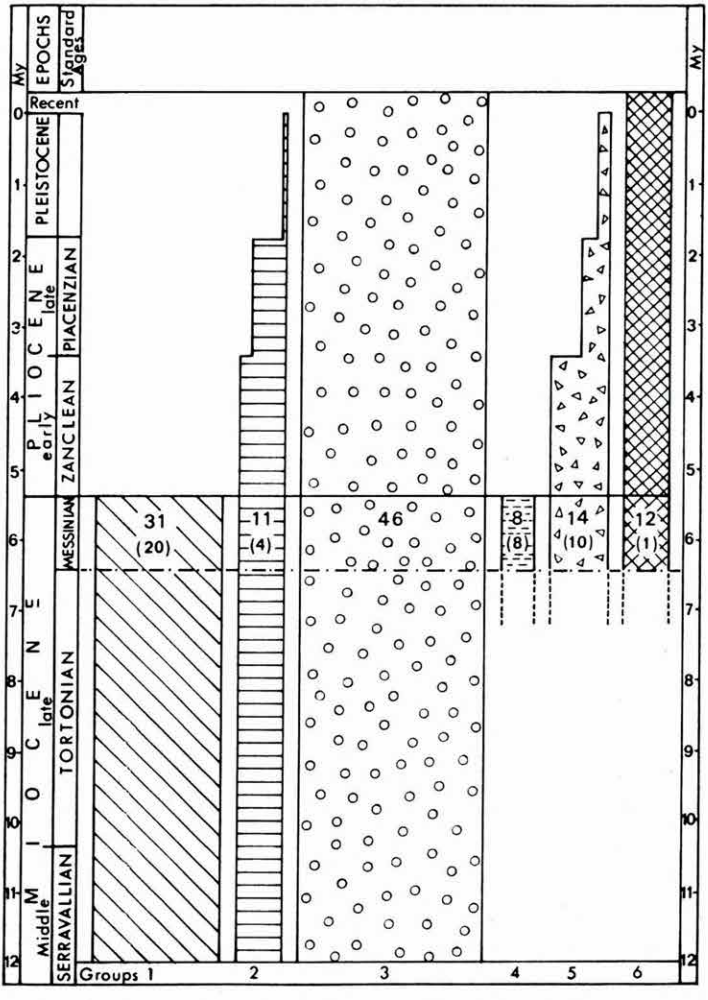

Fig. 2. Diagram showing the stratigraphic distribution of Messinian cheilostome bryozoan species For each group indication is given of the total number of species and, in parenthesis, of the number of endemic species to the Mediterranean basin

Zoogeographical affinities of the Messinian bryozoa

Apart from endemic, temperate-boreal Atlantic and cosmopolitan species, types with tropical affinity—species still living or extinct but belonging to tropical genera (VAVRA, 1980; DAVID & POUYET, 1985)—are found among Messinian to Recent bryozoans. Among the 154 taxa of western Mediterranean Messinian cheilostome bryozoans, the following belong to this group:

Biflustra savarti
**Antropora lecointrei*
Antropora sp.
Chaperia annulus
Tremogasterina catenularia
**Tremogasterina* nov. sp. 1
Tremogasterina nov. sp. 2
Tremogasterina sp.
Tremopora radicifera
Arachnopusia sp.
**Steginoporella cucullata*
**Steginoporella iberica iber.*
**Steginoporella manzonii*
**Steginoporella montenati*
Thalamoporella neogenica
Gephyrophora rostrigera
**Emballotheca* nov. sp. 1
Escharina dutertrei
Stenopsis
Margaretta cereoides
Metrarabdotos canui
Metrarabdotos elegans
Metrarabdotos helveticum
Metrarabdotos lecointrei
Metrarabdotos moniliferum
**Anoteropora aff. persimplex*
**Kionidella* aff. *excelsa*
Lacrimula sp.
Conescharellina sp.

Noteworthy is the fact that the number of tropical types decreases steadily during the Pliocene and the Pleistocene. We have thus 21 species of this group in the Messinian, 10 in the Pliocene, 5 in the Pleistocene and only 2 in the Recent.

Another distinctive feature of the faunas under study is the presence among the tropical taxa of species or genera whose present-day distribution is limited to the Indo—Pacific region:

Tremopora radicifera
Arachnopusia sp.
Gephyrophora rostrigera
**Emballotheca* nov. sp. 1
Escharina dutertrei
Margaretta cereoides
**Anoteropora* aff. *simplex*
**Kionidella* aff. *excelsa*
Lacrimula sp.
Conescharellina sp.

*endemic species

Their presence here must be related to the persistence of a stock of taxa in the Mediterranean since the end of the Early Miocene, when connection with the Indian ocean was disrupted. These forms remained in the Mediterranean and could not have been reintroduced from the Atlantic in the Pliocene; they belong to relics of the palaeomediterranean fauna. Just as for the afore-mentioned group, their number declines progressively: 11 species (7%) in the Messinian and only 3 (2%) in the Recent western Mediterranean.

Conclusions on Messinian cheilostome bryozoan faunas

The data reviewed above indicate that part of the Miocene bryozoan faunas remained in the Mediterranean sea till the Pliocene or further. This could only happen as a result of the persistence of normal marine conditions throughout the Messinian, at least in some basins (DAVID & POUYET, 1985).

Rarefaction and then disappearance of certain species have been progressive, without any major break, and is due essentially to the cooling of the climate (BUGE, 1982).

Nevertheless and in the future, a better knowledge of Neogene bryozoan faunas will still be necessary. This seems particularly true for the Atlantic side (Morocco, Portugal, Spain...), for the western and especially eastern (poorly known) Mediterranean and also for the Indian ocean. We shall then be able to better assess the extent of the faunistic modifications connected with the various events occurring near the Miocene/Pliocene boundary.

Other evidence

Comparable phenomena are noted in some other groups of marine organisms: molluscs (RUGGIERI et al., 1969, GRECCHI, 1977), fishes (GAUDANT, 1978)... although foraminifera (ADAMS, 1976; CITA, 1976) or ostracods (BENSON, 1976b; SISSINGH, 1976) seem to exhibit different patterns and be more sensitive to the salinity crisis.

The complete and definitive disappearance of the hermatypic corals at the end of the Messinian, often invoked in support of "catastrophic" models is only the consequence of modifications—essentially of climatic origin—already initiated during the Tortonian or before: decrease in the number of species and predominance of the genera *Porites* and *Tarbellastraea* (ESTEBAN, 1979; SAINT-MARTIN, 1984).

It should be pointed out, however, that at the end of the Messinian marine faunas hitherto known are principally represented by planktonic forms (often dwarfed) and that, consequently, a continuity of marine conditions is hard to presume for benthic forms such as bryozoans. A set of concordant field observations shows nevertheless the persistence of normal marine conditions in some places of the Mediterranean, even at the end of the Messinian, during deposition of evaporites. We may mention for example the intercalation of normal marine deposits inside gypsiferous sequences —with planktonic but also benthic faunas (MONTENAT et al., 1980)—and the presence of marine deposits above evaporites (ROUCHY, 1982). On the other hand, the evaporitic phenomenon is not so general, so complete than one may think at first: some Messinian basins do not have evaporites at all, Morocco, western Oranie (ROUCHY, 1982) and a marine continuity of sedimentation between Miocene and Pliocene has been suggested by several authors, notably in the western basins (MONTENAT et al., 1976). Lastly, gypsum depositions may occur before the late Messinian. We have thus gypsiferous intercalations inside diatomites (Spain: Lorca; ROUCHY, 1982) and gypsum may be found in some sequences at the end of the Tortonian (Spain: Fortuna, Albanilla; MONTENAT, 1977). There thus exists during the Messinian a diachronism (ROUCHY, 1982) in evaporite deposition: normal marine conditions continued to predominate in some basins, whereas in others growing confinement led to the deposition of evaporites.

Conclusion

On the basis of evidence presented here, a complete disappearance of marine faunas during the salinity crisis is not favoured. Planktonic and benthic organisms remained in situ in some basins during all the Messinian. Atlantic water inlet probably never ceased totally through the Betic-Rif zone. Climatic changes—cooling (BIZON &

MÜLLER, 1976; DEMARCQ, 1979; HEIMANN, 1979)—are then the main factors that induced modifications in the bryozoan and other marine (PÉRÈS & PICARD, 1964) faunas of the Mediterranean and other oceans (BOURROUILH-LE JAN, 1979).

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