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Ostracods from the National Park of La Maddalena Archipelago (Sardinia, Italy)

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ABSTRACT – The infralittoral ostracod fauna recovered from 85 samples collected in the marine National Park of La Maddalena Archipelago (north-eastern Sardinia) consists of 154 species, most of them already reported in the Mediterranean area. This study focuses on the recognition of the ostracod-depth and ostracod-substrate relations. Eight main ostracode depth-related groups are identified: a group of species presents at all depths analysed in this work, a group presents at low and middle depths, and a group presents at the greatest depth. As far as sediment texture is concerned, one group of ostracods is present in all classes (sand, pelitic sand, very sandy pelite and sandy pelite) while four more groups appear to be exclusive of each class. According to these data, either generalistic (occurring at all the depths and on all the types of grain size classes) or exclusive species (characteristic of a specific depth and texture) were evidenced.

RIASSUNTO – [L'ostracofauna del Parco Nazionale dell'Arcipelago de La Maddalena] – È stata studiata l'ostracofauna infralittorale dell'Arcipelago de La Maddalena da 85 campioni di sedimento. In questi campioni sono state individuate 154 specie di ostracodi, la maggior parte delle quali già segnalate nell'area mediterranea. Lo studio è volto ad evidenziare le relazioni tra l'ostracofauna trovata ed i fattori ambientali batimetria e substrato. La relazione con la batimetria ha permesso di individuare 8 gruppi di ostracodi, comprendenti le forme presenti in tutto l'intervallo esaminato, dai 2 ai 7 m, a batimetrie intermedie, dai 32 ai 57 m. La relazione con il substrato ha evidenziato invece 9 gruppi di ostracodi, comprendenti le forme presenti in tutte le classi tessiturali trovate (sabbia, sabbia pelitica, pelite molto sabbiosa e pelite sabbiosa), in due o tre classi tessiturali e le forme esclusive per ogni classe tessiturale. Sulla base di questi dati, si sono evidenziate le specie generaliste, presenti a tutte le profondità e con tutti i tipi di sedimento, e le specie esclusive, presenti a specifici intervalli batimetrici e con substrati ben definiti.

INTRODUCTION

The Archipelago of La Maddalena is an interesting area for the ecological investigations, since it comprises both natural and anthropized settings. Thus, it represents a good field of research to evidence the role of the ostracods in defining different environmental conditions as required by INTERREG 2: "Protection, valorization and management of Sardo-Corso environment" (Resp. prof. A. Cherchi).

The investigated sea floors are included in the infralittoral stage, showing a depth-range of 2-57 m, and substrates mainly characterized by a high sandy content, with or without vegetation (mainly *Posidonia oceanica*).

The modern infralittoral ostracods of the Mediterranean area have been studied for more than a century. Müller's monography (1894) on the Gulf of Naples represents a basic source for this research. Other works followed this monography. In particular, Puri *et al.* (1964) wrote a very important review on the ostracods of the Gulf of Naples, Ascoli (1964), Masoli (1967-68, 1969), Breman (1975), Bonaduce *et al.* (1975) focused their attention on the Adriatic sea; moreover, Bonaduce *et al.* (1977) and Bonaduce & Gervasio (1966) studied the northern Tyrrhenian sea and the Gulf of Salerno, respectively. Subsequently, a synthesis on the ostracods of the Italian shelves is due to Montenegro *et al.* (1998).

This research also takes into account the works regarding different areas of the Mediterranean Sea, i.e. Algerian coastal area (Yassini, 1979), Tunisian platform (Bonaduce *et al.*, 1988), and the seafloors near Lebanon (Bonaduce *et al.*, 1970) and Cyprus (Athersuch, 1979).

The goal of this work is a detailed study of the ostracod fauna from the infralittoral substrates of La Maddalena Archipelago, in order to refine the taxonomic and ecological knowledge of the ostracods there found. Moreover, this work plans to identify the links depth-ostracods and sediment-ostracods in order to obtain ecological data useful for ecologic and palaeoecologic studies.

MATERIALS AND METHODS

This study concerns the analysis of 85 sediment samples (Text-fig. 1), collected by means of the Van Veen grab (capacity of 2 dm³) along several transects. The samplings were performed during two oceanographic cruises organized by prof. S. De Muro of the Department of the Earth Science of Cagliari University, with the collaboration of the Department of Geological, Environmental and Marine Science of Trieste University and the Department of Palaeobiology Museum and Botanical Garden of Modena and Reggio Emilia University. Moreover, O.C.E.A.N.U.S. (Observatory Coast and Natural Underwater Environment

of the Palau municipality – Sassari) has been the sponsor of this research.

The sampling operations were addressed to grain size and micropalaeontologic analyses. The former was carried out by the sedimentologists (G.P. Fanzutti and R. Piani) of Department of Geological, Environmental and Marine Science of Trieste University.

The latter concern a subsample of 50 cm³ of sediment fixed with 2% formalin. This subsample was washed through a 63 µm mesh and dried at 50°C. Samples constituted by abundant material were splitted.

OSTRACOFAUNA

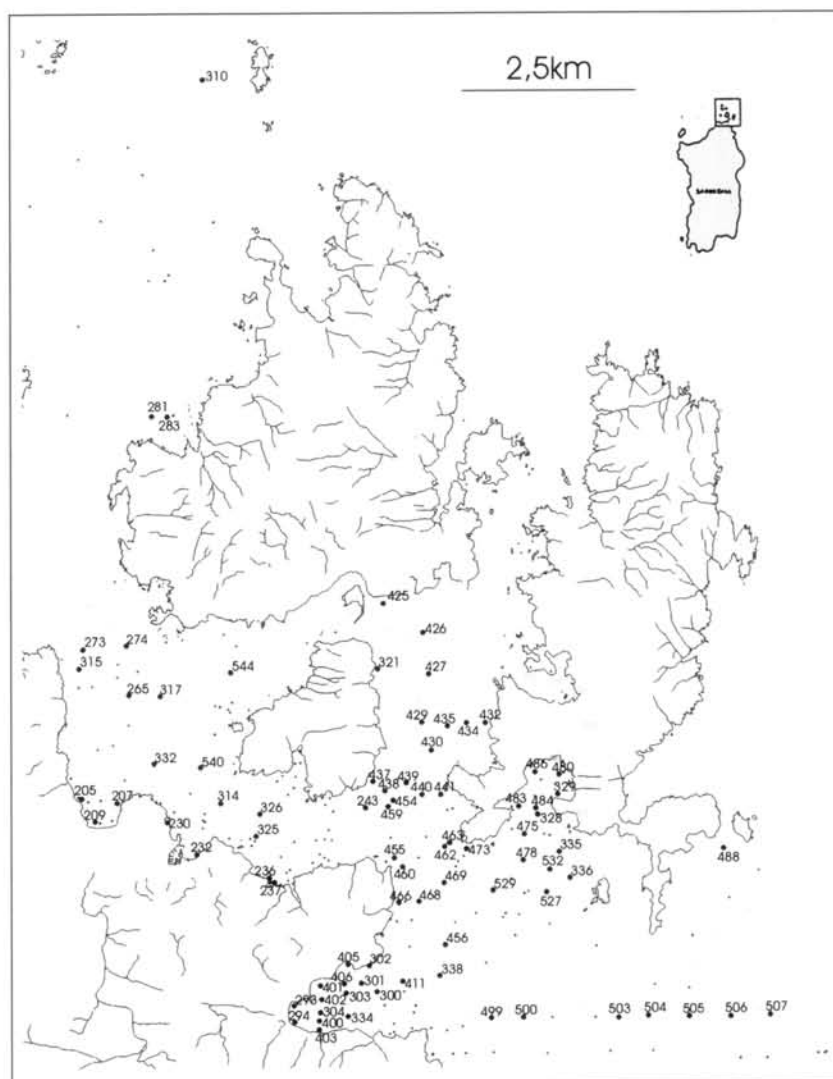
The 85 studied samples yielded 150 species of ostracods belonging to 56 genera. Of these species, 56 are temporarily maintained in open nomenclature. Of them, 10 species belong to *Paradoxostoma*, 10 species

to *Callistocythere*, and 7 species to *Semicytherura*; in addition, others are represented by young specimens or are in bad preservation state.

In this work, the autochthonous forms are considered those living during the sampling (biocoenoses) or dead (thanatocoenoses) but represented by complete carapaces and/or adult valves, together with young instars. In the latter case the species are considered autochthonous, since they show their different development stages, thus recording the continuity of the ontogenetic cycle in that sampling station.

The allochthonous form instead are characterized by the exclusive presence of carapace or valves of young instars, carapaces or valve of adult without young instars, carapaces or valve in a bad condition of preservation.

Summing up, 87 species are autochthonous in at least one sampling station, while 63 are always allochthonous.



Text-fig. 1 - Location map of sampling stations.

OSTRACODS AND ENVIRONMENT

In the Mediterranean area, several authors (i.e. Puri *et al.*, 1964; Bonaduce *et al.*, 1975; Breman, 1975; Montenegro *et al.*, 1998) discussed the relation between ostracods and environmental factors. In particular, they focused their attention on depth and substrate. The links ostracods-depth and ostracods-substrate are discussed below.

OSTRACODS AND DEPTH

Almost all the ostracod species found are well known in the Mediterranean basin, as documented by the previously mentioned literature. Tab. 1 evidences the distribution of the autochthonous species versus depth. The species are listed in increasing order of depth. The analysis of this table enables us to identify 8 groups (D) of species. The species with (*) have been found in only one sampling station; they are provisionally included in the D groups.

In D1 group the species are present at all depths analysed in this work, in D2-D7 groups the species are present at low and middle depths, and in D8 group the species are present at the greatest depth (below the 32 m until 57 m, the greatest depth of this research).

The 8 D groups are:

D1 – depth 2-57 m.

It is formed by 21 species: *Bairdia mediterranea*, *Carinocythereis whitei*, *Loxoconcha ovulata*, *Loxoconcha rhomboidea*, *Urocythereis* gr. *favosa* (at all depths), *Aurila fallax*, (starting from 4 m), *Cytherelloidea sordida*, *Cistacythereis* aff. *C. rubra* (disappearing at 40 m), *Propontocypris pirifera*, *Xestoleberis* gr. *dispar* (disappearing at 42 m), *Aurila convexa*, *Callistocythere lobiancoi*, *Loxoconcha affinis*, *Loxoconcha exagona*, *Paracytheridea* gr. *depressa*, *Tenedocythere prava*, *Xestoleberis communis*, *Xestoleberis plana* (disappearing at 46 m) *Callistocythere* sp. (5-40 m), *Bairdia reticulata*, *Semicytherura acuticostata* (6-46 m).

D2 – depth 2-7 m.

It is formed by 9 species: *Basslerites berchoni**, *Paradoxostoma* cf. *P. simile**, *Cytheretta adriatica*, *Procytherideis complicata*, *Bythocythere turgida**, *Xestoleberis pellucida**, *Callistocythere folliculosa**, *Callistocythere ? badia*, *Microceratina pseudoanfibola*.*

D3 – depth 2-39 m.

It is formed by 9 species: *Aglaioocypris complanata*, *Sclerochilus contortus*, *Costa batei*, *Loxoconcha stellifera*, *Neocytherideis fasciata*, *Urocythereis* gr. *margaritifera*, *Microcythere inflexa*, *Cytherois frequens*, *Cyprideis torosa* (2-32 m), a paralic species, is included into this group.

D4 – depth 5-26 m.

It is formed by 7 species: *Heterocythereis* sp. 1*, *Semicytherura alifera*, *Costa* sp. 1, *Paradoxostoma* cf. *P.*

*versicolor** (present only at 20 m), *Propontocypris* cf. *P. pirifera**, *Semicytherura rarecostata** (present only at 22 m), *Paradoxostoma* sp. 1* (present only at 26 m).

D5 – depth 6-33 m.

It is formed by 3 species: *Semicytherura dispar*, *Propontocypris intermedia*, *Caudites calceolatus*.

D6 – depth 6-46 m.

It is formed by 5 species: *Pseudopsammocythere reniformis*, *Cistacythereis turbida* (appears at 6 m and disappears at 42 m) *Pontocypris acuminata* (appears at 7 m and disappears at 46 m), *Callistocythere adriatica*, *Semicytherura paradoxa* (appears at 13 m and disappears at 46 m).

D7 – depth 19-57 m.

It is formed by 9 species: *Bairdia longevaginata* (19-57 m), *Callistocythere* sp. 5 and *Semicytherura inversa* (22-46 m), *Cytheretta subradiosa* (22-57 m), *Aurila* cf. *A. hesperiae* (26-37 m), *Carinocythereis antiquata* (26-57 m), *Callistocythere* sp. 1 (27-46 m), *Bairdia formosa* (28-46 m), *Callistocythere* sp. 6 (30-46 m).

D8 – depth below 32 m.

It is formed by 24 species: *Paradoxostoma* cf. *P. triste** (32 m), *Callistocythere flavidofusca*, *Echinocythereis laticarina*, *Platyleberis* sp. 1, *Semicytherura incongruens* (32-46 m), *Pterygocythereis jonesi* (32-57 m), *Paradoxostoma* sp.**, *Semicytherura* sp.* (33 m), *Callistocythere* sp. 2 (33-39 m), *Tetracytherura angulosa* (33-46 m), *Callistocythere littoralis** (35 m), *Costa edwardsi* (35-40 m), *Cytheridea neapolitana**, *Leptocythere ramosa** (37 m), *Semicytherura* cf. *S. aenariensis* (37-39 m), *Pontocythere turbida* (37-57 m), *Paradoxostoma* cf. *P. intermedium** (38 m), *Pterygocythereis siveteri*, *Sagmatocythere versicolor* (38-42 m), *Bosquetina dentata* (38-46 m), *Semicytherura* aff. *S. inversa** (40 m), *Buntonia giesbrechtii**, *Callistocythere* sp. 7*, *Sagmatocythere littoralis** (40 m).

From these data, it is possible to identify characteristic species with different capability to tolerate different depth ranges.

A high capability to tolerate wide ranges of depth characterizes group D1. Thus, the corresponding species denote a reduced sensibility with respect to the depth changes.

The capability to tolerate very reduced depth ranges characterizes the groups D2 and D8. The corresponding species occur at 2-7 m and below 32 m, respectively, so denoting a high sensibility to depth changes.

Intermediate capability to tolerate depth changes characterizes the species of groups D4 and D5 (medium-low depths), D6 and D7 (medium-high depths).

The identification of the eight D groups allows to refine the knowledge of the ostracods depth distribution in the infralittoral stage of the Archipelago.

These data, related to the ostracod bathymetric dis-

tribution in the Mediterranean area, show that for most part of the species found in the Archipelago, the bathymetric range is equal to the depth distribution reported in previous literature on the Mediterranean basin. However, *Microceratina pseudoanfibola*, found in the Mediterranean basin below 110 m (Bonaduce *et al.*, 1975, Bonaduce *et al.*, 1981) has also been found in the Archipelago at 7 m of depth; *Loxoconcha exagona* occurring below 18 m in the Mediterranean basin, has been found at 2 m; *Propontocypris pirifera* and *Pseudopsammocythere reniformis*, found in Mediterranean basin below 10 m, have been found in the Archipelago at 2 and at 6 m respectively.

OSTRACODS AND SUBSTRATE

Tab. 2 summarizes the relation between ostracod fauna and substrate. The substrate has been defined

using the classification of Nota (1958), that allowed to identify 4 textural classes: sand (S), pelitic sand (PS), very sandy pelite (VSP), and sandy pelite (SP), as reported by Fanzutti *et al.* (2000, 2001) and Fanzutti & Piani (personal communication, 2002).

It allows to identify 9 groups (S) of species. The species with (*) have been found in one sample only, and are provisionally included in the S groups.

S1 – all textural classes.

It is formed by 16 species: *Aurila convexa*, *Aurila fallax*, *Bairdia mediterranea*, *Callistocythere adriatica*, *Callistocythere lobiancoi*, *Carinocythereis whitei*, *Cistacythereis* aff. *C. rubra*, *Costa batei*, *Loxoconcha affinis*, *Loxoconcha exagona*, *Loxoconcha ovulata*, *Loxoconcha rhomboidea*, *Propontocypris pirifera*, *Tenedocythere prava*, *Xestoleberis communis*, *Xestoleberis* gr. *dispar*.

	S	PS	VSP	SP
<i>Aurila convexa</i>				
<i>Aurila fallax</i>				
<i>Bairdia mediterranea</i>				
<i>Callistocythere adriatica</i>				
<i>Callistocythere lobiancoi</i>				
<i>Carinocythereis whitei</i>				
<i>Cistacythereis</i> aff. <i>C. rubra</i>				
<i>Costa batei</i>				
<i>Loxoconcha affinis</i>				
<i>Loxoconcha exagona</i>				
<i>Loxoconcha ovulata</i>				
<i>Loxoconcha rhomboidea</i>				
<i>Propontocypris pirifera</i>				
<i>Tenedocythere prava</i>				
<i>Xestoleberis communis</i>				
<i>Xestoleberis</i> gr. <i>dispar</i>				
<i>Carinocythereis antiquata</i>				
<i>Cytherelloidea sordida</i>				
<i>Cytheretta subradiosa</i>				
<i>Paracytheridea</i> gr. <i>depressa</i>				
<i>Pontocypris acuminata</i>				
<i>Pterygocythereis jonesi</i>				
<i>Semicytherura inversa</i>				
<i>Urocythereis</i> gr. <i>favosa</i>				
<i>Xestoleberis plana</i>				
<i>Cistacythereis turbida</i>				
<i>Propontocypris intermedia</i>				
<i>Pseudopsammocythere reniformis</i>				
<i>Semicytherura paradoxa</i>				
<i>Aurila</i> cf. <i>A. hesperiae</i>				
<i>Bairdia formosa</i>				
<i>Bairdia longevaginata</i>				
<i>Callistocythere</i> sp.6				
<i>Cytheretta adriatica</i>				
<i>Loxoconcha stellifera</i>				
<i>Neocythereis fasciata</i>				
<i>Pontocythere turbida</i>				
<i>Procythereis complicata</i>				
<i>Tetracytherura angulosa</i>				
<i>Urocythereis</i> gr. <i>margaritifera</i>				
<i>Aglaocypris complanata</i>				
<i>Callistocythere flavidofusca</i>				
<i>Callistocythere</i> sp.5				

	S	PS	VSP	SP
<i>Caudites calceolatus</i>				
<i>Cyprideis torosa</i>				
<i>Cythereis frequens</i>				
<i>Microcythere inflexa</i>				
<i>Platyleberis</i> sp.1				
<i>Sclerochilus contortus</i>				
<i>Semicytherura acuticostata</i>				
<i>Semicytherura incongruens</i>				
<i>Bythocythere turgida</i>				
<i>Semicytherura</i> sp.				
<i>Xestoleberis pellucida</i>				
<i>Bairdia reticulata</i>				
<i>Basslerites berchoni</i>				
<i>Bosquetina dentata</i>				
<i>Buntonia giesbrechti</i>				
<i>Callistocythere littoralis</i>				
<i>Callistocythere</i> sp.1				
<i>Callistocythere</i> sp.2				
<i>Callistocythere</i> sp.7				
<i>Costa edwardsi</i>				
<i>Cytheridea neapolitana</i>				
<i>Echinocythereis laticarina</i>				
<i>Heterocythereis</i> sp.1				
<i>Leptocythere ramosa</i>				
<i>Paradoxostoma</i> sp.				
<i>Paradoxostoma</i> cf. <i>P. simile</i>				
<i>Pterigocythereis siveteri</i>				
<i>Sagmatocythere littoralis</i>				
<i>Sagmatocythere versicolor</i>				
<i>Semicytherura</i> aff. <i>S. inversa</i>				
<i>Semicytherura</i> cf. <i>S. aenariensis</i>				
<i>Microceratina pseudoanfibola</i>				
<i>Callistocythere</i> ? <i>Badia</i>				
<i>Callistocythere folliculosa</i>				
<i>Callistocythere</i> sp.				
<i>Costa</i> sp.1				
<i>Paradoxostoma</i> cf. <i>P. triste</i>				
<i>Paradoxostoma</i> sp.1				
<i>Semicytherura alifera</i>				
<i>Semicytherura dispar</i>				
<i>Semicytherura rarecostata</i>				
<i>Paradoxostoma</i> cf. <i>P. versicolor</i>				

Tab. 2 - Ostracods and sediment.

S2 – S, PS, and VSP.

It is formed by 9 species: *Carinocythereis antiquata*, *Cytherelloidea sordida*, *Cytheretta subradiosa*, *Paracytheridea* gr. *depressa*, *Pontocypris acuminata*, *Pterygocythereis jonesi*, *Semicytherura inversa*, *Urocythereis* gr. *favosa*, *Xestoleberis plana*.

S3 – PS, VSP, and SP.

It is formed by 4 species: *Cistacythereis turbida*, *Propontocypris intermedia*, *Pseudopsammocythere reniformis*, *Semicytherura paradoxa*.

S4 – S and PS.

It is formed by 11 species: *Aurila* cf. *A. hesperiae*, *Bairdia formosa*, *Bairdia longevaginata*, *Callistocythere* sp. 6, *Cytheretta adriatica*, *Loxoconcha stellifera*, *Neocytherideis fasciata*, *Pontocythere turbida*, *Procytherideis complicata*, *Tetracytherura angulosa*, *Urocythereis* gr. *margaritifera*.

S5 – PS and VSP.

It is formed by 11 species: *Aglaiocypris complanata*, *Callistocythere flavidofusca*, *Callistocythere* sp. 5, *Caudites calceolatus*, *Cyprideis torosa*, *Cytherois frequens*, *Microcythere inflexa*, *Platyleberis* sp. 1, *Sclerochilus contortus*, *Semicytherura acuticostata*, *Semicytherura incongruens*.

S6 – only S.

It is formed by 3 species: *Bythocythere turgida**, *Semicytherura* sp.**, *Xestoleberis pellucida**.

S7 – only PS.

It is formed by 20 species: *Bairdia reticulata*, *Basslerites berchoni**, *Bosquetina dentata*, *Buntonia giesbrechtii**, *Callistocythere littoralis**, *Callistocythere* sp. 1, *Callistocythere* sp. 2, *Callistocythere* sp. 7*, *Costa edwardsi*, *Cytheridea neapolitana**, *Echinocythereis laticarina*, *Heterocythereis* sp. 1*, *Leptocythere ramosa**, *Paradoxostoma* sp.**, *Paradoxostoma* cf. *P. simile**, *Pterygocythereis siveteri*, *Sagmatocythere littoralis**, *Sagmatocythere versicolor*, *Semicytherura* aff. *S. inversa**, *Semicytherura* cf. *S. aenariensis*.

S8 – only VSP.

It is formed by 10 species: *Microceratina pseudoanfibola**, *Callistocythere* ? *badia*, *Callistocythere folliculosa**, *Callistocythere* sp., *Costa* sp. 1, *Paradoxostoma* cf. *P. triste**, *Paradoxostoma* sp. 1*, *Semicytherura alifera*, *Semicytherura dispar*, *Semicytherura rarecostata**.

S9 – only SP.

It consists of *Paradoxostoma* cf. *P. versicolor**.

These groups could indicate ostracods assemblages in relation with a particular grain size. The most part of ostracod fauna is recorded in two or more grain size classes. Many species are found in pelitic sand, while in sandy pelite only one species is found.

Analysing these data, it is possible to identify species which are more or less selective concerning the preference for the substrate.

The most tolerant species to grain size variations belong to group S1, which consists of forms present in all the textural classes. The least tolerant species were the groups S6, S7, S8, and S9, characterized by taxa occurring in only one textural class. Groups S2-S3 and S4-S5 include species present in three and two grain size classes, respectively, so denoting an intermediate capability to tolerate grain size variations of the substrate. Thus, these groups enable to identify a hierarchy of species characterized by the extremes "most" and "least" selective taxa in relation to their presence in one or more textural grain size classes.

DISCUSSION AND CONCLUSIONS

The study of the infralittoral ostracod fauna in the Archipelago of La Maddalena highlights taxonomic and ecological results.

From the taxonomic point of view, 150 species of ostracods, belonging to 56 genera, are recognized. Of these species, 56 are temporarily maintained in open nomenclature; some of them are probably new species.

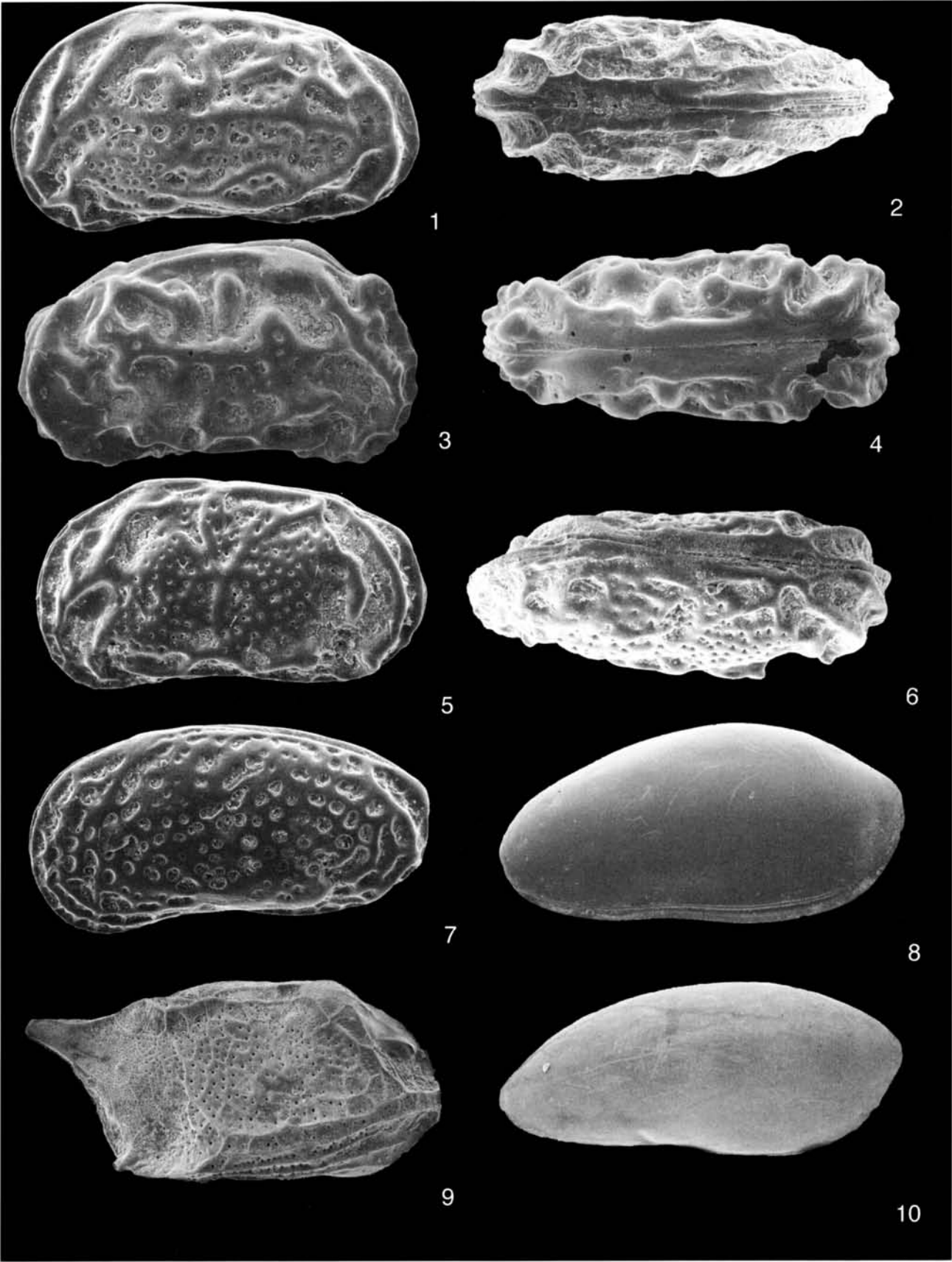
From the ecological point of view, the relation be-

EXPLANATION OF PLATE 1

SEM photomicrographs of some species:

- Fig. 1 - *Callistocythere* ? *badia* (Norman, 1862). Lateral exterior view (left valve, 138x);
- Fig. 2 - *Callistocythere* ? *badia* (Norman, 1862). Complete carapace in dorsal view (140x);
- Fig. 3 - *Callistocythere* sp. 7. Lateral exterior view (right valve, 129x);
- Fig. 4 - *Callistocythere* sp. 7. Complete carapace in dorsal view (135x);
- Fig. 5 - *Callistocythere* sp. 1. Lateral exterior view (left valve, 135x);
- Fig. 6 - *Callistocythere* sp. 1. Complete carapace in dorsal view (135x);
- Fig. 7 - *Callistocythere* sp. 2. Lateral exterior view (left valve, 138x);
- Fig. 8 - *Paradoxostoma* cf. *P. simile* G.W. Müller, 1894. Lateral exterior view (left valve, 93x);
- Fig. 9 - *Semicytherura* cf. *S. aenariensis* Bonaduce, Ciampo, Masoli, 1975. Lateral exterior view (right valve, 143x);
- Fig. 10 - *Paradoxostoma* cf. *P. triste* G.W. Müller, 1894. Lateral exterior view (left valve, 86x).

These species are considered as markers of specific depths and substrates (see the text). Most species are in open nomenclature.



tween autochthonous forms and environmental factors (in particular depth and substrate) have been highlighted.

Concerning the relation between ostracods and depth, 8 characteristic groups of species (D1-D8) have been recognized. These groups include species that are present in a more or less wide bathymetric range of the infralittoral stage. The identification of these groups allows to subdivide the infralittoral stage on the bases of bathymetric data. Excluding group D1 and, partly, group D3, which consists of species present in a very wide depth range, it is possible to utilize other groups to highlight ostracods occurring in the shallowest (group D2), intermediate (D4-D6) and deepest settings of the infralittoral stage (D7-D8). Moreover, additional results are the refinement of the bathymetric distribution of the species. Some species widen their bathymetric range: in previous literature, *Microceratina pseudoanfibola* occurs at depths below 118 m, but in this area it has been found at 7 m. *Loxoconcha exagona*, *Propontocypris pirifera*, *Pseudopsammocythere reniformis* are found at more reduced depths in the Archipelago than other Mediterranean shallow infralittoral areas.

The study of the relation between ostracods and substrate (grain size classes) evidenced 9 characteristic groups (S1-S9) of species. Except group S1, consisting of species present in all the grain size classes, other groups evidence ostracods occurring on a reduced number of grain size classes. Some groups (S6-S9) denote an evident preference for only one grain size.

Combining the data derived from depth and substrate groups of the Archipelago, it is possible to highlight two categories of species: generalistic and exclusive species.

The generalistic species occur at all the depths and on all the types of grain size classes; the exclusive species are present in a specific bathymetric range and a well-defined substrate.

Fourteen generalistic species have been found. They consist of: *Aurila convexa*, *Aurila fallax*, *Bairdia mediterranea*, *Callistocythere lobiancoi*, *Carinocythereis whitei*, *Cistocythereis* aff. *C. rubra*, *Loxoconcha affinis*, *Loxoconcha exagona*, *Loxoconcha ovulata*, *Loxoconcha rhomboidea*, *Propontocypris pirifera*, *Tenedocythere prava*, *Xestoleberis communis*, and *Xestoleberis* gr. *dispar*.

Among the exclusive species, it is possible to identify:

Species found between 2 and 7 m:

- only on sand: *Bythocythere turgida* and *Xestoleberis pellucida*;

- only on pelitic sand: *Basslerites berchoni*, *Paradoxostoma* cf. *P. simile*;

- only on very sandy pelite: *Microceratina pseudoanfibola*, *Callistocythere* ? *badia*; *Callistocythere folliculosa*.

Species found between 19 and 57 m:

- only on pelitic sand: *Callistocythere* sp. 1.

Species found between 32 and 57 m:

- only on sand: *Semicytherura* sp.;

- only on pelitic sand: *Bosquetina dentata*, *Buntonia giesbrechti*, *Callistocythere littoralis*, *Callistocythere* sp. 2, *Callistocythere* sp. 7, *Costa edwardsi*, *Cytheridea neapolitana*, *Echinocythereis laticarina*, *Leptocythere ramosa*, *Paradoxostoma* sp., *Pterygocythereis siveteri*, *Sagmatocythere littoralis*, *Sagmatocythere versicolor*, *Semicytherura* aff. *S. inversa*, *Semicytherura* cf. *S. aenariensis*;

- only on very sandy pelite: *Paradoxostoma* cf. *P. triste*.

These environmental data evidence species that may become very useful in palaeoecological interpretations. Actually, most of these species are diffused in the Quaternary (Ruggieri, 1961, 1975, 1976; Barra, 1991; Ciampo, 1971) and Pliocene (Colalongo & Pasini, 1980; Butturini, 1991), allowing to utilize these assemblages for paleoenvironmental study. In particular, the identification of generalistic and exclusive species may refine these palaeoenvironmental interpretations. Moreover, these species may be also useful for environmental monitoring, since their recognition could highlight different ecological conditions linked to stability or instability.

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