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*Short review*

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# THE MICROCRUSTACEAN FAUNA OF SICILY AND THE CENTRAL MEDITERRANEAN SEA AREA – CURRENT KNOWLEDGE AND GAPS TO BE FILLED

ABSTRACT: The current knowledge of freshwater entomostracans from Sicily and some neighbouring central-Mediterranean countries is briefly reviewed. Data concerning different countries and different taxonomical groups are markedly inhomogeneous and often far from being representative of the real biota of the corresponding countries. This gap prevents a sound biogeographical analysis of the freshwater microcrustacean fauna of the area. The major gaps that have to be filled are highlighted and the need for more surveys and monitoring is emphasised.

KEY WORDS: Branchiopoda, Copepoda, Ostracoda, Sicily, regional faunas, biogeography, Mediterranean Sea

## 1. INTRODUCTION

To date, only scattered data are available on the freshwater microcrustacean faunas of the central Mediterranean countries, i.e. Italy, Tunisia, Libya, Maltese islands and Greece; consequently, a clear picture of entomostracan species richness and distribution in the area is lacking. The availability of more precise and even data on the distribution of the entomostracan taxa in the area could allow a better understanding of the biological history of the Mediterranean basin itself and, through the reconstruction of the histories of the taxa, it could provide independent contributions to the reconstruction of their phylogenies. The aim of this publication is to review the avalaible data about central-Mediterranean and Sicilian entomostracans (Crustacea: Branchiopoda, Copepoda, Ostracoda), emphasising what would be required to understand better the current composition of the Sicilian fauna and the ecological and historical causes which underlie it.

## 2. THE MICROCRUSTACEANS OF THE CENTRAL MEDITERRANEAN COUNTRIES

The degree of knowledge of the faunas of circum-Mediterranean countries varies widely if different countries and taxonomical groups are taken in consideration. Some data are available on the entomostracan faunas of Sicily, Sardinia, central Italy (Ruffo and Stoch 2005), Maltese islands (Lanfranco 2001), Corfu (Stephanides 1948) and Tunisia (Gauthier 1928, Mouelhi *et al.* 2000), but information on southern peninsular Italy, Libya, and peninsular Greece are scarce and, in some cases, almost totally lacking (Belk and Brtek 1995, Brtek and

Table 1. Currently known Branchiopoda and Copepoda Calanoida species richness in some central Mediterranean countries. In brackets the number of allochthonous taxa. Sources: 1: Abatzopoulos *et al.* 1999, 2: Alfonso *et al.* unpublished, 3: Brauer 1877, 4: Dumont *et al.* 1979, 5: Dumont *et al.* 1991, 6: Dussart and Defaye 2002, 7: Gauthier 1928, 8: Ghigi 1921, 9: Lanfranco 2001, 10: Marrone and Mura 2006, 11: Marrone and Naselli-Flores 2005, 12: Marrone *et al.* 2005, 13: F. Marrone *et al.* – unpublished, 14: Massal 1951, 15: Michaloudi et al. 1997, 16: Mouelhi *et al.* 2000, 17: Ruffo and Stoch 2005, 18: Stephanides 1948, 19: Zarfdjian *et al.* 2000.

| Country | Surface area ($km^2$) | Species richness | | Sources |
|---|---|---|---|---|
| | | Branchiopoda | Copepoda Calanoida | |
| Sicily | 25 708 | 66 (2) | 11 | 10, 11, 12 |
| Sardinia | 24 090 | 58 | 9 | 17 |
| Italy (excl. Sicily and Sardinia) | 251 000 | 132 (9) | 23 (1) | 2, 17 |
| Greece (excl. Corfu) | 131 654 | 34 | 6 | 1, 6, 15, 19 |
| Corfu | 638 | 29 | 7 | 18 |
| Maltese Islands | 316 | 10 | 1 | 9, 13 |
| Libya | 1 759 540 | 5 | 1 | 5, 6, 8 |
| Tunisia | 163 610 | 52 | 11 | 3, 4, 7, 14, 16 |

Thiéry 1995, Dussart and Defaye 2002, Ruffo and Stoch 2005). The deficiency of data regarding ostracods and copepods is more marked, but data on the apparently better-known groups like cladocerans and large branchiopod crustaceans are also inadequate. Table 1 shows the currently known species richness of Branchiopoda and Copepoda Calanoida in central Mediterranean countries. The availability of data is noticeably different for different countries and different groups, and it is evident that the faunas of peninsular Greece and Libya are to date nearly unknown. This makes it extremely difficult to assign certain taxa to a chorological category, to single out the gravitation and the barycentre of their distribution area, to cluster different districts on the basis of their faunal similarity and, finally, to reconstruct the anagenesis of the distribution areas of the monophyla and the relationships among different countries.

The absence of data regarding some regions and the incompleteness of some of the available regional checklists prevents a clear picture being formed of the distribution of most of the species and prevents a sound biogeographical analysis.

Due to the qualitative nature of the available data, the faunas belonging to different regions could be compared through the clustering of the regions themselves according to qualitative similarity indexes. However, the different sampling effort on which the species datasets of different countries are based would make these comparisons only tentative. Furthermore, this kind of comparison is *per se* merely descriptive and quite uninformative about the historical (diachronic) and ecological (synchronic) causes which underlie the current distribution of biotas and taxa in the Mediterranean basin.

Conversely, at a smaller scale (e.g. a single region), it is sometimes possible to use existing datasets to try to interpret the ecological causes of the local distribution of the taxa through the identification of their niches.

## 3. SICILY: A CASE STUDY

Sicily is the largest island of the Mediterranean Sea; it is located in the centre of the basin as a crossroads of its biological quadrants (Blondel and Aronson 1999). Its location, along with its complex palaeogeographical and palaeoclimatic history and its current climatic and landscape heterogeneity, makes Sicily a potential pivotal point for the limnofauna of circum-Mediterranean countries. Existing data on Sicilian entomostracans were reviewed and described in recent papers on Branchiopoda (Marrone *et al.* 2005, Marrone and Mura 2006), Copepoda Calanoida (Marrone and Naselli-Flores 2005) and Ostracoda (Pieri *et al.* 2006), and in the updated checklist of the Italian fauna (Ruffo and Stoch 2005). On the whole, 147 entomostracan taxa are currently known to be present on the island, i.e. 66 Branchiopoda, 56 Copepoda and 25 Ostra-

coda. This list is only provisional since some groups have not been adequately studied yet in some areas of the island and in some circum-Sicilian islands. Furthermore, the fact that some taxa are found at a single site only highlights the high probability of overlooking the presence of a number of other locally rare species even in the better-studied areas.

However, the role of Sicily as a transition zone for circum-Mediterranean taxa (Naselli-Flores *et al.* 1998) seems to be confirmed as far as calanoid copepods and cladocerans are involved (Marrone and Naselli-Flores 2005, Marrone *et al.* 2005), while the Sicilian large branchiopod and ostracod faunas (Marrone and Mura 2006, Pieri *et al.* 2006) seem to be composed by widespread taxa and show a low biological diversity.

To date, studies on the historical causes of the species composition of the Sicilian microcrustacean biota are lacking and the Sicilian entomostracan fauna has been studied only with descriptive or ecobiogeographical approaches. Preliminary studies on the ecological forces which could drive the local distribution of some taxa in temporary water bodies were carried out by Naselli-Flores *et al.* (1998), Marrone *et al.* (2006) and Pieri *et al.* (2006). These studies resulted in the identification of hydroperiod, altitude, and conductivity as the most important environmental variables in determining the species composition of the communities studied and allowed the identification of two comprehensive groups of "xerophilous" and "mesophilous" taxa (Marrone *et al.* 2006). Hydroperiod, in particular, deeply influences the biota inhabiting a water body as it determines both the physical and biotic environment to which the organisms are subjected.

In Fig. 1, for instance, the distribution in Sicily of some freshwater calanoid copepod species is described according to envi-

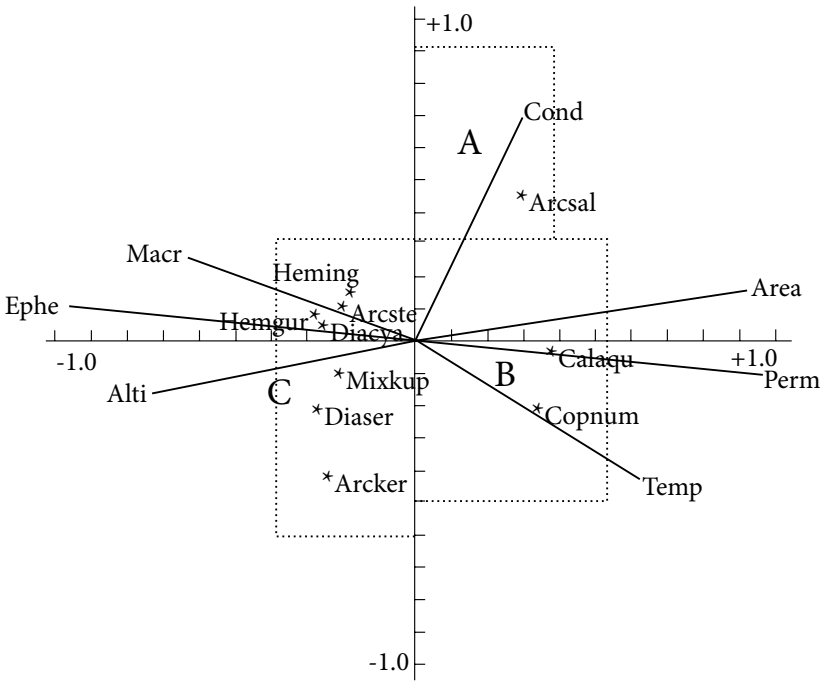


Fig. 1. Ordination triplot of CCA performed on the species-environment relationships in the Sicilian water bodies studied (grouped as A, B and C). Cond: conductivity; Macr: macrophyte abundance; Ephe: temporaneity; Alt: altitude a.s.l.; Temp: temperature of the water; Perm: permanency; Arcsal: *Arctodiaptomus salinus* (Daday); Calaqu: *Calanipeda aquaedulcis* (Kritschagin); Copnum: *Copidodiaptomus numidicus* (Gurney); Arcker: *Arctodiaptomus kerkyrensis* (Pesta); Diaser: *Diaptomus serbicus* Gjorgievic; Mixkup: *Mixodiaptomus kupelwieseri* Brehm; Diacya: *Diaptomus cyaneus* Gurney; Arcste: *Arctodiaptomus stephanidesi* (Pesta); Hemgur: *Hemidiaptomus gurneyi* (Roy); Heming: *Hemidiaptomus ingens* (Gurney).

ronmental features. Two distinct tendencies can be observed: one runs horizontally and separates those temporary to astatic environments (group C) from permanent (group A and B) water bodies, the second is vertical and linked to conductivity values and separates environments with conductivity values lower than 4000 μS $cm^{-1}$ (group B) from those with values ranging between 4000 μS $cm^{-1}$ and 42 000 μS $cm^{-1}$ (group A). This approach, in contrast to the application of similarity indexes, allows us to predict the local and regional potential distribution of the taxa.

In Sicily, the group of branchiopod and calanoid crustaceans linked to temporary waters seems to be more characteristic and representative of the autochthonous biota of the island. This was to be expected if it is taken into consideration that, with few exceptions, all the permanent lentic water bodies of the region are recently built artificial reservoirs (Naselli-Flores 1999). Most of the taxa found in permanent ponds and lakes are widespread in the West-Palaearctic region, while the typical Mediterranean taxa are strictly linked to temporary and ephemeral habitats. The available data on Sicilian freshwater crustaceans are to date not sufficient to test whether this observation could be applied also to the other entomostracan groups.

## 4. CONCLUSIONS

Currently available knowledge about certain microcrustacean groups in the Mediterranean region is at present inadequate to understand their ecology, systematics and biogeography, and, when necessary, to plan appropriate conservation plans. Furthermore, it does not allow the local faunas to be set accurately in the context of a more significant biogeographical district. In order to do that, the major gaps to be filled at the scale of the central Mediterranean basin are those regarding the faunas of southern peninsular Italy, peninsular Greece and Libya. However, a stronger sampling effort should also be devoted to get more exhaustive data on the freshwater microcrustacean faunas of the better studied countries.

Even though the dynamic nature of the biotas possibly prevents a definitive and complete picture of the species inhabiting a region to be obtained, more surveys and monitoring will surely help in characterizing the local faunas and in identifying the distribution trends of some groups.

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