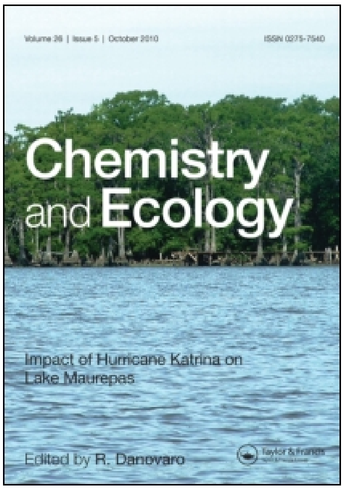

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Ecological characterization and cladocerans, calanoid copepods and large branchiopods of temporary ponds in a Mediterranean island (Sicily, southern Italy)

Federico Marrone[a]; Rossella Barone[a]; Luigi Naselli Flores[a]
[a] Dipartimento di Scienze Botaniche, Università di Palermo, Palermo, Italy

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Ecological characterization and cladocerans, calanoid copepods and large branchiopods of temporary ponds in a Mediterranean island (Sicily, southern Italy)

FEDERICO MARRONE*, ROSSELLA BARONE and LUIGI NASELLI FLORES

Dipartimento di Scienze Botaniche, Università di Palermo, Via Archirafi, 38 90123 Palermo, Italy

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Temporary waters have been sporadically investigated in Sicily. These environments reflect the climatic features of the Mediterranean area with a winter ponding phase and a more or less prolonged dry period in summer. Their biota, especially those organisms strictly linked to aquatic environments and without any terrestrial life stage, have to exhibit special adaptations to survive the dry phases that are recurrent in such ecosystems. This study included more than 250 water bodies distributed on the whole Sicilian territory and on the small circum-Sicilian islands. This paper represents a first attempt to characterize Sicilian temporary waters from an ecological point of view and is mainly based on some of their limnological features and on the crustacean components of their communities. In particular, the groups which have been taken into consideration are those of cladocerans, calanoid copepods, and large branchiopods (notostracans, anostracans, and spinicaudatans).

Keywords: Temporary pools; Mediterranean area; Branchiopods; Calanoid copepods; Cladocerans; Sicily

1. Introduction

Sicily is the largest island of the Mediterranean Sea. It is located in the middle of this Basin, between Europe and Africa, and forms a bridge between East and West. Moreover, it is subjected to the Mediterranean climate. This situation, coupled to its insularity, makes natural perennial water bodies scarce and scattered, and favours the building of hundreds of reservoirs, from small agricultural ponds to large dam reservoirs [1]. Nevertheless, temporary water bodies represent the most common natural aquatic environment of this region. These environments, have been recently included in the framework of the Ramsar Convention on Wetlands, and the Resolution VIII.33, taken at the 8th Meeting of the Conference of the Contracting Parties held in Valencia (Spain) in November 2002, reflects the recognition that temporary pools contribute significantly to the maintenance of global biodiversity due to their highly specialized plant and animal communities. Such habitats have important socio-economic values which include, *inter alia*, storage of water for use by local communities, especially pastoral

*Corresponding author. Email: federico.marrone@neomedia.it

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communities in arid zones; provision of grazing areas to these communities; environmental education, facilitated by the small size of these pools; and scientific research, notably concerning the adaptation of whole biotic communities to unstable environments [2]. Moreover, they also have cultural values, especially in dry regions, including karstic and steppic areas.

In spite of their biological and ecological importance, these environments are currently under considerable threat [3]. Although temporary water bodies are widespread over the Sicilian territory, no regular studies have been carried out yet. Many of these water bodies have been drained in the past because of public worries that they might have been responsible for insect-borne diseases. The poor attention paid to these environments, which are generally small and scarcely resilient to landscape alteration produced by human activities [4], is beyond measure favouring their disappearance from the island.

In order to fill this gap of knowledge, a survey was carried out in recent years on about 250 Sicilian water bodies of different dimensions: from very small rock pools along the seashore to larger ponds on different substrates.

Particular attention was paid to the group of 'entomostracan' crustaceans which, although being completely aquatic organisms, can show peculiar adaptations to survive the dry periods and thus represent one of the most characteristic faunal components of these biotopes. The aim of this paper is to furnish an ecological overview of these environments in the island, mainly based on both selected environmental features and branchiopod and calanoid copepod assemblages. The final aim is to underline the importance of temporary waters in preserving the biodiversity and integrity of an important component of autochthonous organisms in the Mediterranean region.

2. Material and methods

The investigated water bodies, often known by limnologists as 'marginal', may be ranked according to the following environmental typology: rock pools ('kamenitza'), flooded vehicles tracks, freshwater temporary ponds (from turbid and argillotrophic to transparent and macrophyte-rich ponds), brackish to hyperaline ponds, abandoned agriculture reservoirs (locally called 'ggebbie'), brackish coastal lagoons, and abandoned saltworks.

Samples were collected from autumn 2000 to spring 2004 in 200 temporary water bodies scattered throughout the Sicilian territory (figure 1) and the small circum-Sicilian islands. In order to make comparisons, about 50 permanent water bodies were also sampled. Temporary waters range from tracks and small rock pools a few centimetres deep, to ponds larger than 1 ha and reaching a depth of 1.5 m. Their altitudes range from sea level to 1700 m a.s.l. The investigation also included inland hypersaline temporary environments in the central part of the island, as well as coastal brackish, temporary lagoons.

Cladocerans and calanoid copepods were sampled using a 200-μm-mesh hand net along shorelines and through vegetation. Open waters were sampled by means of an 80 μm towing net. The smallest environments were sampled by collecting the water with a flask and concentrating the samples on a 200-μm-mesh sieve. Large branchiopods (anostracans, notostracans, and spinicaudata) were collected using a 50 cm hand sieve with a 500-μm-mesh size. The size of the collected samples strictly depended on the dimensions of the water bodies. Attention was paid to collect samples in all the microhabitats present.

Samples were duplicated and fixed in situ with both 4% buffered formaldehyde and 70% ethanol. They were then sorted in the laboratory under an Optika dissecting microscope.

Identification of calanoid copepods follows [5–11]; cladocerans were identified according to [12–16]. The taxonomy of large branchiopods follows [16–20]. All the samples are stored in the authors' collection.

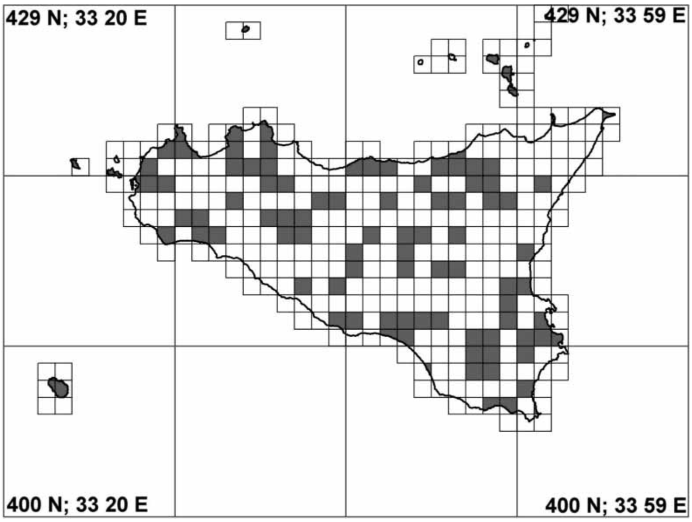

Figure 1. Circum-Sicilian islands. Location of the sites studied. Every darkened 100 km^2 mesh hosts one or more sample sites. In the figure, Pelagie Islands are not displayed but were extensively sampled.

In order to perform statistical analyses, individuals were assigned to three arbitrary classes according to their relative abundances and absolute dimensions.

In each site, conductivity, pH, and water temperature were recorded using a Hanna Instruments HI-991300 multiprobe. An estimate of the abundance of macrophytes and of the water turbidity was assessed for each site by using three arbitrary qualitative classes. The duration of the water phase was considered as 'ephemeral' for those environments showing water for a period of up to 1 or 2 months, 'temporary' for those retaining water for 2–9 months, and 'semi-permanent' for those that have a longer water phase but nevertheless periodically dry out. The geographical coordinates and altitude were recorded with a Magellan 310 GPS. Attention was paid to the geological nature of the substrate and to the landscape context in which the water bodies occurred. Average annual values of precipitation refer to the period 1924–2000 and were supplied by the 'Ufficio Idrografico Regionale' (Sicilian Regional Hydrographic Bureau).

Canonical correspondence analysis (CCA) was undertaken using Canoco 3.1 [21]. The method allows the contemporary use of quantitative and qualitative variables. The significance with which environmental variables explain the variance of species data was tested using Monte Carlo methods (99 unrestricted permutations). Variables were considered to be significant when $P < 0.01$.

3. Results

Figure 2 shows the distribution of temporary water bodies according to their surface, altitude above sea level, conductivity, and average annual precipitation. Among the 200 sampled environments, 31% are represented by rather large temporary freshwater ponds with well-developed macrophyte assemblages and dimensions ranging between 2000 and 10 000 m^2. These environments are mainly located on the Sicilian mainland at altitudes higher than 250 m a.s.l., with an average annual precipitation above 600 mm. Conductivity values generally range between 200 and 800 μS cm^{-1}. Smaller ponds (21%), with a surface area of 500–2000 m^2,

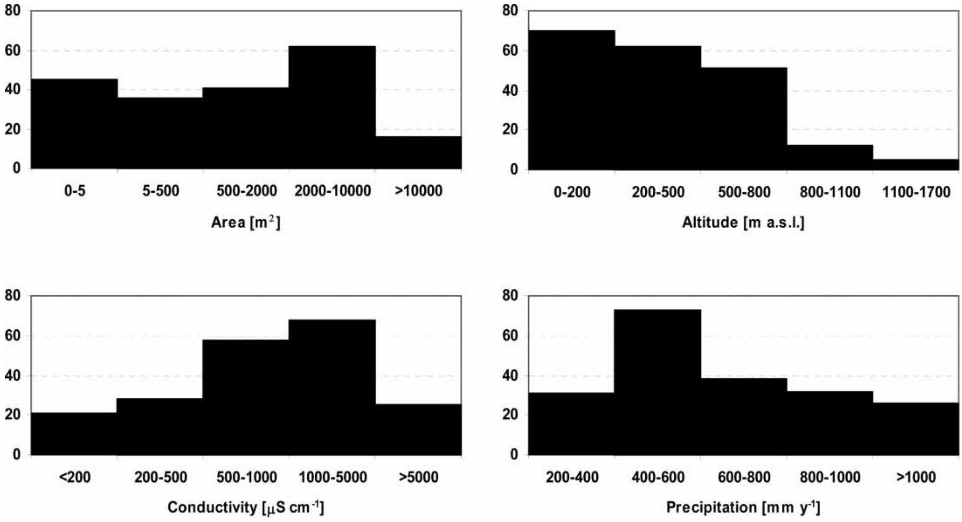

Figure 2. Distribution of the studied sites according to areal dimension, altitude a.s.l., electrical conductivity, and annual average precipitation.

can be present from sea level up to 800 m a.s.l. and may show argillotrophic features [22]. All these environments have a dry period lasting for a maximum of 3–4 months.

About 23% of the studied environments have a surface area of less than 5 m^2. These water bodies are mainly represented by rock pools and are generally located in the most arid part (rainfall of <350 mm yr^{-1}) of the circum-Sicilian islands and along the shoreline of the Sicilian mainland. They show highly variable conductivity values (up to 3900 $\mu S\ cm^{-1}$), and the dry period can be longer than 9 months.

Another group of rather ephemeral pools is represented by vehicle tracks and small ground depressions, more or less covered by flooded herbaceous vegetation in winter. These environments are generally a few centimetres deep, have an area ranging between 5 and 500 m^2, and have conductivity values ranging between 200 and 600 $\mu S\ cm^{-1}$. Very large environments ($>10\,000$ m^2) are mainly represented by brackish or hypersaline coastal swamps.

In the present survey, only six of the nine species of large branchiopods known in Sicily were found (*Artemia salina*, although typically present in several Sicilian saltworks, was not considered in the present study, since it was never collected in temporary waters during this survey). Conversely, the number of known cladocerans increased from 33 (according to [23]) to 55 and that of known calanoid copepods from 6 to 11. A complete list of the identified organisms can be found in [24, 25].

CCA was performed separately for cladocerans, calanoid copepods, and large branchiopods (figure 3). The eigenvalues for the CCA axes explained almost 90% of the variance in the three sets of species–environment relationships.

Calanoid copepods were found in 66 of the sampled environments. This group mainly inhabits large and small temporary ponds, and some brackish/hypersaline swamps. Two distinct tendencies can be observed in figure 3A. One runs horizontally and separates those environments with a shorter water phase (group C) from permanent (group A and B) water bodies. The first group lies on the left part of the plane and shows a higher species richness ($n = 7$). The second is located in the right part and contains three species. Temporality is negatively correlated with axis 1 ($r = -0.90$), whereas semi-permanency is positively ($r = 0.91$) related. These features are strictly linked to altitude, area, and macrophyte covering. In Sicily, temporary ponds are commonly located at a higher altitude, have small areas, and show a rich macrophyte covering compared with semi-permanent environments. The second tendency is vertical and linked to conductivity values and separates environments with conductivity values less 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). Thus, the permanent water bodies lying on the right part of the plane are ranked according to increasing conductivity values, and the associated species reflect this

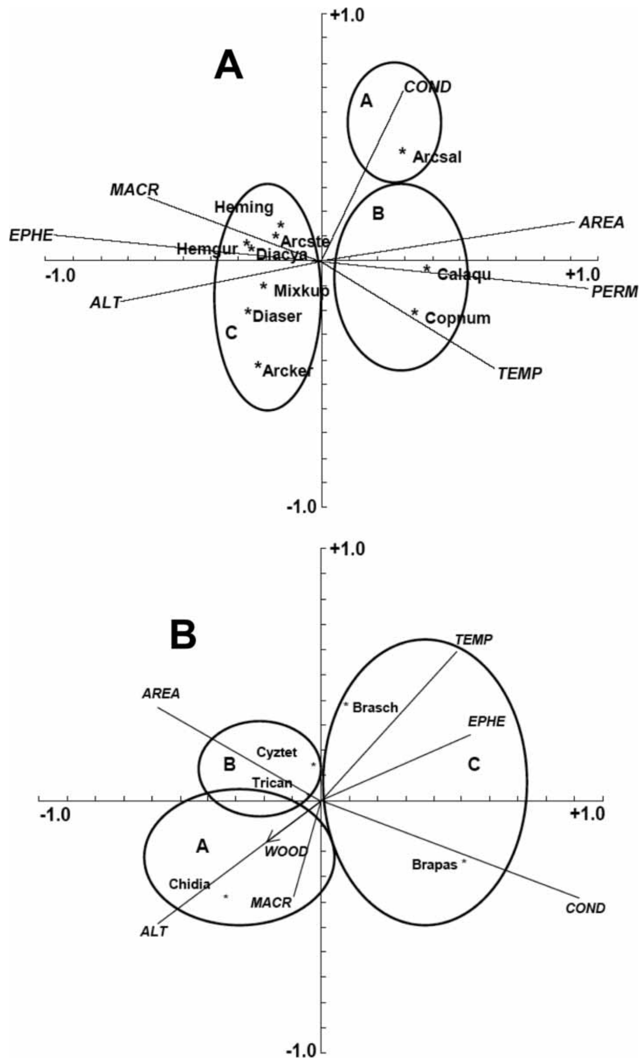

Figure 3. Triplots of the CCA performed on (A) cladocerans species, (B) large branchiopods, (C) calanoid copepods, and their environments and selected environmental variables. The ovals distinguish between different groups of environments. COND: conductivity; ALT: altitude a.s.l.; AREA: water surface; EPHE: short-lasting water phase; SEPE: long-lasting water phase; PERM: permanent water bodies; MACR: macrophyte cover; WOOD: wooded catchment; OPEN: un-wooded catchment; TEMP: temperature; Alorec: *Alona rectangula*; Aloele: *A. elegans*; Alonur: *A. nuragica*; Cerqua: *Ceriodaphnia quadrangula*; Cerret: *C. reticulata*; Chysph: *Chydorus sphaericus*; Ctemag: *Ctenodaphnia magna*; Cteatk: *C. atkinsonii*; Cteche: *C. chevreuxi*; Dapobt: *Daphnia obtusa*; Dappul: *D. pulex*; Daplon: *D. longispina*; Machir: *Macrothrix hirsuticornis*; Moibra: *Moina brachiata*; Plelet: *Pleuroxus letourneuxi*; Simexp: *Simocephalus expinosus*; Simvet: *Simocephalus vetulus*; Cyztet: *Cyzicus tetracerus*; Trican: *Triops cancriformis*; Chidia: *Chirocephalus diaphanus*; Brapas: *Branchipus pasai*; Brasch: *B. schaefferi*; Heming: *Hemidiaptomus ingens*; Hemgur: *H. gurneyi*; Arcste: *Arctodiaptomus stephanidesi*; Arcsal: *A. salinus*; Arcker: *A. kerkyrensis*; Diacya: *Diaptomus cyaneus*; Diaser: *D. serbicus*; Mixkup: *Mixodiaptomus kupelwisieri*; Copnum: *Copidodiaptomus numidicus*; Calaqu: *Calanipeda aquaedulcis*.

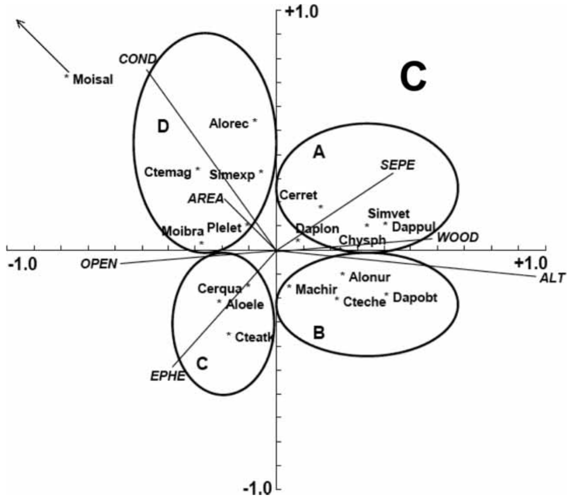

Figure 3. Continued

tendency, with *Copidodiaptomus numidicus*, *Calanipeda aquaedulcis*, and *Arctodiaptomus salinus* being distributed along this gradient.

The group of animals linked to temporary waters seems to be more characteristic of a semi-arid region like Sicily as confirmed by the higher species richness and diversity of calanoid assemblages [24].

Moreover, a similar tendency has also been observed for large branchiopods (figure 3B). These organisms were collected in 38 of the 200 sampled sites, and three groups can be identified in the CCA plot: the first (A) is positively linked to the altitude (ALT, $r = 0.81$), the second (B) is positively correlated with the area of impoundement (AREA, $r = 0.86$), and the third (C) is positively correlated with conductivity (COND, $r = 0.90$). The first group comprises only the anostracan species *Chirocephalus diaphanus*, a mesophylic organism which mainly inhabits long-lasting temporary ponds located between 600 and 900 m a.s.l. The second group, very close to axis origin, includes two euriecious species: *Triops cancriformis* (Notostraca) and *Cyzicus tetracerus* (Spinicaudata). The third group, which occupies the right half part of the plane, is formed by the two anostracans *Branchipus schaefferi* and *Branchipus pasai*. These organisms are typical of rock pools, very shallow, and with a very short water phase, generally located at the sea level and on the open ground. These two species are mainly separated by conductivity values. In fact, *B. pasai* has been found only on the rocky shores of the island of Lampedusa subject to the spray effect of the sea and thus showing rather high conductivity values. Among these large branchiopods, *B. schaefferi* is likely the most thermophilic organism, since it is the only one to be also found during summer.

Among the collected cladocerans, 18 were used to perform CCA. According to the considered variables (figure 3C), two groups, each formed by nine species, can be identified along the vertical axis: one, on the right-hand side of the plot, shows more mesophylous organisms, and the other, on the left-hand side, reveals organisms typical of more arid conditions. The variables which determine this segregation are linked to altitude a.s.l. which is positively correlated to axe 2 (ALT, $r = 0.96$), and to the wood cover (WOOD, $r = -0.78$) which is negatively correlated. Each of these groups is furthermore formed by two subgroups. In particular, the mesophylous organisms are linked to the duration of the hydroperiod (SEPE): those grouped in the first quadrant are typical of long-lasting environments, located mainly in wooded areas. The remainder, grouped in the fourth quadrant, prefer open environments.

Species belonging to the more arid districts are distributed along a conductivity–duration gradient (groups C and D). Those in the second quadrant are typical of low-conductivity, ephemeral environments, whereas those in the third showed a preference for long-lasting, high-conductivity environments.

4. Discussion

Among the environmental variables considered, the hydroperiod, altitude a.s.l., and conductivity have been shown to play an important role in the distribution of the identified taxa. Other variables, such as the dimensions of the water body, turbidity, temperature, presence of macrophytes, and landscape features, were of different importance in the distribution of the considered groups.

On the basis of the results obtained, it has been possible to identify groups of species, characteristic for the different studied environments (table 1). These zoological associations fit well with those found in Spanish aquatic environments by [26]. Moreover, the proposed scheme agrees well with the autoecological characteristics of the species as reported in [12, 16, 20, 27–29]. It is evident that, among the groups studied, notostracans, anostracans, spinicaudatans, the subgenus *Ctenodaphnia*, the species *Alona elegans* and *A. nuragica*, and calanoid copepods are the organisms that are rather strictly linked to temporary waters. Moreover, these crustaceans have limited distribution areas and specific ecological requirements, thus allowing this species to be identified as typically Mediterranean.

A further distinction can be made among species inhabiting ‘steppic regions’ and species typical of ‘humid regions’ (e.g. [26, 27]). Here we prefer to divide the identified taxa as ‘mesophylous’ and ‘xerophylous’ in relation to the typology and duration of impoundment. ‘Xerophylous’ taxa prefer small, short-lasting water bodies with unpredictable hydroperiods, even characterized by several dry and wet phases during the same year; conversely, mesophylous taxa generally inhabit long-lasting, larger, temporary ponds. Typical representatives of the first group are *Branchipus schaefferi* and *Alona elegans*, whereas *Chirocephalus diaphanus* and *Alona nuragica* are more typically mesophylous.

From the distribution of the identified species, we were able to divide Sicilian temporary waters into five limnological districts (figure 4). The Occidental district (area 1) is characterized by arid conditions and carbonatic rocks. The best-represented environments in this area are rock

Table 1. Characteristic and accompanying species in the different temporary environmental typologies.

Characteristic species	Environmental typology	Accompanying species
Alona elegans	Short-lasting pools	*Branchipus schaefferi*
Alona nuragica	Long-lasting pools and ponds	*Arctodiaptomus stephanidesi* *Chirocephalus diaphanus*
Alona guttata	Low-conductivity, macrophyte-rich temporary and semi-permanent ponds	*Daphnia pulex* *Simocephalus vetulus*
Daphnia obtusa	High mountain, turbid pools Vehicle tracks	*Macrothrix hirsuticornis*
Daphnia (*Ctenodaphnia*) *atkinsoni*	Argillotrophic temporary ponds	*Cyzicus tetracerus*
Moina salina	Temporary brackish swamps	*Arctodiaptomus salinus* *Daphnia curvirostris*
Mixodiaptomus kupelwieseri	Transparent, low-conductivity temporary ponds and swamps	–

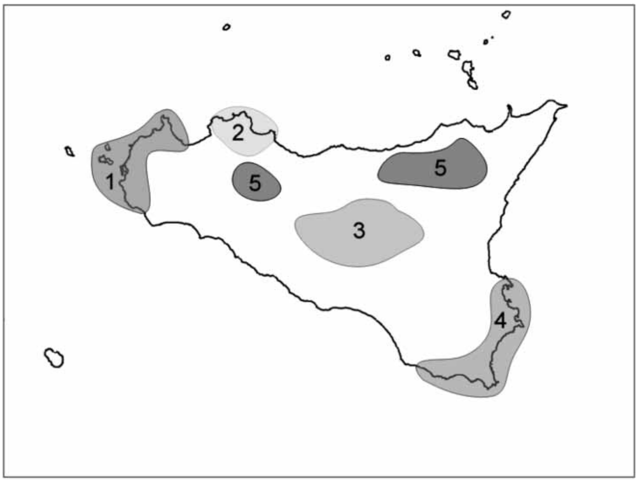

Figure 4. Sicilian limnological districts as identified in the present study.

pools, argillotrophic ponds, and shallow brackish lagoons. The most typical entomostracan association in this district comprises the cladocerans *Pleuroxus letourneuxi*, *Alona elegans*, and *Ctenodaphnia atkinsoni*, the spinicaudatan *Cyzicus tetracerus*, and the anostracan *Branchipus schaefferi*.

The second district (area 2) is characterized by a higher amount of precipitation. The most common environmental typology is represented by large, long-lasting ponds, often showing a dense macrophyte coverage and transparent waters with entomostracan assemblages dominated by the calanoid copepod *Arctodiaptomus* (*Arctodiaptomus*) *stephanidesi* and the anostracan *Chirocephalus diaphanus*.

Central Sicily (area 3) is characterized by rather arid conditions, and, due to evaporitic outcrops, the water bodies lying in this part show very high conductivity values (e.g. [23, 30]). This district is generally characterized by a low number of halotolerant species (*Arctodiaptomus* (*Rhabdodiaptomus*) *salinus*, *Daphnia* (*Ctenodaphnia*) *magna* and *Alona rectangula*).

The South-oriental part of the island (area 4) is characterized by the presence of very large coastal, brackish/hyperaline lagoons. The cladocerans *Daphnia curvirostris*, *Moina salina*, and *Dunhevedia crassa* were exclusively recorded in this district.

The fifth district (area 5) is the most humid of the island and is formed in the mountain chains in the northern part of the region. Rather high precipitation values ($>$800 mm) and large, macrophyte rich, temporary, and semi-permanent waters with low conductivity values ($<$500 ?S cm^{-1}), and a long period of impoundment (more than 9 months) are typical of this district where most of the Sicilian residual woodlands are concentrated. This district is mainly inhabited by taxa with a temperate affinity (e.g. the cladocerans *Alona guttata, Simocephalus vetulus, Daphnia pulex*, and *D. obtusa* and the calanoid copepods *Hemidiaptomus gurneyi* and *Mixodiaptomus kupelwieseri*).

The small circum-Sicilian islands show rather distinct features, and the ecology of the populations inhabiting their ecosystems needs further investigation. In any case, it seems that the aquatic environments on carbonatic islands show a certain affinity with those of the occidental district, whereas the water bodies on volcanic islands are closer to those of the second district.

5. Conclusion

From the results obtained, Sicily is characterized by a wide variety of temporary aquatic environments. Many show typical Mediterranean features but also the presence of more typically temperate environments has been recognized. These environments have a very rich entomostracan fauna compared with that of Italian mainland. Moreover, they are particularly fragile, especially because of their small dimensions which make them rather 'invisible' to local conservation agencies. In the past, this has caused the disappearance of several sites and of an undeterminable number of taxa in the island. The higher richness is particularly evident when considering calanoid copepods and cladocerans. Many representatives of these groups are exclusive of temporary environments and have limited and punctual distributions: the destruction of their habitats can seriously impair the biodiversity of the region. As a consequence, these biotopes and their inhabitants have to be carefully considered when conservation and landscape management plans are developed.

References

[1] L. Naselli-Flores. Limnological aspects of Sicilian reservoirs: a comparative, ecosystemic approach. In *Theoretical Reservoir Ecology and Its Applications*, J.G. Tundisi, M. Straškraba (Eds), pp. 283–311, Backhuys, Leiden, The Netherlands (1999).
[2] Anonymous. The Ramsar Strategic Plan 2003–2008. Available online at: http://ramsar.org/key_strat_plan_2003_e.htm (accessed 22 June 2005).
[3] P. Williams, J. Biggs, G. Fox, P. Nicolet, M. Whitfield. History, origins and importance of temporary ponds. *Freshwat. Forum*, **17**, 7–15 (2001).
[4] D.D. Williams. *The ecology of temporary waters*, pp. 205, Croom Helm, London (1987).
[5] B. Dussart. *Les Copépodes des eaux continentales d'Europe occidentale. I. Calanoides et Harpacticoides*, Ed. Boubée & Cie, Paris (1967).
[6] B. Dussart, B. (1984). Crustacés copépodes calanoïdes des eaux intérieures africaines. *Crustaceana*, Supplement 15, 1–205 (1984).
[7] U. Einsle. *Crustacea Copepoda. Calanoida und Cyclopoida. Susswasserfauna Mitteleuropas*, 8/4-1, Gustav Fisher, Germany (1993).
[8] F. Kiefer. *Das Zooplankton der Binnengewaesser. Freilebende Copepoda. Die Binnengewaesser*, Band 26 Teil 2, E.Schweizerbart'sche Verlagbuchhandlung, Stuttgart (1978).
[9] T.K. Petkovski. *Calanoides–Calanoida (Crustacea–Copepoda). Faune de Macedonie*, 5, Musée Histoire Naturelle de Macedonie, Skopje, Macedonia (1983).
[10] Y. Ranga Reddy. *Copepoda: Calanoida: Diaptomidae*, SPB Academic, The Hague, The Netherlands (1994).
[11] E. Stella. *Copepoda: Calanoida, Fauna d'Italia*, 21, Ed. Calderini, Bologna (1984).
[12] F.G. Margaritora. *Cladocera, Fauna d'Italia*, 23, Ed. Calderini, Bologna (1985).
[13] N.M. Korovchinsky. *Sididae & Holopedidae (Crustacea: Daphniiformes)*, SPB Academic, The Hague, The Netherlands (1992).
[14] N.N. Smirnov. *The Macrothricidae of the World*, SPB Academic, The Hague, The Netherlands (1992).
[15] N.N. Smirnov. *Cladocera: the Chydorinae and Sayciinae (Chydoridae) of the World*, SPB Academic, The Hague, The Netherlands (1996).
[16] M. Alonso. Crustacea, Branchiopoda. In *Fauna Iberica*, vol. 7, M.A. Ramos *et al.* (Eds), pp. 1–486, Museo Nacional de Ciencias Naturales, CSIC, Madrid (1996).
[17] E. Daday de Deés. Monographie systématique des Phyllopodes conchostracés. 1.re partie, Caenestheridae. *Ann. Sc. Nat. Zool.*, **20**, 39–330 (1914).
[18] E. Daday de Deés. Monographie systématique des Phyllopodes conchostracés. 2.re partie, Leptestheridae. *Ann. Sc. Nat. Zool.*, **6**, 331–390 (1923).
[19] A.R. Longhurst. A review of the Notostraca. *Bull. Br. Mus. (Nat. Hist.) Zool.*, **3**, 1–57 (1955).
[20] V. Cottarelli, G. Mura. Anostraci, Notostraci, Concostraci (Crustacea: Anostraca, Notostraca, Conchostraca). *Guide per il riconoscimento delle specie animali delle acque interne italiane. 18, AQ/1/194*, Consiglio Nazionale delle Ricerche, Rome (1983).
[21] C.J.F. ter Braak, P.F.M. Verdonschot. Canonical correspondence analysis and related multivariate methods in aquatic ecology. *Aquat. Sci.*, **57**, 255–289 (1995).
[22] G. Castelli, F. Marrone, R. Barone, L. Naselli-Flores. Crustacean dynamics in two argillotrophic, temporary ponds (North-Western Sicily, Italy). *Verh. Int. Verein. Limnol.*, **29** (in press).
[23] L. Naselli-Flores, R. Barone, M. Zunino. Distribution patterns of freshwater zooplankton in Sicily (Italy). *Verh. Int. Verein. Limnol.*, **26**, 1973–1980 (1998).

[24] F. Marrone, L. Naselli Flores. First record of a representative of the subfamily Paradiaptominae (Copepoda Calanoida Diaptomidae) in Italy: Metadiaptomus chevreuxi (Guerne & Richard, 1894). *J. Limnol.*, **64**, 89–92 (2005).
[25] F. Marrone, L. Naselli-Flores. Cladocera (Branchiopoda: Anomopoda, Ctenopoda and Onychopoda) from Sicilian inland waters: an updated inventory. *Crustaceana*, **78**, 1025–1039.
[26] M. Alonso. Las lagunas de la España peninsular. *Limnetica*, **15**, 1–176 (1998).
[27] H. Gauthier. *Recherches sur la faune des eaux continentales de l'Algérie et de la Tunisie*, Imprimerie Minerva, Algeria (1928).
[28] D. Flössner. *Die Haplopoda und Cladocera Mitteleuropas*, Backhuys, Leiden, The Netherlands (2000).
[29] M. Nourisson, A. Thiéry. Crustacés Branchiopodes (Anostracés, Notostracés, Conchostracés). *Bull. Mens. Soc. Linn. Lyon*, **57**, 75–95 (1988).
[30] S. Calvo, R. Barone, L. Naselli Flores, C. Fradà Orestano, G. Dongarrà, A. Lugaro, G. Genchi. Limnological studies on lakes and reservoirs of Sicily. *Nat. Sicil.*, **17** (Suppl.), 1–292 (1993).