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UPDATED STATUS OF ANOSTRACA, NOTOSTRACA  
AND SPINICAUDATA (*Crustacea Branchiopoda*) IN SICILY (ITALY):  
REVIEW AND NEW RECORDS

SUMMARY

A survey on distribution, phenology and status of large branchiopod crustaceans (Branchiopoda: Anostraca, Notostraca, Spinicaudata) in Sicily and in circum-Sicilian islands was carried out from autumn 2000 to winter 2004/2005 with the purpose of providing an organised contribution to the knowledge of the distribution of these crustaceans in the region. Data from literature on Sicilian large branchiopods has been briefly reviewed, and field surveys allowed us to add new data on their actual consistency in the area. Current Sicilian large branchiopod fauna is characterised by a low species richness and diversity, having possibly been impoverished by the high anthropic impact which has interested the Sicilian wetlands.

The need for further surveys directed towards getting the knowledge necessary in order to correctly understand and manage temporary pools, the elective habitat of a rich and peculiar biota whose large branchiopods are "flagship species", is stressed.

RIASSUNTO

*Aggiornamento sullo status degli Anostraci, Notostraci e Spinicaudati (Crustacea Branchiopoda) in Sicilia (Italia): rassegna bibliografica e nuovi reperti.* Nel quinquennio compreso tra l'autunno del 2000 e l'inverno 2004\2005 è stata condotta una indagine sulla distribuzione, fenologia e status dei cosiddetti "grandi branchiopodi" (Branchiopoda: Anostraca, Notostraca, Spinicaudata) in Sicilia e nelle isole circum-siciliane. I dati originali raccolti nell'ambito delle indagini sul campo, integrati con quelli disponibili in letteratura, hanno permesso la realizzazione di un primo contributo organico alla conoscenza di questi crostacei nella regione.

La fauna siciliana odierna a grandi branchiopodi è caratterizzata da una bassa ricchezza specifica e si mostra poco diversificata essendo stata verosimilmente banalizzata ed impoverita dall'impatto antropico che ha interessato le aree umide siciliane. È auspicabile che siano realizzate ulteriori indagini finalizzate ad una migliore comprensione e gestione del patrimonio biologico legato ai

corpi d'acqua ad idroperiodo temporaneo, ecosistemi che ospitano un biota ricco e peculiare di cui i grossi branchiopodi sono "specie bandiera".

## INTRODUCTION

With a surface area of about 26,000 km<sup>2</sup>, Sicily is the biggest Mediterranean island. According to the De Martonne-Gottmann's algorithm most of its territory is subjected to arid or semi-arid conditions (DURO *et al.* 1997). As precipitation are concentrated in winter months, Sicilian climate is characterised by hot, dry summers and mild, wet winters. The annual average temperature ranges between 11 °C (Floresta, Messina province) and 20 °C (Gela, Caltanissetta province), and the average precipitation varies between 385 mm/year (Gela, Caltanissetta province) and 1192 mm/year (Zafferana etnea, Catania province). The high water deficit characteristic of the summer months causes the lack of a well-developed permanent surface hydrographical network; conversely, temporary water bodies are widely spread throughout the island and represent the most common and peculiar Sicilian inland water ecosystems. As a consequence, studying their biota is of pivotal importance in order to correctly understand the autochthonous Sicilian freshwater fauna.

Its position in the centre of the Mediterranean basin makes Sicily a potential active transition zone for freshwater invertebrates, at least as far as freshwater zooplankton is concerned (NASELLI-FLORES *et al.*, 1998). Unfortunately, an exhaustive survey on the distribution of Sicilian large branchiopods, the "flagship group" of temporary waters biota, is lacking and reports on the species are sparse. The purpose of this paper is to contribute to review and integrate the current knowledge on large branchiopod crustaceans in the Mediterranean basin by providing data on their distribution, phenology and status in Sicily.

## MATERIALS AND METHODS

During the ponding phase of the water bodies, samples were collected by means of 125 µm mesh towing net and 200 µm mesh hand net, preserved in 90% ethanol or buffered formaldehyde (4%), and stored in the authors' collections. During the dry phase, core samples were collected from the edge and from the deepest point of the depressions studied. Core samples were afterwards partly rehydrated in the laboratory at room temperature and partly sieved with a 125 µm mesh sieve in order to sort out the resting eggs. Identification of adult specimens was performed according to DADAY DE DEÉS

(1914, 1923), LONGHURST (1955), COTTARELLI & MURA (1983), NOURISSON & THIÉRY (1988) and ALONSO (1996). Resting eggs were identified according to MURA *et al.* (1978), THIÉRY & GASC (1991) and MURA (1986).

The distribution of the species is mapped using the UTM grid system, map datum WGS 84.

#### DESCRIPTION OF THE HABITATS

Sicilian temporary water bodies vary considerably in terms of size, depth, hydroperiod and turbidity. However, they can be grouped into five main typologies: ground pools, rock pools, ponds, saltworks and abandoned concrete reservoirs. Large branchiopods were observed in all of these habitat typologies.

1. Ground pools are a few centimetres deep ephemeral habitats, often turbid and greatly disturbed by the passing of cattle and vehicles. Most of them are formed in vehicle ruts.

2. Rock pools, even though present on substrata of different lithology, are mostly spread on carbonatic outcrops, forming complex systems of pools which are periodically connected.

3. Temporary ponds vary markedly depending on the underlying substratum, the surrounding landscape and the altitude at which they occur. Accordingly, the hydroperiod lasts from 4 to over 9 months *per* year, and water turbidity ranges from crystal clear waters, rich in aquatic macrophytes, to argillotrophic systems.

4. Saltworks were once spread all around the Sicilian coasts. Nowadays, they are in activity only along the western coast of the island, between the towns of Trapani and Marsala (Trapani province). In the remaining parts of the island they are now abandoned.

5. Artificial concrete water reservoirs, locally called “*ggebbie*”, were built up for irrigation and watering purposes. Although they characterise the Sicilian agriculture landscape, the establishment of modern irrigation techniques caused the abandonment of most of such reservoirs. In this way, they started to act as temporary water bodies, their hydroperiod being subjected only to rainfall and evaporation.

#### BIBLIOGRAPHICAL REVIEW

Literature data concerning Sicilian large branchiopods list eighteen inland water bodies hosting large branchiopods (Tab. 1). Moreover, a spinicaudatan species is reported as being present on the island without having a

Table 1  
List of literature sites. As: Artemia salina; Bp: Branchipus pasai; Bs: Branchipus schaefferi; Cd: Chirocephalus diaphanus; Ct: Cyzicus tetracerus; Lc: Leptestheria cf. cortieri; Tc: Triops cancriformis. PA: Palermo province; TP: Trapani province; AG: Agrigento province; EN: Enna province; SR: Siracusa province; CT: Catania province; ME: Messina province

Cod	Name	Location	Altitude (m asl)	Size (m)	Typology	Discovery date	Occuring species	Actual status	Sources
1.01	Torre dell'Orsa	Punta Raisi (PA)	5	-	Pond on clayey ground	04/III/1978	Tc, Bs, Ct	Disappeared	Cottarelli & Mura, 1979 Zaffagnini & Trentini, 1980
1.02	Gorgo Salato	Ustica island (PA)	20	40 x 30	Temporary pond	06/X/2002	Tc, Cd	Existing	Marrone, 2003
1.03	Gorgo di Tramoniana	Ustica island (PA)	15	12 (diameter)	Temporary pond	11/II/2003	Cd	Existing	Marrone, 2003
1.04	Gorgi Di Lorenzo	Ustica island (PA)	5	16 X 13	Pool on ploughed field	11/II/2003	Tc	Existing	Marrone, 2003
1.05	Gorgo di Baglio Cofano	Monte Cofano (TP)	250	15 X 12	Temporary pond	29/XI/2001	Cd, Tc, Ct	Existing	Marrone & Naselli Flores, 2004
1.06	Saline di Trapani e Marsala	Trapani and Marsala (TP)	0	Variable	Active saltworks	-	As	Existing	Faranda, 1977; Mura, 2001
1.07	Fontanile di Favignana	Favignana island (TP)	-	3 (length)	Concrete reservoir	-	Bs, Tc	Disappeared	Cottarelli & Mura, 1995
1.08	Pozze dell'Ucceria	Favignana island (TP)	5	variable	Ground pools	14/III/2004	Bs, Tc	Existing	Marrone & Naselli Flores, 2005
1.09	Pozza di Cala Rossa	Favignana island (TP)	-	6 X 6	Rock pool	-	Bs, Tc	Existing	Cottarelli & Mura, 1995 New Datum (Tc)
1.10	Pozza di Arta Rossa	Lampedusa island (AG)	-	2.5 X 2.5	Ground pool	-	Bp	Likely existing	Cottarelli & Mura, 1995
1.11	Pozza di Cala Francese	Lampedusa island (AG)	3	0.30 (diameter)	Rock pool	-	Bp	Existing. Other pools were found nearby	Cottarelli & Mura, 1995
1.12	Pozza di Cala Pisana	Lampedusa island (AG)	-	-	-	V/1954	Bp	Disappeared	Cottarelli, 1968
1.13	Pozze di Taccio Vecchio	Lampedusa island (AG)	-	1.5 - 3 (length)	Ground pools	-	Bp	Existing	Cottarelli & Mura, 1995
1.14	Albero Sole	Lampedusa island (AG)	-	-	-	1997	Bp	Likely existing	C. Tara legit
1.15	Pozza Sangaiamo	km 61.2 of the road SS 117 (EN)	800	3 X 5	Pasture pool	05/III/1978	Cd	Likely disappeared	Cottarelli & Mura, 1979; Margaritora et al., 1982
1.16	Saline di Siracusa	Siracusa (SR)	0	Variable	Abandoned saltworks	-	As	Disappeared	Vanhaecke et al., 1987
1.17	Pozza tra Portelle e Cerami	km 111.5 of the road SS. 120 (CT)	-	3 (diameter)	-	04/III/1982	Cd	Likely disappeared	Cottarelli & Mura, 1979; Margaritora et al., 1982
1.18	Mortelle	near Mortelle (ME)	-	-	-	16/II/1968	Lc	Disappeared	Cottarelli & Mura, 1979

precise geographical location. To date, four anostracan, two notostracan and three spinicaudatan taxa have been recorded on the island.

*Lepidurus apus lubbocki* is the first large branchiopod ever sampled in the island (BRAUER, 1873, 1877). The presence of this taxon in the island is confirmed by GURNEY (1909), who studied a Sicilian specimen of "*Lepidurus lubbocki*". After that, several authors (GHIGI, 1921; LONGHURST, 1955; COTTARELLI & MURA, 1983; BRTEK & THIÉRY, 1995) reported the presence of *L. apus lubbocki* in Sicily quoting Brauer's papers. Lacking any recent record of specimens belonging to the genus *Lepidurus* in Sicily, the current presence of this species on the island needs to be confirmed.

GHIGI (1921) is the first author who reports the presence of "*Thriops cancriformis*" (= *Triops cancriformis*) in Sicily. The specimens he studied, sent him by the "Museo di Palermo", included males. An apparently gonochoric population (the sample consisted of 3 males and 2 females) was, in fact, found on Favignana island by COTTARELLI & MURA (1995). Conversely, ZAFFAGNINI & TRENTINI (1980) worked on a maleless *Triops cancriformis* population from Punta Raisi, near Palermo. Other *Triops cancriformis* populations were recently found on Ustica island (MARRONE, 2003), on Monte Cofano (MARRONE & NASELLI-FLORES, 2004) and on Favignana island (MARRONE & NASELLI-FLORES, 2005). Specimens from the Monte Cofano pond have been studied by MANTOVANI *et al.* (2004). Conversely, the reports on the presence of *Triops granarius* in Sicily (THIÉRY, 1987; CHAMPEAU & THIÉRY, 1990) are erroneous and based on the misunderstanding of two works by COTTARELLI & MURA (1979, 1983).

DADAY DE DEÉS (1914) reported the presence of *Cyzicus cycladoides* (Joly, 1841) in Sicily. Unfortunately, the location of the site where the specimens he studied were collected was not specified. GURNEY (1909) reported that "*Estheria cycladoides*" is "widely distributed in North Africa and occurs also in Southern France, Spain and Sicily". COTTARELLI & MURA (1979) collected *C. tetracerus* in a pool at Torre dell'Orsa (Palermo province) and pointed out that this species cannot be told apart from *C. cycladoides* based on morphology, the latter being possibly a synonym of the former. A population of *C. tetracerus* was recently found on Monte Cofano (MARRONE & NASELLI-FLORES, 2004).

Two Leptestheriidae species are reported in Sicily: *Leptestheria dahalacensis* and *Leptestheria cf. cortieri*. *L. dahalacensis* is reported by DADAY DE DEÉS (1923) on the basis of specimens stored at the Museum of Natural History of Berlin. *Leptestheria cf. cortieri* was collected in Mortelle (Messina province) by COTTARELLI & MURA (1979). The identification of the *Leptestheria* from Mortelle as *L. cortieri* raises some doubts, as the authors themselves wrote (COTTARELLI & MURA, 1979, 1983). THIÉRY (1987), BRTEK & THIÉRY (1995) and ALONSO (1996), referring to the draw-

ings published by COTTARELLI & MURA (1979, 1983), attribute to *Leptesteria mayeti* (Simon, 1885) the spinicaudatan collected in Mortelle.

The anostracan *Chirocephalus diaphanus* has been reported in two small temporary pools in eastern Sicily (COTTARELLI & MURA, 1979; MARGARITORA *et al.*, 1982), two temporary ponds on Ustica island (MARRONE, 2003) and another one on Monte Cofano (MARRONE & NASELLI-FLORES, 2004).

Two *Branchipus* species are reported in Sicily: *B. pasai* and *B. schaefferi*. The former was described on the basis of specimens collected in 1954 in Cala Pisana, Lampedusa island (COTTARELLI, 1968). In Lampedusa the species has been also recorded in Cala Francese, Taccio Vecchio, Aria Rossa (COTTARELLI & MURA, 1995) and Albero Sole (G. Tara *legit*, 1997). *B. schaefferi* is a common palearctic species. It is currently known to occur in Torre dell'Orsa (COTTARELLI & MURA, 1979) and on Favignana island (COTTARELLI & MURA, 1995; MARRONE & NASELLI-FLORES, 2005).

*Artemia salina* is known to occur in Trapani and Marsala saltworks (FARANDA, 1977; COTTARELLI & MURA, 1983; VANHAECKE *et al.*, 1987; MURA, 2001; MURA & BRECCIAROLI, 2004). The presence of this species in the Siracusa saltworks is cited by VANHAECKE *et al.* (1987).

#### UPDATED LARGE BRANCHIOPODS DISTRIBUTION IN SICILY

The survey, carried out from 2000 to 2005, covered the whole Sicilian territory and led to the finding of 39 new sites hosting large branchiopods, 34 of which are hitherto unpublished (Tab. 2). Updated distribution of large branchiopod species in Sicily is illustrated in Figures 1 and 2, while the main features of literature and new sites are summarised in Tables 1 and 2, respectively. The updated large branchiopods distribution in Sicily follows.

#### 1. *Notostraca: Triopidae*

##### *Lepidurus apus lubbocki* (Brauer, 1873)

Occurrence sites: unknown.

Main bibliographical references: BRAUER, 1877; GURNEY, 1909.

Distribution: Palermo (PA).

Chorology: Mediterranean

##### *Triops cancriformis* (Bosc, 1802)

Occurrence sites: 1.01; 1.02; 1.04; 1.05; 1.07; 1.08; 1.09; 2.10; 2.19; 2.30.

Main bibliographical references: ZAFFAGNINI & TRENTINI, 1980; COTTARELLI & MURA, 1995; MARRONE, 2003; MARRONE & NASELLI-FLORES, 2004, 2005; MANTOVANI *et al.*, 2004.

Distribution: Carini (PA); Ustica (PA); Custonaci (TP); Favignana (TP); Gela (CL).

Chorology: Palearctic

Table 2  
List of new sites. Bp: *Branchipus pasai*; Bs: *Branchipus schaefferi*; Cd: *Chirocephalus diaphanus*; Ct: *Cyzicus tetracerus*; Tc: *Triops cancriformis*. PA: Palermo province; TP: Trapani province; AG: Agrigento province; CL: Caltanissetta province; SR: Siracusa province; CT: Catania province; ME: Messina province

Cod	Name	Location	Coordinates	Altitude (m asl)	Size (m)	Typology	Occurring Species
2.01	Abbeveratorio di Barcarello	Barcarello (PA)	4230744 N 33 350270 E	5	12 X 7	Concrete reservoir	Bs
2.02	Pozza di Barcarello	Barcarello (PA)	4230829 N 33 350334 E	25	0,6 X 0,5	Rock pool	Bs
2.03	Gebbia di Monte Gallo	Monte Gallo (PA)	4230519 N 33 352431 E	310	15 X 9	Concrete reservoir	Cd, Ct, Bs
2.04	Gorgo Secco	Belmonte Mezzagno (PA)	4210837 N 33 356439 E	600	9 X 9	Temporary pond	Cd
2.05	Gorgo Mennula	Belmonte Mezzagno (PA)	4208884 N 33 350535 E	520	20 X 20	Temporary pond	Cd
2.06	Lago Bomes	Bosco Granza e della Favara (PA)	4186899 N 33 396223 E	1000	Not detected	Temporary pond	Cd
2.07	Gorgo di Colobria	Monte Carcaci (PA)	4175773 N 33 368338 E	800	200 X 100	Temporary pond	Cd
2.08	Slagni di Piano Insiati	Monti di Palazzo Adriano (PA)	4166781 N 33 352875 E	800	Variable	Temporary ponds	Cd
2.09	Dolina della Rocca di Entella	Rocca di Entella (PA)	4182511 N 33 334171 E	484	40 X 40	Temporary pond	Cd
2.10	Gorgo di S. Bartolucchio	Ustica (PA)	4285081 N 33 341095 E	99	35 X 35	Concrete reservoir	Tc
2.11	Vasca di Torre S. Maria	Ustica (PA)	n.d.	n.d.	n.d.	Concrete reservoir	Cd
2.12	Pozza di Monte Scornace	Busetto Palizzolo (TP)	4206609 N 33 304264 E	450	1 X 0,8	Rock pool	Bs
2.13	Gorgo di Puziiddi	Zingaro (TP)	4217746 N 33 306568 E	370	13 X 15	Temporary pond	Cd, Ct
2.14	Gorgo di Pianello	Zingaro (TP)	4217513 N 33 305204 E	600	30 X 40	Temporary pond	Cd, Ct
2.15	Secondo gorgo di Pianello	Zingaro (TP)	4218594 N 33 305157 E	600	15 X 15	Temporary pond	Cd, Ct
2.16	Pozze di c.da Macarese	Monte Colafano (TP)	4219 N 33 294 E	5 - 20	Variable	Rock pools	Bs, Ct

follows Table 2

follows Table 2

Cod	Name	Location	Coordinates	Altitude (m asl)	Size (m)	Typology	Occurring Species
2.17	Pozze della cima di Monte Cofano	Monte Cofano (TP)	n.d. 4192 N 33 274 E	500	Variable	Rock pools	Bs
2.18	Stagno 2 di Isola Longa	Isola Longa (TP)	4198962 N 33 267667 E	0	30 X 30	Temporary pond	Bs
2.19	Pozze di Punta Fmfalo	Favignana (TP)	4074237 N 33 233310 E	16	Variable	Rock pools	Tc, Bs
2.20	Stagno di Monte Gibebe	Pantelleria (TP)	4162614 N 33 370653 E	600	9 X 5	Temporary pond	Cd
2.21	Gorgo di Massaro	S. Stefano Quisquina (AG)	4163178 N 33 371054 E	1000	14 X 40	Submerged cornfield	Cd
2.22	Bosco allagato	Bosco della Buonanotte (AG)	4163241 N 33 371948 E	948	500 X 40	Submerged wood	Cd
2.23	Stagno della Buonanotte	Bosco della Buonanotte (AG)	41374 N 33 3756 E	1000	11 X 20	Temporary pond	Cd
2.24	Stagni delle Macalube di Aragona	Aragona (AG)	3932 N 33 280 E	230	Variable	Temporary ponds	Cd
2.25	Pozze di Cala Galera	Lampedusa (AG)	931579 N 33 281061 E	18 to 35	Variable	Rock pools	Bp
2.26	Pozza di Cala Greca	Lampedusa (AG)	3932959 N 33 278603 E	20	1.7 X 0.8	Rock pool	Bp
2.27	Pozza di Cala dei Conigli	Lampedusa (AG)	3933802 N 33 276960 E	80	0.7 X 0.4	Rock pool	Bp
2.28	Pozza di Case Teresa	Lampedusa (AG)	n.d.	110	6.7 X 1	Ground pool	Bp
2.29	Pozza di Cala Madonna	Lampedusa (AG)	4104190 N 33 422922 E	10	Not detected	Rock pool	Bp
2.30	Pozza Macchitella	Gela (CL)	4103384 N 33 524484 E	10	53 X 7.5	Ground pool	Cd, Tc
2.31	Pozza del Teatro Greco	Siracusa (SR)	4189800 N 33 489051 E	25	2.5 X 1	Rock pool	Bs
2.32	Stagno delle Sciare di S. Venera	Maletto (CT)	4190 N 33 491 E	870	30 X 30	Temporary pond	Cd
2.33	Pozze del Gurridda	Lago Gurridda (CT)	4192143 N 33 470633 E	850	Variable	Ground pools	Cd
2.34	Pozza di Piano Cicogna	Piano Cicogna (ME)		1300	4 X 5	Ground pool	Cd



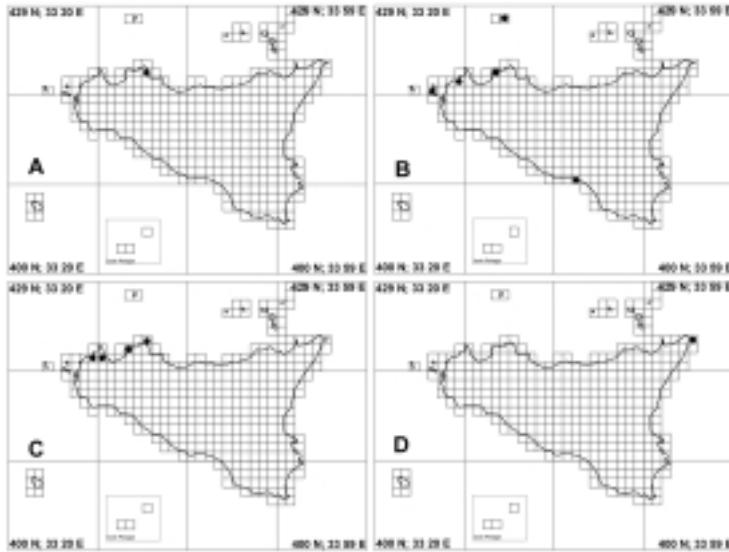


Figure 1 — Updated distribution of Notostraca and Spinicaudata in Sicily. The black dots in the cells indicate the presence of one or more sites hosting the species inside the cells themselves. Location of the site hosting *Leptestheria dahalacensis* is unknown and thus is not displayed. A: *Lepidurus apus lubbocki*; B: *Triops cancriformis*; C: *Cyzicus tetracerus*; D: *Leptestheria cf. cortieri*.

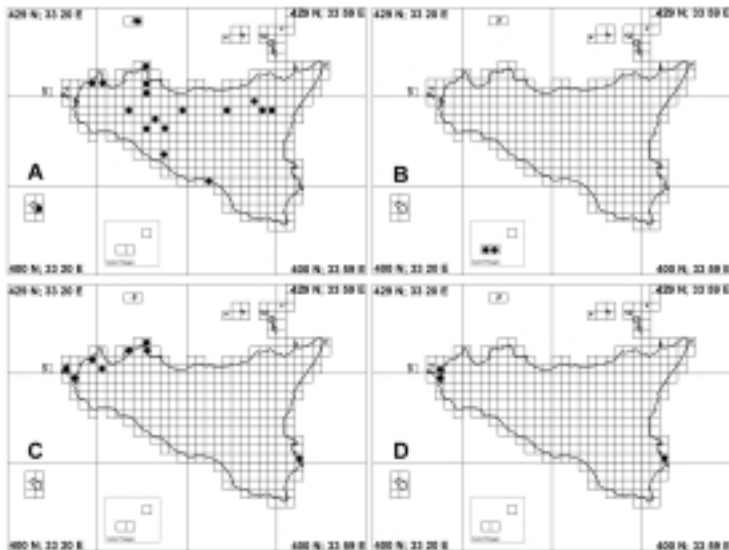


Figure 2 — Updated distribution of Anostraca in Sicily. The black dots in the cells indicate the presence of one or more sites hosting the species inside the cells themselves. A: *Chirocephalus diaphanus*; B: *Branchipus pasai*; C: *Branchipus schaefferi*; D: *Artemia salina*.

## 2. *Spinicaudata: Cyzicidae*

### *Cyzicus tetracerus* (Krynicky, 1830)

Occurrence sites: 1.01; 1.05; 2.03; 2.13; 2.14; 2.15; 2.16.

Main bibliographical references: COTTARELLI & MURA, 1979; MARRONE & NASELLI-FLORES, 2004.

Distribution: Palermo (PA); Carini (PA); Custonaci (TP); Scopello (TP).

Chorology: Palearctic

## 3. *Spinicaudata: Leptestheriidae*

### *Leptestheria dahalacensis* (Rüppel, 1837)

Occurrence sites: unknown.

Main bibliographical reference: DADAY, 1923.

Distribution: unknown.

Chorology: Palearctic

### *Leptestheria cf. cortieri* Daday, 1923

Occurrence site: 1.18.

Main bibliographical reference: COTTARELLI & MURA, 1979.

Distribution: Mortelle (ME).

Chorology: unknown (*species inquirenda*)

## 4. *Anostraca: Chirocephalidae*

### *Chirocephalus diaphanus* Prévost, 1803

Occurrence sites: 1.02; 1.03; 1.05; 1.15; 1.17; 2.03; 2.04; 2.05; 2.06; 2.07; 2.08; 2.09; 2.11; 2.13; 2.14; 2.15; 2.20; 2.21; 2.22; 2.23; 2.24; 2.30; 2.32; 2.33; 2.34.

Main bibliographical references: COTTARELLI & MURA, 1979; MARRONE, 2003; MARRONE & NASELLI-FLORES, 2004.

Distribution: Palermo (PA); Belmonte Mezzagno (PA); Lercara Friddi (PA); Palazzo Adriano (PA); Contessa Entellina (PA); Montemaggiore Belsito (PA); Ustica (PA); Scopello (TP); Custonaci (TP); Pantelleria (TP), Cammarata (AG); Aragona (AG); Gela (CL); Troina (EN); Cerami (EN); Maletto (CT), Randazzo (CT); Cesarò (ME).

Chorology: European-Mediterranean

## 5. *Anostraca: Branchipodidae*

### *Branchipus pasai* Cottarelli, 1968

Occurrence sites: 1.10; 1.11; 1.12; 1.13; 1.14; 2.25; 2.26; 2.27; 2.28; 2.29.

Main bibliographical references: COTTARELLI, 1968; COTTARELLI & MURA, 1995.

Distribution: Lampedusa (AG).

Chorology: Mediterranean

### *Branchipus schaefferi* Fischer, 1834

Occurrence sites: 1.01; 1.07; 1.08; 1.09; 2.01; 2.02; 2.03; 2.12; 2.16; 2.17; 2.18; 2.19; 2.31.

Main bibliographical references: COTTARELLI & MURA, 1979, 1995; MARRONE & NASELLI-FLORES, 2005.

Distribution: Palermo (PA); Carini (PA); Busto Palizzolo (TP); Custonaci (TP); Isola Longa (TP); Favignana (TP); Siracusa (SR).

Chorology: Palearctic

## 6. *Anostraca*: *Artemiidae*

### *Artemia salina* (L., 1758)

Occurrence sites: 1.06; 1.16.

Main bibliographical references: FARANDA, 1977; VANHAECKE *et al.*, 1987; MURA, 1999.

Distribution: Trapani (TP); Marsala (TP); Siracusa (SR).

Chorology: Mediterranean

## NOTES ON THE SPECIES

The present survey resulted in the finding of six large branchiopod species. Two spinicaudatans and one notostracan among those reported as present on the island were not found and are hereby listed on the basis of bibliographic data only. The lack of findings of *Leptestheria dahalacensis*, *L. cf. cortieri* and *Lepidurus apus lubbocki* highlights the need for carrying out further samplings on the island.

The phenology of the five species monitored from the winter 2000 to the winter 2005 is shown in Fig. 3. It is clearly evident that, in Sicily, most of the species are totally absent in the summer months, roughly from May to September. *Branchipus schaefferi* is the most eurythermal taxon among the Sicilian ones, and proved to develop when water is available irrespective of the season in which the ponding phases occur. In fact, it is the only species which has also been found during summer months, despite the high water temper-

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Triops cancriformis</i>	■	■	■	■	■	■	■	■	■	■	■	■
<i>Cyzicus tetracerus</i>	■	■	■	■	■	■	■	■	■	■	■	■
<i>Chirocephalus diaphanes</i>	■	■	■	■	■	■	■	■	■	■	■	■
<i>Branchipus schaefferi</i>	■	■	■	■	■	■	■	■	■	■	■	■
<i>Artemia salina</i>	■	■	■	■	■	■	■	■	■	■	■	■

Figure 3 — Phenology of selected large branchiopod species.

ature. This datum is in agreement with the observations carried out by CVETKOVIĆ-MILIČIĆ *et al.* (2004), who consider *Branchipus schaefferi* to be a “warm stenothermal to eurythermal species”.

*Branchipus pasai* is a species with a controversial taxonomical status; according to BELK & BRTEK (1995) it is possibly a synonym of *B. schaefferi*.

The most common and widespread large branchiopod species in Sicilian inland waters is *Chirocephalus diaphanus*. It is an eurieciuous taxon inhabiting both the coastal plain and high altitude ponds, both in pasture lands and in wooded areas. Conversely, the species belonging to the genus *Branchipus*, showed themselves to be confined to ephemeral and shallow water bodies located at low altitude. Few specimens belonging to the “*visnyai* form” of *Branchipus schaefferi* occur syntopically with individuals belonging to the “*typica* form”, as previously recorded in the former Yugoslavia (PETROV & MARINČEK, 1991; PETKOVSKI, 1997) and in the Maltese Islands (LANFRANCO, 2001). “*Branchipus visnyai*” Kerstéz, 1956 is presently thought to be a synonym of *B. schaefferi* (BELADJAL & MERTENS, 1999; ZARATTINI *et al.*, 2001), although further studies are needed to definitely clarify the situation.

*Artemia salina* proved to be still present in the Trapani and Marsala saltworks, while it seems to be extinct in the Siracusa saltworks. AMAT *et al.* (2005) recorded the presence of the allochthonous species *Artemia franciscana* (Kellog, 1906) in Portugal and along the Mediterranean coasts of France and Spain. The cyst sample they studied from Isola Longa (Trapani saltworks), collected in 1985, proved to belong to the autochthonous Mediterranean species *A. salina*, but this has yet to be confirmed by recent checks, since MURA *et al.* (in press) found the invasive *A. franciscana* in the saltworks of Margherita di Savoia (Apulia).

Two notostracan species have been reported in Sicily: *Triops cancriformis* and *Lepidurus apus lubbocki*. Unfortunately, in spite of the previous findings of apparently gonochoric populations of *T. cancriformis* on the island, all the populations recently found in Sicily appear to be maleless.

*Cyzicus tetracerus* is the only spinicaudatan found in the frame of the present survey. The females we collected show the 9<sup>th</sup> and 10<sup>th</sup> pairs of limbs modified as a egg-bearing flabellum. This datum is in accordance with the features typical of the family Cyzicidae (ALONSO, 1996; DUMONT & NEGREA, 2002) but contrasts with COTTARELLI & MURA (1983), who report only the 10<sup>th</sup> pair of limbs as ovigerous in the specimens they collected in Torre dell’Orsa (Palermo province), a population which has nowadays disappeared.

As already outlined, it is possible that the *Leptestheria* cf. *cortieri* collected by COTTARELLI & MURA, (1979) is, in fact, *Leptestheria mayeti* (THIÉRY, 1987; BRTEK & THIÉRY, 1995; ALONSO, 1996), an African spinicaudatan common in Maghreb and known also to occur on Balearic islands (PRETUS, 1990).

On the basis of the description of this taxon given by COTTARELLI & MURA (1979), the spinicaudatan collected near Messina differs from *L. cortieri* at least in respect to the presence of some spineless trunk segments that the latter lacks completely. The disappearance of the only known Sicilian population of this species and the deterioration of the sample collected and studied by COTTARELLI & MURA (1979) make it impossible to ascertain the identity of this Leptestheriidae.

As a result of both confirmed literature and recently found sites, the current presence of large branchiopods was checked in forty sites. Usually, a single species *per site* was found. When more species co-occur, the most commonly observed assemblages are composed of *Chirocephalus diaphanus* and *Cyzicus tetracerus*, and of *Branchipus schaefferi* and *Triops cancriformis*. Unlike what has been observed in northern Tunisia, a region close to Sicily and with a similar climate, where often two or more anostracan species share the same habitat (Marrone, *unpublished observations*), the co-existence of two species belonging to the same order has been observed only once in Sicily (Tab. 2; site 2.03).

#### GENERAL REMARKS

The results of the present survey show that, based on current knowledge, Sicilian large branchiopod fauna is not well diversified, hosting widespread taxa and lacking endemic species. All the Sicilian species with a certain taxonomical position are known also to occur in Tunisia and the Italian mainland, with the only exception being the controversial *Branchipus pasai*, which has its only European site on the Island of Lampedusa (Pelagie Archipelago, AG) as well as *Cyzicus tetracerus*, which is still unknown on Italian mainland but known to occur in Sardinia and Tunisia. Moreover, it seems that the noteworthy speciation process which interested the genus *Chirocephalus* on the Italian mainland did not take place in Sicily and that many steppic taxa, common in northern Tunisia, are absent from Sicily. Very likely, the low species richness characterising the current Sicilian large branchiopod fauna is not the natural condition of Sicily, but the outcome of the heavy human impact which affected, and continues to affect, Sicilian wetlands. Less than a third of the thirteen sites mentioned in literature older than 2003 have been found to be still existing: the remaining ones have been eliminated through draining, filling in or, conversely, through deepening, in order to make them permanent.

As pointed out by BELK (1998), the major risk affecting worldwide large branchiopod populations is the destruction of their habitats. Unfortunately,

little effort has been made so far to preserve Mediterranean temporary ponds in Sicily. This situation implies a high risk for the vulnerable Sicilian large branchiopod fauna and for all the temporary waters biota, as only in threat-free areas can temporary water bodies and their fauna survive the spreading urbanization and landscape changes.

Among the taxa with a known distribution, only *Leptestheria* cf. *cortieri* was not observed in protected areas, a situation which possibly led to the extinction of this species in Sicily. The location and status of the sites hosting *Lepidurus apus lubbocki* and *Leptestheria dahalacensis* are currently unknown (Tab. 3).

As often pointed out (e.g. DUMONT *et al.*, 1995; MURA & BELMONTE,

Table 3  
Species, sites and their protection status. R.N.O.: Riserva Naturale Orientata;  
R.N.I.: Riserva Naturale Integrale.

Taxa	Protection	Sites
<i>Lepidurus apus lubbocki</i>	?	?
<i>Triops cancriformis</i>	R.N.O. "Monte Cofano" Not protected	1.05 1.01; 1.02; 1.04; 1.07; 1.08; 1.09; 2.10; 2.19; 2.30
<i>Cyzicus tetracerus</i>	R.N.O. "Capo Gallo" R.N.O. "Zingaro" R.N.O. "Monte Cofano" Not protected	2.03 2.13; 2.14; 2.15 1.05; 2.16 1.01
<i>Leptestheria dahalacensis</i>	?	?
<i>Leptestheria</i> cf. <i>cortieri</i>	Not protected	1.18
<i>Chirocephalus diaphanus</i>	R.N.O. "Monte Carcaci" R.N.O. "Bosco Granza e della Favara" R.N.O. "Capo Gallo" R.N.O. "Monti di Palazzo Adriano e Valle del Sosio" R.N.O. "Grotta di Entella" R.N.O. "Zingaro" R.N.O. "Monte Cofano" R.N.O. "Isola di Pantelleria" R.N.I. "Macalube di Aragona" Parco Regionale dell'Étna Parco Regionale dei Nebrodi Not protected	2.07 2.06 2.03 2.08 2.09 2.13; 2.14; 2.15 1.05 2.20 2.24 2.32; 2.33 2.34 1.02; 1.03; 1.15; 1.17; 2.04; 2.05; 2.11; 2.21; 2.22; 2.23; 2.30
<i>Branchipus pasai</i>	R.N.O. "Isola di Lampedusa" Not protected	2.25; 2.26; 2.27; 2.28 1.09; 1.10; 1.11; 1.12; 1.13; 2.29
<i>Branchipus schaefferi</i>	R.N.O. "Capo Gallo" R.N.O. "Monte Cofano" R.N.O. "Isole dello Stagnone" Not protected	2.01; 2.02; 2.03 2.16; 2.17 2.18 1.01; 1.07; 1.08; 1.09; 2.12; 2.19; 2.31
<i>Artemia salina</i>	R.N.O. "Saline di Trapani e Marsala" R.N.O. "Isole dello Stagnone" R.N.O. "Foce del Ciane e saline di Siracusa"	1.06 1.06 1.16

2004), the current knowledge on “certain less charismatic animal species” like branchiopod crustaceans is far from being complete and, in the light of the rapid erosion of the global biological heritage, more monitoring and specialists are urgently needed.

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