

A REVIEW OF THE BRANCHIOPOD FAUNA OF THE MALTESE ISLANDS (CRUSTACEA: BRANCHIOPODA)

Sandro Lanfranco¹

ABSTRACT

Twelve branchiopod species from seven families and four orders have been positively identified from the Maltese Islands. Four orders are recorded (Anostraca, Notostraca, Spinicaudata, Cladocera), three of these (Anostraca, Notostraca, Spinicaudata) represented by only one family. Four families of Cladocera have been recorded (Daphniidae, Moinidae, Macrothricidae, Chydoridae). Only three families are represented by more than a single species (Branchipodidae: 2 species, Daphniidae: 4 species, Chydoridae: 2 species). Three cladoceran species are reported for the first time from the Maltese Islands [*Alona diaphana* King var. *iheringi* Richard; *Moina brachiata* (Jurine) (?) and *Macrothrix hirsuticornis* Norman et Brady].

INTRODUCTION

Published records of Branchiopoda from the Maltese Islands are not numerous. Various genera and species have been recorded by Medlycott (1870), Gulia (1873), Baldacchino (1983), Schembri (1989) and Lanfranco (1996b) as part of more general works on the fauna of the Maltese Islands while a synopsis of the non-cladoceran branchiopods was given by Lanfranco *et al.* (1991). A number of unpublished dissertations also contain records pertaining to branchiopods (Zammit-Lucia, 1971; Lanfranco, 1990; Lanfranco, 1995a; Hewitt, 1996; Grech, 1996). The present work aims to review all published records of Branchiopoda from the Maltese Islands and present new records from previously unpublished material.

CLASSIFICATION

The taxonomy of the Branchiopoda is in a state of flux as a consequence of the morphological heterogeneity of the members of this group. Morphological features that are considered unifying factors for this assemblage are essentially symplesiomorphic and therefore unsuitable as a basis for recognition of phylogenies (Fryer, 1987). Some of the most influential (but not necessarily most logical nor most accurate) classification schemes prior to 1987, such as that of Tasch (1969), subdivided the Branchiopoda into three subclasses (Calmanostraca, Diplostraca and Sarsostraca) and seven orders (Notostraca, Kazachartra, Acerostraca, Conchostraca, Cladocera, Anostraca and Lipostraca). The Lipostraca and Kazachartra are only known from fossils (Devonian and Jurassic, respectively) whilst the Acerostraca are now known not to be crustaceans at all. A new classification of the Branchiopoda proposed by Fryer (1987), separated the Conchostraca into two taxa of ordinal status (Spinicaudata and Laevicaudata) whilst the Cladocera were subdivided into

four orders (Anomopoda, Ctenopoda, Onychopoda, Haplopoda). Nevertheless, recent molecular evidence suggests that the Cladocera form a true monophyletic group (Crease and Taylor, 1998; Hanner and Fugate, 1997). Although the term Conchostraca now has no taxonomic significance, it is still useful for descriptive purposes. A review of all genera and species recorded from the Maltese Islands follows:

ANNOTATED LIST OF SPECIES

Class **Branchiopoda** Latreille, 1817

Order **Anostraca** Sars, 1867
Family **Branchipodidae**

Branchipus schäfferi Fischer

Synonyms: *Branchipus pisciformis* Schaeffer; *Branchipus stagnalis* Latreille; *Branchipus stagnalis* Latreille forma *typica* Kertész

Records from the Maltese Islands: Schembri (1989); Lanfranco (1990); Lanfranco *et al.* (1991); Lanfranco (1995a); Lanfranco & Schembri (1995); Lanfranco (1996a); Hewitt (1996); Grech (1996)

Habitat and local distribution: This anostracan is euryhaline (Lanfranco *et al.*, 1991) and has been recorded from inland pools as well as mesohaline coast-fringing habitats throughout the Maltese Islands.

Global distribution: This species is present throughout the Palearctic region (Cottarelli and Mura, 1983). It is particularly frequent in Western and Southern Europe but is rarer in the northern parts of its range (Nourisson and Thiery, 1988).

¹ Department of Environmental Science, GF Abela Junior College, University of Malta, Msida, Malta. sandro.lanfranco@um.edu.mt

Branchipus visnyai Kertesz

Synonyms: *Branchipus stagnalis* Latreille forma *visnyai* Kertesz

Records from the Maltese Islands: Schembri (1989); Lanfranco (1990); Lanfranco *et al.* (1991); Lanfranco & Schembri (1995); Lanfranco (1996a); Hewitt (1996).

Taxonomic status: The taxonomic rank of this species is under contention. It is morphologically similar to *B. schaefferi* except for the shape of the frontal shield and the degree of flexure of the second antennae in males. These appendages are recurved in *B. visnyai* and unflexed in *B. schaefferi*. It has been maintained that *Branchipus visnyai* should be afforded full species rank (Cottarelli, 1969). This claim is disputed by Petrov and Marinček (1991) who conclude that the separation of *B. visnyai* as a distinct species is unfounded. Other work (Petkovski, 1997; Beladjal and Mertens, 1999) indicates that confusion between the two forms may arise following preservation of specimens in alcohol, since this procedure may lead to deformation of key characteristics of taxonomic importance. This has not been the case for specimens collected from the Maltese Islands since antennal flexure in males was noted in living material. More recent work based on protein electrophoresis of specimens from two natural populations of *B. schaefferi* and *B. visnyai* in central Italy indicates that the genetic divergence between the two forms is very low (Zarattini *et al.*, 2001).

The current state of knowledge suggests that the separation of these two forms as distinct species is presently unfounded and previous records of *Branchipus visnyai* should therefore be referred to *Branchipus schaefferi* until further evidence to the contrary is forthcoming.

Habitat and local distribution: This species is a colonist of temporary freshwater habitats and has been recorded from three localities in the Maltese Islands:

Wied ir-Raheb, Gozo (temporary rockpools): A population colonising freshwater rockpools was recorded by P.J. Schembri in 1984. Representative individuals were collected and identified (P.J. Schembri pers. comm.).

Ghadira s-Safra, Malta (transitional coastal wetland): A single individual, syntopic with *B. schaefferi*, was recorded and subsequently collected by the author on 19 December 1989.

Il-Qaliet, Malta (transitional coastal wetland): A population colonising a maritime freshwater pool and syntopic with *B. schaefferi* was recorded by R. Hewitt and the author in October 1995. Representative individuals were collected and identified. A small number of individuals with taxonomically-significant characteristics intermediate between those of *B. schaefferi* and *B. visnyai* were also collected. These specimens were examined by V. Cottarelli at Università di Roma "La Sapienza" and classified as "malformed" *B. schaefferi*.

Global distribution: Apart from the Maltese Islands, this species has been recorded from Eastern Europe (Czech Republic, Slovakia, Hungary, Romania), Sardinia, Latium (Italy) and Algeria (Cottarelli and Mura, 1983).

Branchipus stagnalis Latreille

Synonym: *Branchipus schaefferi* Fischer

Records from the Maltese Islands: Medlycott (1870) [as *Branchipus stagnalis* (Cuv.)]; Baldacchino (1983) (as *Branchipus stagnalis* L.)

All records of *B. stagnalis* are presumed to refer to *B. schaefferi* Fischer.

Order **Notostraca** Sars

Family **Triopsidae** Keilhack

Triops cancriformis cancriformis (Bosc)

Synonyms: *Monoculus apus* L.; *Apus cancriformis* Bosc; *Triops palustris* Schrank; *Triops cancriformis* Keilhack; *Triops cancriformis cancriformis* Longhurst

Records from the Maltese Islands: Schembri (1989); Lanfranco (1990); Lanfranco & Schembri (1995); Lanfranco (1996a); Lanfranco & Lanfranco (1996) [all as *Triops cancriformis* (Bosc)]; Lanfranco (1990); Lanfranco *et al.* (1991).

Habitat and local distribution: This species is a colonist of temporary freshwater habitats and has only been recorded from the main island, Malta. The most recent records are from the following localities:

Ghadira s-Safra, Malta (transitional coastal wetland): Two juveniles were noted and collected by the author on 18 December 1989.

Mosta, Malta (temporary freshwater rockpools): A single live adult was noted and collected by the author on 3 December 1990.

Tal-Wej, Malta (temporary freshwater rockpools): A single live adult and a single dead adult were noted and collected by the author on 23 December 1994.

Mosta, Malta (temporary freshwater rockpools): Two adults were collected from a drying pool by the author on 10 November 1996.

Southern Malta (temporary freshwater rockpools): Numerous adults were recorded by the author on 18 June 2001.

Individuals belonging to this species have also been noted from il-Qaliet wetland (G Lanfranco pers. comm.; E.Lanfranco pers. comm.) and Wied il-Ghasel (P.J. Schembri pers. comm.). A small number of sporadic sightings from other localities in Malta have been claimed but these have not yet been verified.

Global distribution: The species has been divided into three geographical races by Longhurst (1955): *cancriformis cancriformis* Bosc, *cancriformis simplex* Chigi and *cancriformis mauretanicus* Chigi. The subspecies *cancriformis cancriformis* is found throughout Europe with the exception of Southern Spain where it is replaced by *cancriformis mauretanicus* (Cottarelli and Mura, 1983).

***Limnodia melitensis* Gulia**

Records from the Maltese Islands: Gulia (1873)

Taxonomic status: The taxonomic status and validity of this record are unknown and this is the only reference to the species and the genus in the literature. No type specimens are known and no type localities are listed in Gulia (1873).

Order Spinicaudata Linder
Family Cyzicidae Stebbing

***Cyzicus tetracerus* (Krynicky)**

Synonyms: *Limnadia tetracera* Krynicky; *Estheria tetracera* Baird; *Estheria cycladoides* Chyzer; *Caenestheriella variabilis* Daday; *Cyzicus tetracerus* Audoin

Records from the Maltese Islands: Schembri (1989); Lanfranco (1990); Lanfranco *et al.* (1991); Lanfranco (1995a); Lanfranco (1996a)

Habitat and local distribution: Occurs throughout the Maltese Islands where it is restricted to temporary freshwater rockpools and is generally present at low population densities.

Global distribution: The species occurs throughout the Palearctic region. It is widespread in Eastern Europe (Nourisson and Thiery, 1988) but infrequent in France. The species has not been recorded from Southwestern France. Sicily is the only Italian territory from where *Cyzicus tetracerus* has been recorded (Cottarelli and Mura, 1983).

***Eocyclus* (?) *orientalis* Daday**

Records from the Maltese Islands: Baldacchino (1983)

This record referred to *Cyzicus tetracerus*. The original specimens were misidentified (P.J. Schembri, pers.comm.).

Order Cladocera Latreille
Family Daphniidae Straus

***Ceriodaphnia quadrangula* (O.F. Müller)**

Synonyms: *Daphnia quadrangula* O.F. Müller; *Monoculus clathratus* Jurine; *Ceriodaphnia punctata* P.E. Müller; *C. quadrangula* var. *hamata* Sars

Records from the Maltese Islands: Lanfranco (1990); Lanfranco (1995a); Lanfranco (1995b); Lanfranco (1996a); Hewitt (1996); Grech (1996) (all as *Ceriodaphnia* sp.); Lanfranco (1996b).

Habitat and local distribution: Occurs throughout the Maltese Islands where it is restricted to temporary freshwater rockpools.

Global distribution: This is a holarctic and neotropical species. It has been recorded throughout Europe, as well as from the Canary Islands, North Africa, Central Asia, Japan,

North and South America and in Arctic and Antarctic regions (Margaritora, 1985).

***Simocephalus vetulus* (O.F. Müller)**

Synonyms: *Daphnia vetula* O.F. Müller; *Daphnia sima* O.F. Müller; *Monoculus sima* Jurine; *Monoculus nasutus* Jurine; *Daphnia vetula* Baird; *Simocephalus vetulus* Schödler

Records from the Maltese Islands : Baldacchino (1983)

Habitat and local distribution: This species has only been recorded once from the Maltese Islands. It was noted from a large pool at Rabat where it was present in high abundance.

Global distribution: The species is cosmopolitan and very common (Margaritora 1985).

***Daphnia pulex* Leydig emend. Scourfield**

Synonyms: *Monoculus pulex* L.; *Daphnia pennata* Schödler; *Daphnia pulex* Leydig; *Daphnia ovata* Sars; *Daphnia hastata* Sars; *Daphnia groenlandica* Wesenberg-Lund; *Daphnia helvetica* Stingelin; *Daphnia glacialis* Parenzan.

Records from the Maltese Islands: Gulia (1873) (as *Daphnia pulex* Müller); Lanfranco (1995b). The specimens listed as *D. pulex* by Lanfranco (1995b) refer to *Daphnia* (*Daphnia*) *pulicaria* (F. Margaritora, pers. comm.). Gulia (1873) notes that *D. pulex* was accompanied by other unidentified cladocerans. No description of the habitat from where the material was collected was given.

Global distribution: The species is holarctic and neotropical and is widely distributed in all temperate latitudes. Nevertheless, the precise pattern of distribution is confounded by considerable intraspecific variation since a large number of species generally classified as *D. pulex* should actually refer to *D. obtusa* or *D. curvirostris* (Margaritora 1985).

***Daphnia* (*Daphnia*) *pulicaria* Forbes emend. Hrbáček**

Synonyms: *Daphnia pulex* var. *pulicaria* Forbes; *D. pulex* var. *pulicariodes* Burckhardt; *D. wierzyiskii* Litynski; *D. pulicaria* Hrbáček

Records from the Maltese Islands Lanfranco (1990) (as *Daphnia* sp.1); Lanfranco (1990) (as *Daphnia* sp.2); Lanfranco (1996b) (as *Daphnia pulicaria*).

Habitat and local distribution: Recorded from aseasonal freshwaters such as artificial ponds and reservoirs. Also recorded from pools in the bed of Wied Ghollieqa (Malta) on 14 February 1990. On this occasion, the species was undergoing a bloom phase and population density was extremely high.

Global distribution: The species is holarctic, although its pattern of distribution is confounded by its imprecisely-defined taxonomic status (Margaritora 1985).

***Daphnia* sp.**

Records from the Maltese Islands: Zammit-Lucia (1971).

Habitat and local distribution: Recorded from Wied il-Qlejgha (Chadwick Lakes), Malta. The material has not been examined.

Family **Moinidae** Goulden

***Moina brachiata* (Jurine) (?)**

Synonyms ; *Monoculus brachiatus* Jurine; *Daphnia brachiata* Liévin; *Moina rectirostris* Baird; *M. brachiata* Baird; *M. lilljeborgi* Schödler.

Records from the Maltese Islands : Lanfranco (1996a) (as Moinidae).

Habitat and local distribution: A single record exists. Material was collected from a freshwater pool in the bed of Wied il-Kbir (Gozo) by E. Lanfranco and passed on to the author. The outer surface of the carapace of all specimens observed was colonised by *Colacium* sp. (Euglenophyta).

Global distribution: The species has been recorded from Europe, central Asia and Africa. It is apparently absent from the Americas (Margaritora 1985).

Taxonomic status: The identity of the specimens collected from the Maltese Islands and assigned to this species is uncertain. The material in the collection showed features shifting towards *Moina micrura* Kurz, although it could also be *Moina micrura dubia* (circum-Mediterranean and North African distribution). Collection of more samples (primarily males) is required to resolve the doubtful identity of these specimens (F. Margaritora, pers. comm.).

Family **Macrothricidae** Norman et Brady

***Macrothrix hirsuticornis* Norman et Brady**

Synonyms: *Macrothrix arctica* Sars; *Macrothrix hirsuticornis* var. *arctica* Lilljeborg; *Macrothrix hirsuticornis* var. *groenlandica* Lilljeborg.

Records from the Maltese Islands: Lanfranco (1996a) (as Macrothricidae)

Habitat and local distribution: A single record exists. Material was collected from a temporary freshwater rockpool at Ta' Cenc (Gozo) by Ms J Grima and passed on to the author.

Global distribution

This species is cosmopolitan and is particularly widespread in Europe (Margaritora 1985).

Family **Chydoridae** Stebbing

***Pleuroxus letourneuxi* Richard**

Synonyms: *Chydorus letourneuxi* Richard; *Pleuroxus obtusirostris* Smirnov; *P. letourneuxi* Smirnov.

Records from the Maltese Islands: Lanfranco (1995b) (as *Alona* sp.); Lanfranco (1996a) (as Chydoridae); Lanfranco (1996b) [as *Pleuroxus letourneuxi* (sic)]; Grech (1996); [as *Pleuroxus letourneuxi* (sic)].

Habitat and local distribution: Recorded from temporary freshwater rockpools throughout the Maltese Islands.

Global distribution: The species is circum-Mediterranean and has been recorded from Tunisia, Algeria, Spain, Turkey and Sardinia (Margaritora 1985).

***Alona diaphana* King var. *iheringi* Richard**

Synonyms: *Alona davidi* Richard; *Alonella diaphana* Sars var. *iheringi* Richard *A. punctata* Daday

Records from the Maltese Islands: Lanfranco (1990) (as *Alonella* sp.); Lanfranco (1995a) (as *Alona* sp.); Lanfranco (1996a) (as Chydoridae); Hewitt (1996) (as *Alona* sp.).

Habitat and local distribution: Recorded from temporary freshwater rockpools throughout the Maltese Islands.

Global distribution: This species is present in all tropical and sub-tropical regions and is particularly widespread in Africa (Margaritora 1985).

DISCUSSION

General The branchiopods recorded from the Maltese Islands represent a depauperate subset of the branchiopod fauna of the circum-Mediterranean region. This comparative scarcity of species is mainly attributable to the following factors:

1. Insularity of the Maltese Islands; colonisers are required to cross an ecological barrier prior to successful establishment.
2. Restricted size of the Maltese Islands, presenting a smaller target destination for potential colonisation.
3. Paucity of colonisation sites as a consequence of the scarcity of suitable wetland habitats.
4. Loss of suitable habitat due to anthropogenic interference.

Records of Cladocera The large branchiopods (Anostraca, Spinicaudata, Notostraca) are visually conspicuous and their occurrence and distribution has been fairly well-documented. The cladocera present a different problem. Most are small and inconspicuous, and would probably be overlooked or ignored during casual or non-specific surveys of freshwater habitats. The cladoceran species recorded from 1990 onwards (six of the eight local records) were noted as part of a broader programme of work on freshwater rockpools of the Maltese Islands. No systematic survey of cladocerans has yet been carried out although such a search is in preparation.

Conservation status Many branchiopods are limited in their occurrence and distribution throughout the Maltese Islands and are therefore of considerable conservation value in a local context. The conservation status of branchiopods

Table 1. Conservation status of Maltese Branchiopods.

Order	Species	Conservation status
Anostraca	<i>Branchipus schäfferi</i> Fischer	Restricted distribution in the Maltese Islands
Anostraca	<i>Branchipus visnyai</i> Kertész	Very rare with a restricted distribution in the Maltese Islands
Spinicaudata	<i>Cyzicus tetracerus</i> listed as (?) <i>Eocyclus</i> cf. <i>orientalis</i> Daday	Restricted distribution in the Maltese Islands
Notostraca	<i>Triops cancriformis</i> (Bosc)	Rare with a restricted distribution in the Maltese Islands

according to Schembri (1989) is given in Table 1. No cladocerans were listed in Schembri (1989), presumably due to the paucity of data pertaining to this group at the time.

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specimens, Prof. Vezio Cottarelli for assessing doubtful *Branchipus visnyai* / *Branchipus schäfferi* material, Edwin Lanfranco for identification of epizoic algae on cladoceran carapaces and Prof. P.J. Schembri and Prof. G. Mura for key literature and for several important discussions regarding the branchiopoda and their ecology. The author is also grateful to Noel Toledo, Paul Catania, Joe Gatt and officials of Nature Trust (Malta) for indicating sites colonised by *Triops cancriformis*.

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