

First record of *Arctodiaptomus wierzejskii* (Richard, 1888) (Copepoda Calanoida Diaptomidae) from Malta

Luca Montevago, Luca Vecchioni, Federico Marrone*

Abstract - Diaptomid copepods belonging to the genus *Arctodiaptomus* Kiefer, 1932 were collected in two temporary water bodies in Malta. The morphological identification of the collected specimens proved that they belong to *Arctodiaptomus wierzejskii* (Richard, 1888) even if a morphological peculiarity pertaining to the morphology of the male right antennule of the Maltese populations was observed and here briefly discussed. This finding constitutes the first record of a calanoid copepod from the inland waters of the Maltese Islands.

Key words: Maltese inland waters, microcrustaceans, temporary waters.

Riassunto - Prima segnalazione di *Arctodiaptomus wierzejskii* (Richard, 1888) (Copepoda Calanoida Diaptomidae) da Malta.

Copepodi diaptomidi appartenenti al genere *Arctodiaptomus* Kiefer, 1932 sono stati raccolti in due corpi d'acqua temporanei a Malta. L'identificazione morfologica degli esemplari raccolti ha consentito di attribuirli alla specie *Arctodiaptomus wierzejskii* (Richard, 1888) anche se da questa si differenziano per una particolarità morfologica relativa alla morfologia delle antennule maschili destre, qui brevemente discussa. Questo rinvenimento è il primo di un copepode calanoide per le acque interne delle isole maltesi.

Parole chiave: acque interne maltesi, acque temporanee, microcrustacei.

INTRODUCTION

The Maltese Archipelago is formed by three main islands (Malta, Gozo and Comino) and a number of minor islets and small rocks mainly composed of Oligo-Miocene limestones. It is located at the centre of the Mediterranean basin, 96 km south of the Sicilian coast. Overall, the archipelago presents a surface area of about 315 km²,

with Malta, the largest island, covering an area of about 246 km². The climate is typically Mediterranean, with a wet season in which about 85% of the total annual rainfall occurs, and a dry period lasting roughly from April to September. The average annual precipitation is about 530 mm and the average temperature is 18.6°C (Schembri, 1993).

To date, the available data on Maltese non-marine crustaceans focused on Branchiopoda (Lanfranco *et al.*, 1991; Lanfranco, 2001; Korn *et al.*, 2006; Lukić *et al.*, 2019; Marrone & Vecchioni, 2020) and malacostracans (*e.g.* Vecchioni *et al.*, 2017, 2019; Deidun *et al.*, 2018; Hupało *et al.*, 2019), whereas only scarce data are to date available on Copepoda and Ostracoda (*e.g.* Baldacchino, 1983). In particular, no inland water calanoid copepods have ever been reported from the archipelago.

In the frame of a wide survey aimed at exploring the inland water copepod fauna of the Central Mediterranean area, some calanoid copepods were collected in Malta whose identity and morphology are hereby discussed.

MATERIALS AND METHODS

Crustacean samples were collected in Malta on 31st January 2008 in a “rock-pool” located in Wied Es-Sabtah (site MT001, WGS84 geographical coordinates: 35.836060 N, 14.514882 E; 44 m a.s.l.) and in a concrete reservoir near Siġġiewi (site MT002, WGS84 geographical coordinates: 35.847023 N, 14.434342 E; 108 m a.s.l.) (Fig. 1). Sampling was carried out with a 200 µm mesh hand net. The collected specimens were fixed *in situ* using 90% ethanol and sorted out in laboratory under a stereomicroscope.

Collected calanoid copepod specimens were identified according to Kiefer (1978) and Ranga-Reddy (1994). Further comparisons were made with the drawings reported in Gurney (1931), Damian-Georgescu (1966), Petkovski (1983), Stella (1984), and Einsle (1993). Moreover, Tunisian specimens of *Arctodiaptomus wierzejskii* (Richard, 1888) from Sidi Othman and El Hisiane (sites F109 and F193 in Marrone *et al.*, 2016) were included as comparative material. Drawings were made with a microscope equipped with a camera lucida.

Department of Biological, Chemical and Pharmaceutical Sciences and Technologies (STEBICEF), University of Palermo, Italy.
E-mail: luca-lm@live.it; luca.vecchioni@unipa.it

* Corresponding author: federico.marrone@unipa.it

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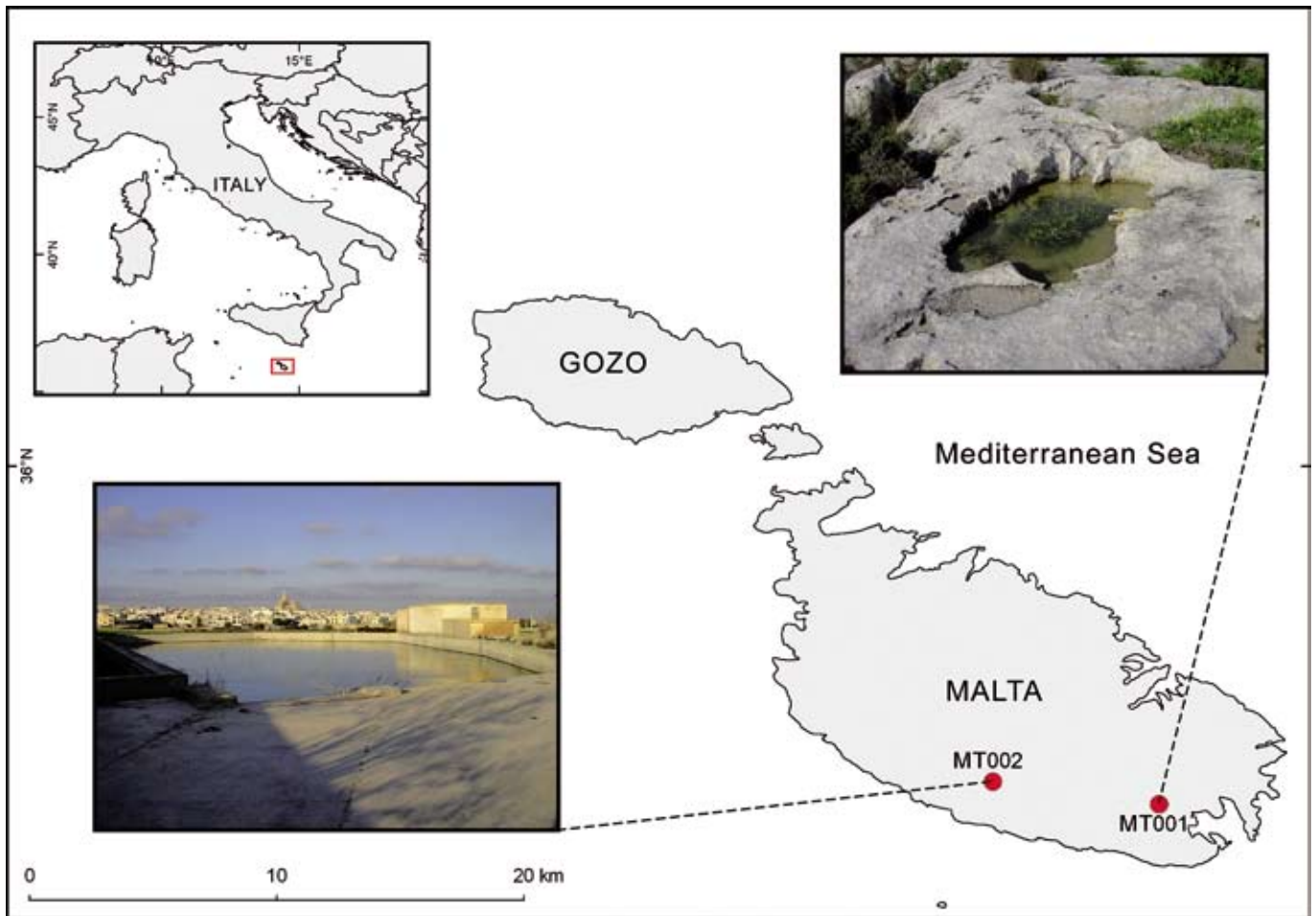


Fig. 1 - Location of the Maltese occurrence localities of *Arctodiaptomus wierzejskii*: rock pool in Wied Es-Sabtah (MT001) and concrete reservoir near Siggiewi (MT002). / Località maltesi di *Arctodiaptomus wierzejskii*: pozza in roccia a Wied Es-Sabtah (MT001) e vasca di cemento presso Siggiewi (MT002).

Co-occurring branchiopod and ostracod taxa were identified according to Alonso (1996) and Meisch (2000), respectively. Samples of Maltese and Tunisian *A. wierzejskii*, and co-occurring crustacean taxa, are kept in FM collections at the University of Palermo and are available for loan on request. Moreover, 10 males and 10 females from MT002 were deposited in the collection of the Zoology Section “La Specola”, Natural History Museum, University of Florence (Italy) under the collection number MZUF 661.

RESULTS

At the sampling date, the electric conductivity values were $199 \mu\text{S cm}^{-1}$ (20°C) in MT001 and $688 \mu\text{S cm}^{-1}$ (17°C) in MT002. The co-occurring crustacean fauna (Tab. 1) is richer in MT001, including the species typically found in temporary rock pools, whereas that occurring in MT002 only includes the euryecious daphniid *Daphnia magna* (see also Marrone & Vecchioni, 2020). Unexpectedly, no cyclopoid copepods were collected in the two sites.

The morphology of the collected diaptomid copepods allowed us to identify them as *Arctodiaptomus wierzejskii*, although the Maltese specimens slightly differ from the standard morphology of the species in a detail related to male right antennule (see below).

The antennules (A1) of females are symmetrical and consist of 25 segments, with the typical chaetotaxy of the species as described in Kiefer (1978). The right male antennule is modified and geniculated in the fourth last segments. The thirteenth segment of the right antennule has a robust and well-developed spine, while in its antepenultimate segment there is a spiny comb-shaped process (Fig. 2A). When compared with the available drawings of *A. wierzejskii* and with *A. wierzejskii* individuals from Tunisia, the Maltese specimens present a morphological peculiarity. In Tunisian male specimens, the 14th segment of the right antennule has a short but stout tooth. This feature is constantly represented in all the available drawings of the species. Conversely, in the Maltese individuals the tooth on the 14th segment is normally absent (Fig. 3). Only in one out of the 35 studied Maltese males the spine is present, although poorly developed (Fig. 3H).

Tab. 1 - Crustacean assemblages recorded in the two study sites on January 31th 2008. / Popolamenti a crostacei osservati nei due siti di studio il 31 gennaio 2008.

* *Ceriodaphnia quadrangula* Müller, 1785 *sensu* Alonso (1996).

TAXA	MT001	MT002
Branchiopoda		
Anostraca		
<i>Branchipus schaefferi</i> Fischer, 1834	X	
Spinicaudata		
<i>Cyzicus tetracerus</i> (Krynicky, 1830)	X	
Anomopoda		
<i>Daphnia (Ctenodaphnia) magna</i> Straus, 1820		X
<i>Ceriodaphnia</i> sp.*	X	
<i>Coronatella (Ephemerlonia) elegans</i> (Kurz, 1875)	X	
Ostracoda		
Podocopa		
<i>Plesicypridopsis newtoni</i> (Brady & Robertson, 1870)	X	
<i>Potamocypris arcuata</i> (Sars, 1903)	X	
Copepoda		
Calanoida		
<i>Arctodiaptomus wierzejskii</i> (Richard, 1888)	X	X

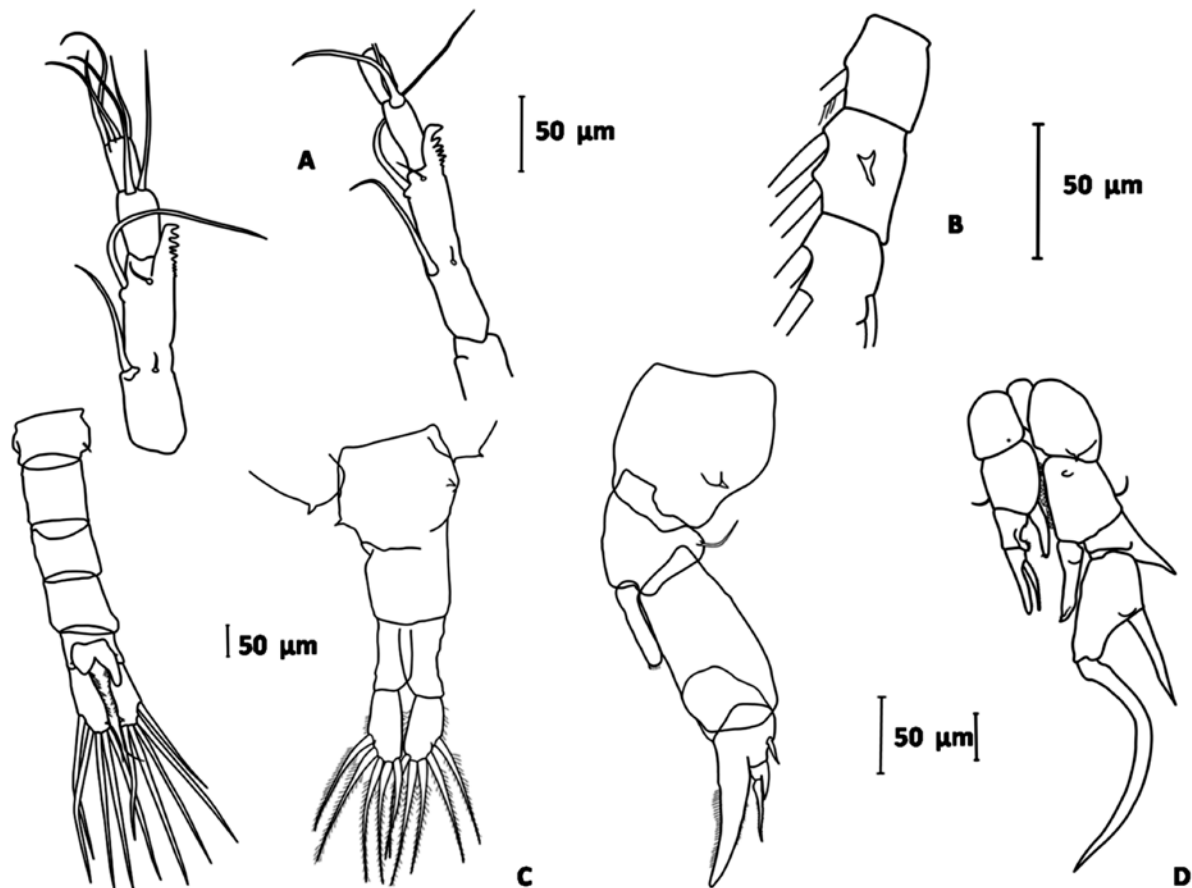


Fig. 2 - Morphological details of *A. wierzejskii* individuals from Malta. A) detail of the male right antennule. The comb-shaped process is evident; B) detail of the second endopodite segment of male P2; C) male (left) and female (right) urosomes; D) female (left) and male (right) P5. / Dettagli morfologici di individui maltesi di *A. wierzejskii*. A) particolare delle antennule destre maschili. Il processo a forma di pettine è evidente; B) particolare del secondo segmento dell'endopodite del P2 maschile; C) urosoma maschile (a sinistra) e femminile (a destra); D) P5 femminile (a sinistra) e maschile (a destra).

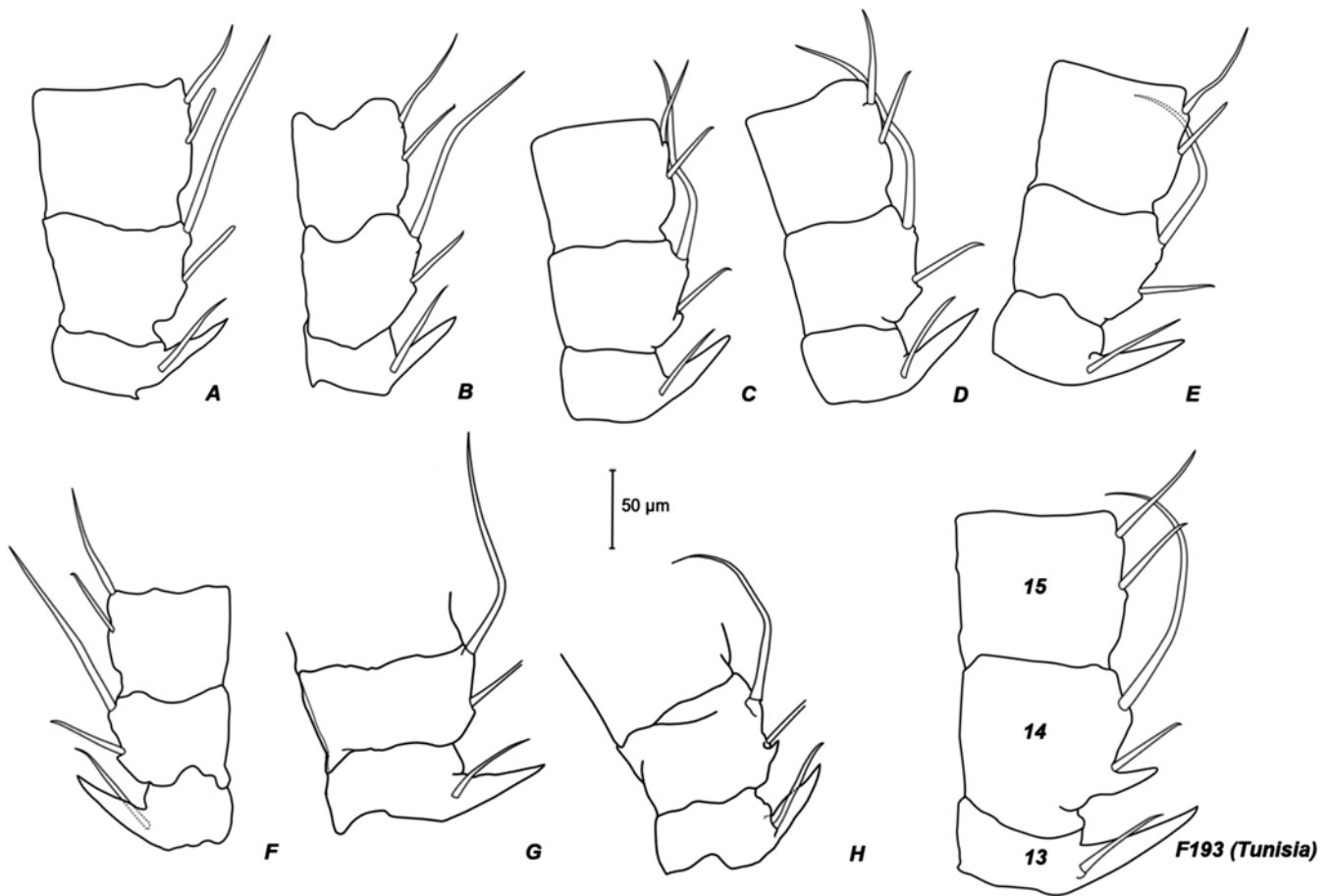


Fig. 3 - Segments 13-15 of the right male antennule from Malta. A-H) compared with an individual from Tunisia (site F193). A, B, F) MT002; C, D, E, G, H) MT001. / Segmenti 13°-15° delle antennule destre dei maschi maltesi. A-H) confrontati con un individuo tunisino (sito F193). A, B, F) MT002; C, D, E, G, H) MT001.

DISCUSSION AND CONCLUSIONS

Arctodiaptomus Kiefer, 1932 is a diverse diaptomid genus currently divided in various subgenera of doubtful validity (e.g. Ranga-Reddy, 1994; Dussart & Defaye, 2002; Boxshall & Halsey, 2004). Its type species, *Arctodiaptomus wierzejskii*, is a euryecious taxon, which can produce both subitaneous and drought-resistant eggs, and is able to colonise a wide range of different habitat types, ranging from brackish, warm and shallow temporary pools, to tundra pools and large oligotrophic lakes (Gurney, 1931; Kiefer, 1978; Ranga-Reddy, 1994; Błędzki & Rybak, 2016). The species is widely distributed across the Palearctic region including the Maghreb, the whole Europe north to the Shetlands, and the eastern Palearctic east to Mongolia and northern China (Dussart & Defaye, 2002; Błędzki & Rybak, 2016; Marrone *et al.*, 2017). Oddly enough, although the species is known to occur in peninsular Italy and Sardinia, with few scattered populations (Ruffo & Stoch, 2006), it seems to be absent in Sicily (Marrone *et al.*, 2006). Conversely, in some relatively close areas, for example the Apulian peninsula, it is the most widespread calanoid copepod in temporary inland waters (Alfonso & Belmonte, 2011), often dominating and characterizing the microcrustacean communities of these ponds (Alfonso *et al.*, 2016).

The existence of morphological differences between different *A. wierzejskii* populations was already reported in literature; e.g. in the Tunisian, Algerian and Central Asian populations females have the right lobe of the fifth thoracic somite distinctly facing outwards (Gurney, 1931), the males of some Scottish populations present a projection of the antepenultimate segment of the right antennula much shorter than usual (Fryer & Joyce, 1981), and an unusual male and female chaetotaxy was observed in *Arctodiaptomus* cf. *wierzejskii* from Mongolia (Marrone *et al.*, 2015). Accordingly, in spite of the slight morphological difference pertaining to male right A1, we are here conservatively attributing the Maltese *Arctodiaptomus* populations to *A. wierzejskii*. However, also in the light of the wide distribution area and the great variety of habitats colonized by the species, it cannot be excluded that under the binomen *Arctodiaptomus wierzejskii* are actually lumped several different evolutionary lineages. The molecular characterization of selected populations is needed in order to understand whether the observed morphological differences are consistent with a clear pattern of genetic diversity, or are rather to be ascribed to a noteworthy intraspecific morphological variability with no taxonomical value.

To date no information on the presence of calanoid copepods in Maltese inland waters was available. The present finding thus constitutes the first record of a representative of the family Diaptomidae in the Maltese Archipelago, and contributes to the knowledge of the distribution of freshwater calanoids in the Mediterranean area. However, the finding of an unidentified calanoid specimen in a rock pool in the area of Għallis (Malta; S. Lanfranco, *in litteris*) suggests that diaptomids could be widespread in the Maltese Archipelago, and that more surveys aimed at getting a better knowledge of its freshwater copepod fauna are desirable.

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