

NOTES CONCERNING THE SEMI-TERRESTRIAL
AND FRESHWATER AMPHIPODS (CRUSTACEA: PERACARIDA)
OF THE MALTESE ISLANDS

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Introduction

Interest in Mediterranean amphipods has been re-focused recently by the appearance of a new multi-author monograph on the group edited by Professor Sandro Ruffo (1982 and continuing) which, when complete, will replace the classic work of Chevreux & Fage (1925). In spite of this progress, however, wide areas of the Mediterranean are still almost unknown amphipodologically (Ruffo (ed.), 1982) and detailed fauna lists are wanting for many regions.

For the past few years, one of us (P.J.S.) has been surveying bodies of freshwater in the Maltese Islands and samples have now been amassed from all the main fresh- and brackish water sites in the islands. Since just about every body of freshwater dries up early in the summer (and remains so for the best part of six months each year) it is interesting to see just how many amphipod species the islands' freshwaters support. Since present knowledge of Maltese semi-terrestrial amphipods is also limited they too have been included in our surveys.

The following list summarizes our taxonomic (P.G.M.) and ecological (P.J.S.) knowledge of the Amphipoda from these habitats on the Maltese Islands. All material is deposited in the personal collections of P.J.S. with the exception of *Allorchestes aquilinus* (A. Costa) which is in the collections of P.G.M.

Species List

FAMILY GAMMARIDAE

Echinogammarus ebusitanus (Margalef)

GOZO: 2 ♂♂, 8 ♀♀ (ovigerous), 2 imm. [tube 9] Wied tal-Lunzjata (Kercem end), 11.11.84; watercourse with permanent stream; P.J. Schembri leg.; 97 specimens [tube 10], Wied tal-Lunzjata, 10.8.83; watercourse with permanent stream; P.J. Schembri leg.; 98 specimens [tube 11], Xlendi Valley (NE end), 21.9.83; watercourse with permanent stream; P.J. Schembri & M. Gauci leg.; 2 ♂♂, 2 ♀♀ (ovig.), 3 imm. [tube 14], Wied tal-Lunzjata (Kercem end), 11.11.84; under stones by edges of watercourse with permanent stream; P.J. Schembri leg.

Literature: Malta island (Karaman, 1977).

Echinogammarus pungens (Milne Edwards)

MALTA: 3 ♂♂, 1 ♀ (ovig.), 3 imm. [tube 12], Mtarfa (old train station), 2.4.84; spring; M. Gauci leg.; 4 ♂♂, 6 ♀♀ (5 ovig.) [tube 13], Bahrija Valley, 17.2.85; watercourse with permanent stream; D.M. Johnson leg.

Taxonomic note: all Maltese *E. pungens* material examined had relatively poor setation on the inner face of pereopod 7 basis.

Literature: Rabat under Mtarfa bridge and from Bahrija (Nov. 1972) (Baldacchino, 1983).

Gammarus aequicauda (Martynov)

MALTA: 2 ♂♂, 4 imm. [tube 4], Salina (marsh), 16.4.77; P.J. Schembri leg.; 6 ♂♂, 1 ♀ [tube 18], Ghadira Nature Reserve, 11.3.83; saltmarsh, under stones round edges of brackish water pool; P.J. Schembri leg.; 1 ♂, 2 ♀♀ (1 ovig.) [tube 21], Ghadira Nature Reserve, 18.12.84; in brackish water pool; P.J. Schembri leg.

Literature: along coast of Malta (Karaman, 1979).

Rhipidogammarus rhipidiophorus (Catta)

GOZO: 5 ♂♂, 3 ♀♀ (ovig., one incomplete), Fontana (Ghajn tal-Hasselin), 21.9.83; freshwater fountain; P.J. Schembri & M. Gauci leg.

Literature: Coast of Malta (Karaman, 1979).

Allorchestes aquilinus (Catta)

MALTA: 8 ♂♂, 5 ♀♀ under stones in shallow

Orchestia gammarellus (Catta)

GOZO: 2 ♂♂, 6 ♀♀ (5 ovig.), 5 ♀♀, 6 imm. [tube 1] with permanent stream; Qawra (Dwejra), Il-Qat water; P.J. Schembri leg.

MALTA: 1 ♂, 1 ♀ [tube 2], Ghadira (marsh), 8.5.77; 22.12.77; P.J. Schembri leg.; 11.9.82; P.J. Schembri Reserve, 24.4.84; saltmarsh; P.J. Schembri leg.; 2 ♀♀ [tube 3], 18.12.84, saltmarsh (as

Orchestia mediterranea (Catta)

GOZO: 2 ♀♀ (?) (both ovig.), both water spring; M. Gauci leg.

MALTA: 10 ♂♂, 9 ♀♀ (5 ovig.) round edges of brackish water pool; P.J. Schembri leg. 7 imm. [tube 22], Saqqajja; P.J. Schembri leg. 16 saltmarsh, under dry Lanfranco leg.; 2 ♂♂ littoral, under stones;

Orchestia montagui (Catta)

MALTA: 4 ♂♂ [tube 28], Marsaxlokk; 1 ♂ [tube 28], Marsaxlokk; P.J. Schembri leg.

Literature: Guadalupe

FAMILY TALITRIDAE

Allorchestes aquilinus (A. Costa)

MALTA: 8 ♂♂, 5 ♀♀ (2 ovig.), 17 juveniles [tube 27], Marsaxlokk Bay, 2.3.85; under stones in shallow supralittoral pools; P.J. Schembri leg.

Orchestia gammarellus (Pallas)

GOZO: 2 ♂♂, 6 ♀♀ (3 ovig.), 2 juv. [tube 14], Wied tal-Lunzjata (Kercem end), 11.11.84; under stones by edges of permanent stream; P.J. Schembri leg.; 2 ♂♂, 5 ♀♀, 6 imm. [tube 15], Xlendi Valley (NE end), 21.9.83; edges of watercourse with permanent stream; P.J. Schembri & M. Gauci leg.; 2 ♂♂, 8 ♀♀ [tube 16], Qawra (Dwejra), Il-Qattara pool, 10.11.84, under vegetation growing in dripping water; P.J. Schembri leg.

MALTA: 1 ♂, 1 ♀ [tube 1], San Martin (stream), 1.2.75; P.J. Schembri leg.; 2 ♂♂ [tube 2], Ghadira (marsh), 10.11.74; P.J. Schembri leg.; 3 ♂♂, 1 ♀ [tube 3], Ghadira (marsh), 8.5.77; P.J. Schembri leg.; 4 ♂♂, 11 ♀♀ [tube 5], Salina (marsh) 22.12.77; P.J. Schembri leg.; 11 ♂♂, 3 ♀♀ [tube 7], Wied il-Hesri (watercourse), 11.9.82; P.J. Schembri leg.; 2 ♂♂, 5 ♀♀ (1 ovig.) [tube 19], Ghadira Nature Reserve, 24.4.84; saltmarsh, under stones round edges of brackish water pool; P.J. Schembri leg.; 2 ♂♂, 3 ♀♀ (all ovig.) [tube 20], Ghadira Nature Reserve, 18.12.84, saltmarsh (as above); P.J. Schembri leg.

Orchestia mediterranea A. Costa

GOZO: 2 ♀♀ (?) (both gravid) [tube 17], Qawra (Dwejra), 22.9.83; edges of freshwater spring; M. Gauci leg.

MALTA: 10 ♂♂, 9 ♀♀ [tube 24], Ghadira s-Safra (Maghtab), 10.2.84; under stones round edges of brackish water pool; P.J. & S.P. Schembri leg.; 1 ♂, 6 ♀♀, 7 imm. [tube 22], Salina, 14.5.83; saltmarsh, under drying leaves of *Posidonia*; P.J. Schembri leg. 16 ♂♂, 19 ♀♀ [tube 23], Il-Maghluq (Marsaxlokk), 13.9.83; saltmarsh, under drying leaves of *Posidonia*; P.J. Schembri, M. Gauci & E. Lanfranco leg.; 2 ♂♂, 5 ♀♀ (3 ovig.) [tube 28], Marsaxlokk Bay, 2.3.85, supralittoral, under stones; P.J. Schembri leg.

Orchestia montagui Audouin

MALTA: 4 ♂♂ [tube 6], Marsaxlokk (hypersaline pool/marsh); P.J. Schembri leg.; 1 ♂ [tube 28], Marsaxlokk Bay, 2.3.85; supralittoral, under stones; P.J. Schembri leg.

Literature: Gulia (1873).

Talitrus saltator (Montagu)

GOZO: 2 ♂♂ [tube 25], Ramla Bay, 4.3.84; supralittoral, burrowing in sand; S.P. Schembri leg.; 12 ♂♂, 1 ♀ [tube 26], Ramla Bay, 2.2.85; sand-dunes, burrowing in sand; P.J. Schembri leg.

Literature: Gulia (1873); Micallef & Evans (1968).

Ecological commentary

The semi-terrestrial and freshwater habitats occupied by amphipods in the Maltese Islands may be grouped into six types: supralittoral, adlittoral, marshland, dry valley watercourses, permanent streams and subterranean waters. Two principal physical factors differentiate these habitat types: degree of inundation and pattern of salinity fluctuation.

On Maltese rocky shores, supralittoral amphipods (*A. aquilinus*, *O. montagui*, *O. mediterranea*) live among stones and in shallow (at times only 1-3 cm deep) pools above mean sea level but well within reach of the splash from breaking waves. This is the most marine habitat: inundation is very frequent and salinity close to that of seawater (3.5‰ at Marsaxlokk Bay, Malta; unpublished data). On sandy shores, amphipods were found in two supralittoral habitats: burrowing in the sand within the splash zone (*T. saltator*) and living in the banks of drying debris of the eel-grasses *Posidonia oceanica* and *Cymodocea nodosa* deposited on the shore by waves, especially during autumn (*O. mediterranea*). These banks of eel-grass debris (usually referred to as « banquettes » by Mediterranean workers; eg. Bellan-Santini, 1985 and references therein) form a characteristic Mediterranean supralittoral habitat (Pérès, 1967) but next to nothing is known about their ecology. They are wetted by spray during rough seas but during the hot summer months, when there is little wave action, they may bake in the sun for days without being wetted (the average maximum and minimum air temperatures during July and August, the hottest months, for the period 1951-1980 were 30.2° and 21.0°, and 30.6° and 21.8° C, respectively; Meteorological Service, Malta). Even under these conditions, however, it is only the top 20 cm or so of the bank that dries out completely; beneath this dry outer layer, the decomposing debris is quite wet (cf. Moore & Francis, 1985). In the Maltese Islands, eel-grass banks on sandy shores are usually between 0.5 and 1 m deep, sometimes more; eel-grass debris is also deposited on rocky shores but there the banks

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tend to be less deep and of very limited extent. Inlets most are periodical months.

Most Maltese sandy beaches are so degraded that in Gozo and here the sand as far up as 10 m from the sea. At times sea spray but mainly

The mean tidal range and the spring rainfall tables 1986 - European (Mediterranean), coastal marine annual cycle of precipitation in late September-October rainfall 1986 and appreciable rainfall in May-early September. During this dry season, and runoff from rainwater and seepage from the sea full of brackish water level falls rapidly becoming hypersaline. Such a « marsh » season.

This has been declared a nature reserve in the marsh even at Ghadira before mo was found (*O. gam* 1984) an additional aquatic species is year-round supply at Ghadira, the on

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tend to be less deep and less permanent. Since sandy shores are of very limited extent in the Maltese Islands and of high touristic value, most are periodically cleared of eel-grass debris during the summer months.

Most Maltese sandy beaches are backed by dunes. Human use of these beaches is so intense, however, that in almost all cases the dunes are much degraded. The best developed dune system is at Ramla Bay in Gozo and here amphipods (*T. saltator*) were found burrowing in sand as far up as the upper reaches of the sublittoral, some 50 m away from the sea. At these distances, inundation is partly by wind-blown sea spray but mainly by rain during the wet season (October to March).

The mean tidal range in the Maltese Islands being only 0.06 m and the spring range 0.15 m (U.S. Dept. of Commerce, 1985: *Tide tables 1986 - Europe and the west coast of Africa including the Mediterranean*), coastal marshes are maintained not by tidal cycles but by the annual cycle of precipitation and evaporation. The rainy season starts in late September and rainfall is heaviest during October (average October rainfall 1951-1980, 117.9 mm; Meteorological Service, Malta) and appreciable rainfall continues until mid-April. During the period May-early September little or no rain falls and the temperature is high. During this dry season, evaporation is very marked. Direct precipitation, and runoff from surrounding high ground, fills coastal marshes with rainwater admixed with a little seawater from spray and from seepage from the sea through permeable substrata. The marsh continues full of brackish water until the start of the dry season whereupon the water level falls rapidly and salinity increases, the water eventually becoming hypersaline before the marsh ultimately dries up completely. Such a «marsh» remains desiccated until the start of the next wet season.

This has been the natural pattern of events in all Maltese coastal marshes. In 1980, however, the largest marsh at Ghadira, Malta was declared a nature reserve and deepened so that some water remains in the marsh even during the dry season. In samples taken from Ghadira before modifications were made, only one species of amphipod was found (*O. gammarellus*), but in samples taken more recently (1983-1984) an additional species was encountered (*G. aequicauda*). This more aquatic species is more 'delicate' than *O. gammarellus* and requires a year-round supply of saline water. Previous to its recent appearance at Ghadira, the only other locality where it had been found in the

Maltese Islands was at Salina, a coastal marsh about 7 km southeast of Ghadira and surrounded by extensive artificial salt-pans which provide saline pools all year.

Apart from the two species already mentioned, another two (*O. montagui* and *O. mediterranea*) were also found in marsh habitats. The former was found only at Il-Magħluq, a small marsh at Marsaxlokk Bay, Malta, the latter at Il-Magħluq, at Salina and at Ghadira s-Safra. In the first two localities, *O. mediterranea* occurred in banks of wave-deposited eel-grass debris. It therefore belongs to the supralittoral «banquette» habitat rather than the marsh habitat proper. Ghadira s-Safra is a very small marshy area (approx. 576 m²) situated on the northeast coast of Malta between Magħtab and Ghallis. This marsh undergoes the same seasonal fluctuations in water level as described above, but the fauna here is not typical of other Maltese coastal marshes; for example, the pool macrofauna of Ghadira s-Safra includes species of fairy-shrimp (? *Branchipus*, Branchiopoda: Anostraca) and tadpole-shrimp (? *Triops*, Branchiopoda: Notostraca) which are not found in any other coastal marsh but are typical of temporary rainwater pools.

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The Maltese Islands have no lakes, rivers or streams. The only natural freshwater is that which flows through the *widien* [*Widien* (singular: *wied*) is the Maltese term for 'valleys' which drain the surrounding ground] and the very few springs fed from limestone aquifers. Geographically, the Maltese *widien* are described as Dry Valleys, that is, valleys in which water flows only during part of the year. Outside the rainy season the *widien* are absolutely dry. The youngest rock type in the Maltese Islands is the Upper Coralline Limestone (UCL) which is well jointed (Zammit Maempel, 1977). This is underlain by an impervious layer of clays, collectively called Blue Clay (BC), which gives rise to an aquifer/aquiclude system which in suitable areas forms a perched water table in the UCL (Newbery, 1968). Where this water table coincides with exposed UCL/BC junctions, water trickles out to give the so called High Level Springs (Zammit Maempel, 1977). These constitute the only year-round natural running water in the Maltese Islands and even so, there are great seasonal fluctuations in flow rates. In many cases high level springs drain through a *wied* and such *widien* then attain the nature of miniature 'river' valleys. If the *wied* is particularly long though, the water evaporates in summer (or is pumped off for irrigation purposes) before it can reach the coasts and the seawards part of these *widien* are typical dry valley habitats.

With one exception water habitats can have a year-round flow. One exception is *O. montagui* in a dry valley. However, at Il-Luq and Wied ta' Ghadira, their upper reaches are flooded by this drainage system even in this case, t

Two other pools are found from Qawra, near the edges of a high water is not the typical high level spring pool of freshwater shrimp (*marellus*) and from The distance between contamination of conditions may be of the freshwater shrimp (*rhipidiophorus*). The tana, Gozo, which runs through a system where the amphipod is enlarged and embedded in known subterranean

Discussion

Gulia (1873) listed species: *Talitrus montagui* and *Phrosina nicetens dentaria* Latr. (= sites or habitats) list of the marine include one gammarid

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With one exception, all Maltese amphipods from strictly fresh-
water habitats came from *widien* draining high level springs, that is,
having a year-round supply of flowing water. The species involved are
E. ebusitanus, *R. rhipidiophorus*, *O. gammarellus* and *E. pungens*. The
one exception is *O. gammarellus* from Wied il-Hesri, Malta which is a
dry valley. However, Wied il-Hesri is fed by two tributary *widien*, Wied
il-Luq and Wied tal-Girgenti, both of which carry high level springs in
their upper reaches. It may be that amphipods migrate up and down
this drainage system depending on availability of water and therefore
even in this case, they may be associated with year-round flowing water.

Two other points need be made. The first concerns *O. mediterranea*
from Qawra, near Dwejra, Gozo. Here, this species was collected from
the edges of a high level spring draining onto the Qawra coast. Fresh-
water is not the typical habitat of this species. The situation at Qawra
is a high level spring cascading into a depression to form a shallow
pool of freshwater (Il-Qattara, with one species of amphipod, *O. gam-
marellus*) and from here the water overflows and drains to the sea.
The distance between sea and Il-Qattara is only some 250 m, so that
contamination of the drainage channel with seawater is possible and
conditions may be brackish at certain times of the year when the flow
of the freshwater spring is reduced. The second point concerns *R.*
rhipidiophorus. This species was found in a natural fountain at Fon-
tana, Gozo, which is supplied from a high level spring. This spring
runs through a system of underground channels and the fountain itself,
where the amphipods were collected, is situated in a small cavern
enlarged and embellished by man. This habitat accords well with the
known subterranean habits of *R. rhipidiophorus* (Ruffo (ed.), 1982).

Discussion

Gulia (1873) first reported amphipods from Malta, identifying five
species: *Talitrus platycheles* Guerin (= *T. saltator* (Montagu)), *Orche-
stia montagui* Audouin, *Gammarus locusta* Fabr. (= *G. locusta* (L.)),
Phrosina nicetensis Edw. (? = *P. semilunata* Risso) and *Phronima se-
dentaria* Latr. (= *P. sedentaria* (Forsk.) without giving details of
sites or habitats (the last three species are offshore planktonic). In their
list of the marine fauna of the Maltese Islands, Micallef & Evans (1968)
include one gammarid [*Gammarus locusta*] and one talitrid [*Talitrus*

saltator] together with another eight strictly marine hyperid and caprellid species, also without details of sites or habitats. Karaman (1977) redescribed *Echinogammarus ebusitanus* from Malta (exact locality not stated) and included several Maltese records of coastal gammarids in a later paper (Karaman, 1979). Most recently, Baldacchino (1983) has reported finding *Gammarus pungen* Milne-Edwards [now *Echinogammarus pungen* (Milne-Edwards)] in freshwater sources on Malta.

Our extensive collections of amphipods from Maltese freshwater and semi-terrestrial habitats now reveal four gammarid species (above) one of which, *E. ebusitanus*, was confined to Gozo in our samples where it apparently inhabits a restricted area (the species' localities of Wied tal-Lunzjata and Xlendi Valley are part of the same drainage system). Karaman (1977), however, recorded this species from « Malta island ». 'Malta' is the name of both the largest island of the Maltese archipelago and of the Maltese islands as a whole. Since Karaman does not specify the exact locality of collection, there is some doubt as to whether his specimens came from the island of Malta itself or another island (? Gozo) of the Malta group. Another gammarid, *R. rhipidiophorus* appears to be even more restricted, being found only in a single site in Gozo (Fontana).

The five talitrid species found show an interesting gradation from supralittoral pool-dwelling (*A. aquilinus* and some *O. montagui* and *O. mediterranea*) and eel-grass « banquette » species (most *O. mediterranea*), through marsh species (*O. montagui* and some *O. gammarellus*), to a freshwater association (*O. gammarellus*). This pattern accords well with the habitual finding of *O. gammarellus* penetrating further inland than *O. mediterranea* and *O. montagui*. It is interesting to note the wide ecological valency of *O. gammarellus* in the Maltese Islands. Here this species is found in habitats ranging from hypersaline (eg. salt-marshes) through freshwater (eg. high level springs) to comparatively arid sites (eg. dry valley watercourses). The apparent absence of *O. cavimana* Heller (= *O. bottae* Milne-Edwards) and of *O. platensis* Kröyer from the Maltese Islands may be one factor affecting this. Were these species present, they might inhibit the extent to which inland sites are colonized by *O. gammarellus*. Apparently the absence of these species leaves their putative habitats free for occupation by *O. gammarellus*. As usual, *Talitrus saltator* is confined to sandy supralittoral and adlittoral habitats.

It is interesting to note that amphipods in the Maltese Islands are found at two sites only (Baldacchino, 1983) and again at some 6 km apart (Qlejgha Valley and Xlendi Valley, 6 km from Mtarfa). This is due to the lack of suitable habitats in the vicinity of freshwater sources (Baldacchino, 1986) under local conditions. These sites are separated by a distance of 6 km, making transport of suitable habitats difficult. Water transport of amphipods between the Maltese Islands, however, is not an intrinsic local phenomenon (Sultana & Gauci, 1986) and operates only rarely.

Acknowledgements

We gratefully acknowledge the assistance of Lanfranco and S. Gauci and the help of Mario Gauci for the collection of specimens.

I seguenti anfipodi sono stati trovati sulle isole Maltesi: *Aequicauda*, *Rhipidophorus*, *O. mediterranea*, *O. montagui*, *O. gammarellus*, *O. cavimana*, *O. platensis*, *O. bottae*, *Talitrus saltator*. La loro distribuzione sulle isole Maltesi è stata studiata in relazione alle condizioni di abitazione, e le

Parole chiave

The following amphipods were found in the Maltese Islands: *Aequicauda*, *Rhipidophorus*, *O. mediterranea*, *O. montagui*, *O. gammarellus*, *O. cavimana*, *O. platensis*, *O. bottae*, *Talitrus saltator*. Their distribution in the Maltese Islands is studied in relation to the conditions of habitation, and the

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It is interesting to note the patchy distribution of freshwater amphipods in the Maltese Islands. For example, *E. pungens* was found at two sites only, Bahrija Valley and Mtarfa, both in 1972 (Baldacchino, 1983) and again more recently (this work). These two localities are some 6 km apart. Intriguingly, the Fiddien Valley/Chadwick Lakes/Qlejgha Valley complex, an extensive drainage system only some 0.9-1.5 km from Mtarfa, apparently has no amphipods. This may be a result of lack of suitable habitats but may also reflect restricted dispersive capacity of freshwater and semi-terrestrial amphipods (cf Moore & Spicer, 1986) under local conditions, where potentially suitable humid habitats are separated by tracts of arid terrain. Under such conditions, colonization of suitable new habitats would depend on more or less accidental transport. Waterbirds have been shown to be important agents for amphipod dispersal elsewhere (eg. Swanson, 1984). In the Maltese Islands, however, the number of waterbirds is small, both because of an intrinsic lack of wetland areas and because of human persecution (Sultana & Gauci, 1982); hence locally this dispersal route probably operates only rarely.

Acknowledgements

We gratefully acknowledge the contribution of M. Gauci, D.M. Johnson, E. Lanfranco and S.P. Schembri in collecting specimens. Special thanks are due to Mario Gauci for providing logistic support on collecting trips.

RIASSUNTO

I seguenti anfipodi sono stati raccolti da abitazioni semi-terrestre e da acqua dolce sulle isole Maltesi: *Echinogammarus ebusitanus*, *E. pungens*, *Gammarus aequicauda*, *Rhipidogammarus rhipidiophorus*, *Allorchestes aquilinus*, *Orchestia gammarellus*, *O. mediterranea*, *O. montagui* e *Talitrus saltator*. La loro distribuzione sulle isole Maltesi è descritta e discussa in relazione alle sue preferenze di abitazione, e letteratura Maltese scritta prima su questo gruppo è riassunta.

Parole chiave: isole Maltesi; anfipodi non-marini; faunistica.

SUMMARY

The following amphipods are reported from freshwater and semiterrestrial habitats on the Maltese islands; *Echinogammarus ebusitanus*, *E. pungens*, *Gam-*

marus aequicauda, *Rhipidogammarus rhipidiophorus*, *Allorchestes aquilinus*, *Orchestia gammarellus*, *O. mediterranea*, *O. montagui* and *Talitrus saltator*. Their distribution in the Maltese islands is described and discussed in relation to their known habitat preferences and earlier Maltese literature on the group is summarized.

Key words: Maltese Islands; non-marine amphipods; Faunistics.

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