SOCIETÀ TOSCANA
DI
Scienze Naturali
RESIDENTE IN PISA

# ATTI
## DELLA
# SOCIETÀ TOSCANA
## DI
# SCIENZE NATURALI

MEMORIE • SERIE B • VOLUME CXXXII • ANNO 2025

Edizioni ETS

# ATTI DELLA SOCIETÀ TOSCANA DI SCIENZE NATURALI
# MEMORIE

Via Santa Maria, 53 - 56126 Pisa

Rivista di proprietà della Società Toscana di Scienze Naturali. Fondata nel 1875, la rivista pubblica Memorie e Note originali, recensioni, corrispondenze e notiziari nel campo delle Scienze Naturali. È inviata ai soci e depositata in biblioteche corrispondenti. Tutti i contenuti dei volumi a stampa (articoli originali, comunicazioni brevi, notizie e recensioni) sono liberamente disponibili in rete, in conformità all'Open Access, sulle pagine http://www.stsn.it/en/memorie-serie-a.html (Serie A) e http://www.stsn.it/en/memorie-serie-b.html (Serie B).
*Journal owned by Società Toscana di Scienze Naturali. Founded in 1875, the journal publishes original papers, short communications, news and book reviews on Natural Sciences. The Journal is sent to Società Toscana di Scienze Naturali members and deposited in selected libraries. All content of the printed version (original papers, short communications, news and book reviews) is freely available online in accordance with the Open Access at http://www.stsn.it/en/memorie-serie-a.html (Serie A) and http://www.stsn.it/en/memorie-serie-b.html (Serie B).*

Gli Atti sono pubblicati in due volumi (Serie A - Abiologica, ISSN 0365-7655; Serie B - Biologica, ISSN 0365-7450) all'anno nel mese di dicembre. Possono essere pubblicati ulteriori volumi, definiti Supplementi, su temi specifici.
*Atti are published yearly in two Issues (Serie A - Abiological, ISSN 0365-7655; Serie B - Biological, ISSN 0365-7450) in December. Some monographic volumes may be published as Supplementi.*

Le lingue usate dalla rivista sono l'inglese o l'italiano // *The languages of the journal are English or Italian.*





La corrispondenza deve essere inviata ai Segretari agli Atti (per la Serie A: A. Chelli, Dipartimento di Chimica, Scienze della Vita e della Sostenibilità Ambientale, Parco Area delle Scienze, 157/A - 43124 Parma, email: attia@stsn.it; per la Serie B: D. Ciccarelli, Dipartimento di Biologia, via Derna, 1 - 56126 Pisa, e-mail: attib@stsn.it).
*The correspondence must be sent to Editors (for Serie A: A. Chelli, Dipartimento di Chimica, Scienze della Vita e della Sostenibilità Ambientale, Parco Area delle Scienze, 157/A - 43124 Parma, email: attia@stsn.it; for Serie B: D. Ciccarelli, Dipartimento di Biologia, via Derna, 1 - 56126 Pisa, e-mail: attib@stsn.it).*

Per ulteriori informazioni / *For further information*: http://www.stsn.it/
Per informazioni editoriali / *For editorial information*: Edizioni ETS - https://www.edizioniets.com/





Autorizzazione n. 17/56 del 26 luglio 1956, Trib. di Pisa
*Direttore responsabile (Editor in Chief)*: Paolo Roberto Federici

Atti Soc. Tosc. Sci. Nat., Mem., Serie B, 132 (2025)
pagg. 5-15; figg. 4; tab. 1; *doi: 10.2424/ASTSN.M.B.2025.01*


Giuseppe Montesanto [1], Johnny Nardi [1,2], Alessandro Sergenti [2], Marco Dellacasa [1]

# DIVERSITY OF TERRESTRIAL ISOPODS FROM THE CARTHUSIAN MONASTERY OF CALCI, PISA, ITALY (CRUSTACEA, ISOPODA, ONISCIDEA)

**Abstract -** G. Montesanto, J. Nardi, A. Sergenti, M. Dellacasa, *Diversity of Terrestrial Isopods from the Carthusian Monastery of Calci, Pisa, Italy (Crustacea, Isopoda, Oniscidea).*

The main goal of this work is to provide a list of the species of terrestrial isopods living within the perimeter of the Carthusian Monastery of Calci (Pisa, NW-Italy), an area never previously investigated regarding the isopod fauna of Monte Pisano. A total of 385 individuals belonging to 12 species of the suborder Oniscidea were collected. Some notes on their ecology and distribution of each species are reported. A comparison is also provided on the specific richness of oniscideans living in urban and suburban environments but also in more preserved and protected areas. A second, but not less important aim, is to establish a new collection of terrestrial isopods hosted at the Invertebrate Zoology section of the Museum of Natural History of the University of Pisa. Up to date, in fact, the Museum carcinological collection was lacking the taxon Oniscidea.

**Key words -** biodiversity, fauna, zoology, ecology, taxonomy, systematics

**Riassunto -** G. Montesanto, J. Nardi, A. Sergenti, M. Dellacasa, *Diversità degli Isopodi terristri nella Certosa di Calci, Pisa (Crustacea, Isopoda, Oniscidea).*

L'obiettivo principale di questo lavoro è quello di fornire un elenco delle specie di isopodi terrestri viventi all'interno del perimetro della Certosa di Calci (Pisa), un'area mai indagata in precedenza per quanto riguarda la fauna isopodologica del Monte Pisano. Sono stati raccolti 385 individui appartenenti a 12 specie del sottordine Oniscidea. Per ciascuna specie vengono riportate alcune note sulla loro ecologia e distribuzione. Viene inoltre fornito un confronto sulla ricchezza specifica degli oniscidei che vivono in ambienti urbani, suburbani ma anche in zone più conservate e in aree protette. Un secondo, ma non meno importante, obiettivo è la creazione di una nuova collezione di isopodi terrestri conservata presso la sezione di Zoologia degli Invertebrati del Museo di Storia Naturale dell'Università di Pisa. Fino a oggi, il Museo era infatti privo di una collezione carcinologica che rappresentasse esclusivamente il taxon Oniscidea.

**Parole chiave -** biodiversità, fauna, zoologia, ecologia, tassonomia, sistematica

## Introduction

The Carthusian Monastery of Pisa in Calci, founded in 1366, is located about 10 kilometers East of Pisa, situated in the Val Graziosa, a valley within Monte Pisano known for its remarkable landscape and naturalistic significance. The Charterhouse, situated in a typical rural environment, owes its current appearance to successive phases of expansion and growth, which occurred especially in the 17th century. Recently, parts of the complex have been handed over to the Superintendence for Environmental, Architectural, Artistic and Historical Heritage of Pisa, and can be visited almost entirely. The premises, which were once intended to host production and artisan activities (such as granaries, cellars, blacksmiths' and carpenters' workshops, etc.), currently house the exhibitions of the Museum of Natural History of the University of Pisa.

The taxon Oniscidea is the only suborder of Crustaceans that have become completely terrestrial. The adaptations that have allowed them to colonize the emerged lands are: the presence of a rigid exoskeleton and a waterproof cuticle that entirely covers the body, protecting it from excessive dehydration due to evapotranspiration (Ziegler & Miller, 1997); the presence of more advanced respiratory systems than gills, such as pleopodal lungs (or *pseudotracheae*) (Paoli *et al.*, 2002); and the ability to carry out internal insemination and protect the eggs by holding them in a female incubating cavity: the brood pouch (Hoese & Jansen, 1989). The Oniscideans have therefore colonized all terrestrial environments, from deserts to the heights of mountain ranges. Many species are halophilous and live exclusively in coastal environments (Montesanto *et al.*, 2007), others are confined to riparian environments, to leaf litter or under large stones, but always where the humidity is quite high. Several species of terrestrial isopods are linked to cave environments (troglobitic or troglophilic) (Campos-Filho *et al.*, 2017; Taiti & Montesanto, 2018); some are myrmecophilous or termitophilous (Taiti & Ferrara, 1989; Montesanto *et al.*, 2008). Some species are well adapted to live in drier environments like deserts and subdeserts, and some have also colonized anthropized areas, such as cultivated lands, gardens, or even human houses (Flasarová, 1995; Szlavecz *et al.*, 2018).

The first studies on Oniscideans living in urban environments were mainly focused on faunal surveys conducted in parks adjacent to residential areas, in villas

[1] Museo di Storia Naturale, Università di Pisa, Via Roma, 79, 56011 Calci, Pisa
[2] Dipartimento di Biologia, Università di Pisa, Via Alessandro Volta, 4bis, 56126 Pisa
*Corresponding author:* Giuseppe Montesanto (giuseppe.montesanto@unipi.it)

or houses courtyards (e.g. Flasarová, 1995). Habitats such as botanical gardens and greenhouses have been studied by zoologists since the beginning of the 20th century (Bagnall, 1909; Arcangeli, 1914, 1921; Holthuis, 1945). Greenhouses and botanical gardens, which often host exotic plants and soils introduced from other regions, are privileged habitats for the discovery of species new to the local fauna or even new to science (Korsós *et al*., 2002; Kontschán, 2004; De Smedt *et al*.; 2017). The exploration of these urban, sub-urban, and rural environments continues today (Montesanto, 2015a; De Smedt *et al*., 2017; Szlavecz *et al*., 2018).

Early records of species occurrence are extremely valuable, as we can use this historical information to document changes in the local fauna. In a recent work, Montesanto (2015a) compared the isopod fauna of the Botanical Garden of Pisa, about a century later. Although the total number of species was similar (seven species between 1914 and 1916; eight species between 2014 and 2015), the specific composition obtained was widely different: only one species, *Armadillidium depressum* Brandt, 1833, was reported in both collection periods about a century after the last survey.

The main goal of this work is to provide a list of the species of Oniscidea living within the perimeter of the Carthusian Monastery of Calci, an area never previously investigated with regard to the isopod fauna. A second aim is to establish a new collection of terrestrial isopods (Crustacea, Isopoda, Oniscidea) hosted at the Invertebrate Zoology section of the Museum of Natural History of the University of Pisa. To date, the carcinological collection of the Museum was in fact lacking the taxon Oniscidea.

## Materials and methods

Samplings were conducted within the compound of the Charterhouse, fenced by walls and buildings. The points delimiting its perimeter are as follows: 43°43'24» N, 10°31'23" E at North-West; 43°43'23" N, 10°31'35" E at North-East; 43°43'15"N, 10°31'23"E at South-West; 43°43'17" N, 10°31'34" E at South-East; for a total area of about 6.8 hectares (Fig. 1).

Samplings were performed with two different techniques; manually, with the help of entomological tweezers, and with the use of pitfall traps for surface species with nocturnal activity (Fig. 1). A saturated solution of water and sodium chloride was used as a preservative inside the traps. Samplings took place from January to December 2018, to have an all-year round coverage. The contents of the pitfall traps were collected monthly. Each monthly collection session was always carried out by the same two operators (GM, JN) according to the optimization procedures described by Messina *et al.* (2016). In particular, in each month, in addition to the manual recovery of the material in the traps, manual collection was carried out over the entire area for a duration of 4 hours. The area in the vicinity of the pitfall traps was also checked, since different sampling methods lead to differences in the sampled faunal composition (see also Messina *et al*., 2016). All collected material, together with manual sampling, was stored in 75% ethanol. Samples were identified and individuals were counted separately as males, females and juveniles for each species. The entire sampling started a new carcinological collection at the Invertebrate Zoology section of the Museum of Natural History (University of Pisa), abbreviated as: MSN-UNIPIONI. The photographs for Fig. 3 were taken with a Nikon D7000 camera mounted on a Wild Heerbrugg stereomicroscope. The measurements were taken using the IMAGEJ software (Rasband, 1997) and then reported using the GIMP graphics processing software (www.gimp.org). The figures were drawn using the method reported in Montesanto (2015b, 2016).

## SYSTEMATICS

Kingdom: Animalia
Phylum: Arthropoda
Subphylum: Crustacea
Class: Malacostraca
Subclass: Eumalacostraca
Superorder: Peracarida
Order: Isopoda
Suborder: Oniscidea

Family: Trichoniscidae

Genus: *Haplophthalmus* Schöbl, 1860

### 1. ***Haplophthalmus danicus*** **Budde-Lund, 1880**
(Fig. 3A)

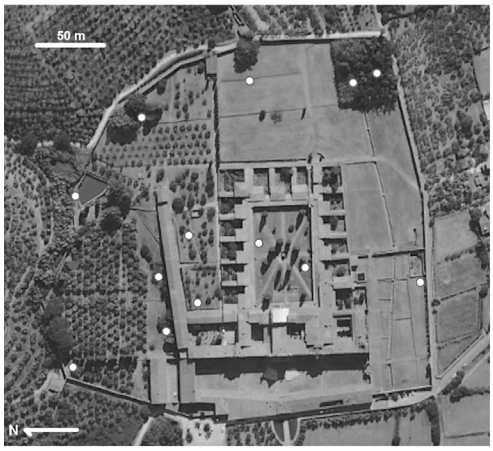
Material examined. Calci (Pisa), Certosa Monumentale, 8/III/2018, G. Montesanto and J. Nardi leg., 1 ♂ (MSN-UNIPI ONI-10).

Remarks. *Haplophthalmus danicus* is common among debris in decay and rarely shelter in cave environments.

### 2. ***Haplophthalmus mengii*** **(Zaddach, 1844)**
(Fig. 3B)

Material examined. Calci (Pisa), Certosa Monumentale, 4/XII/2018, G. Montesanto and J. Nardi leg., 3 ♂♂, 3 ♀♀ (MSN-UNIPI ONI-31).

Remarks. *Haplophthalmus mengii* is usually syntopic with *H. danicus*.

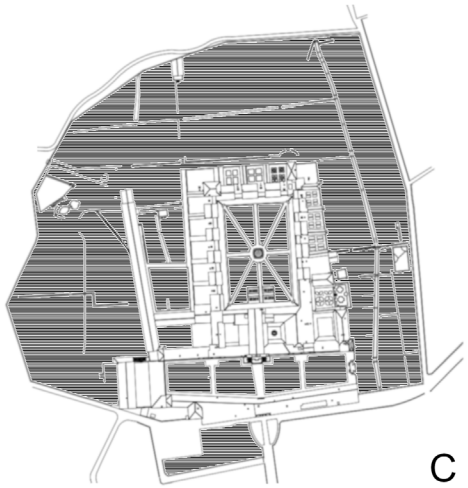




Figure 1. The sampling area. A, The white dot indicates the position of the municipality of Calci in Tuscany (Italy). B, The Monumental Charterhouse of Calci (aerial photo). The white dots indicate the position of the pitfall traps used for the samplings (map: source Apple Maps, Rev. 12 March 2019, © 1992 – 2024 TomTom). C, Map of the Monumental Charterhouse of Calci, areas with gray horizontal lines indicating the hand-sampling surfaces (Digital drawing, courtesy of Andrea Giovarruscio, University of Pisa).

Genus: *Androniscus* Verhoeff, 1908

### 3. ***Androniscus dentiger*** **Verhoeff, 1908**
(Fig. 3C)

Material examined. Calci (Pisa), Certosa Monumentale, 18/I/2018, G. Montesanto and J. Nardi leg., 1 ♀ (MSN-UNIPI ONI-04); same locality, 8/III/2018, G. Montesanto and J. Nardi leg., 1 ♂, 5 ♀♀ (MSN-UNIPI ONI-11); same locality, 4/XII/2018, G. Montesanto and J. Nardi leg., 1 ♀ (MSN-UNIPI ONI-28).

Remarks. *Androniscus dentiger* is found in a wide range of natural and synanthropic habitats, sometimes submerged in proximity of streams.

Genus: *Trichoniscus* Brandt, 1833

### 4. ***Trichoniscus pygmaeus*** **Sars, 1898**
(Fig. 3D)

Material examined. Calci (Pisa), Certosa Monumentale, 18/I/2018, G. Montesanto and J. Nardi leg., 2 ♂♂ (MSN-UNIPI ONI-03); same locality, 8/III/2018, G. Montesanto and J. Nardi leg., 1 ♂, 2 ♀♀, 1 *juv.* (MSN-UNIPI ONI-09); same locality, 8/XI/2018, G. Montesanto and J. Nardi leg., 6 ♂♂, 5 ♀♀ (MSN-UNIPI ONI-20); same locality, 4/XII/2018, G. Montesanto and J. Nardi leg., 3 ♂♂, 6 ♀♀ (MSN-UNIPI ONI-25).

Remarks. *Trichoniscus pygmaeus* is a humicolous species common in limestone areas, synanthropic and widely diffused by humans.

Family: Philosciidae

Genus: *Philoscia* Latreille, 1804

5. ***Philoscia affinis*** **Verhoeff, 1908**
(Fig. 3E)

Material examined. Calci (Pisa), Certosa Monumentale, 18/I/2018, G. Montesanto and J. Nardi leg., 1 ♂, 3 ♀♀ (MSN-UNIPI ONI-02); same locality, 10/IV/2018, G. Montesanto and J. Nardi leg., 1 ♂, 1 ♀ (MSN-UNIPI ONI-13); same locality, 9/VI/2018, G. Montesanto and J. Nardi leg., 3 ♀♀ (MSN-UNIPI ONI-17); same locality, 8/XI/2018, G. Montesanto and J. Nardi leg., 2 ♂♂, 2 ♀♀ (MSN-UNIPI ONI-19); same locality, 4/XII/2018, G. Montesanto and J. Nardi leg., 1 ♀ (MSN-UNIPI ONI-24).

Remarks. *Philoscia affinis* is commonly found under rocks and in dead leaf litter in wet areas as woods, fresh meadows, rivers, and stream banks.

Genus: *Chaetophiloscia* Verhoeff, 1908

6. ***Chaetophiloscia elongata*** **(Dollfus, 1884)**
(Fig. 3F)

Material examined. Calci (Pisa), Certosa Monumentale, 18/I/2018, G. Montesanto and J. Nardi leg., 4 ♂♂, 7 ♀♀, 1 *juv.* (MSN-UNIPI ONI-06); same locality, 8/III/2018, G. Montesanto and J. Nardi leg., 4 ♂♂, 16 ♀♀, 2 *juv.* (MSN-UNIPI ONI-07); same locality, 9/VI/2018, G. Montesanto and J. Nardi leg., 1 ♂ (MSN-UNIPI ONI-18); same locality, 8/XI/2018, G. Montesanto and J. Nardi leg., 21 ♂♂, 65 ♀♀ (MSN-UNIPI ONI-21), same locality, 4/XII/2018, G. Montesanto and J. Nardi leg., 9 ♂♂, 36 ♀♀ (MSN-UNIPI ONI-26).

Remarks. *Chaetophiloscia elongata* is particularly abundant in areas with high relative humidity such as ditch, stream banks or meadows.

Family: Oniscidae

Genus: *Sardoniscus* Arcangeli, 1939

7. ***Sardoniscus verhoeffi*** **(Ferrara & Taiti, 1978)**
(Fig. 3G)

Material examined. Calci (Pisa), Certosa Monumentale, 18/I/2018, G. Montesanto and J. Nardi leg., 1 ♂, 1 ♀ (MSN-UNIPI ONI-01).

Remarks. *Sardoniscus verhoeffi* lives in humid places such as stream banks, leaf litter or humus of the undergrowth.

Family: Platyarthridae

Genus: *Platyarthrus* Brandt, 1833

8. ***Platyarthrus hoffmannseggii*** **Brandt, 1833**
(Fig. 3H)

Material examined. Calci (Pisa), Certosa Monumentale, 8/XI/2018, G. Montesanto and J. Nardi leg., 2 ♂♂, 1 ♀ (MSN-UNIPI ONI-23).

Remarks. *Platyarthrus hoffmannseggii* is frequently found under stones and fallen logs, together with different species of ants.

Family: Porcellionidae

Genus: *Agabiformius* Verhoeff, 1908

9. ***Agabiformius lentus*** **(Budde-Lund, 1885)**
(Fig. 3I)

Material examined. Calci (Pisa), Certosa Monumentale, 18/I/2018, G. Montesanto and J. Nardi leg., 1 ♀ (MSN-UNIPI ONI-05); same locality, 4/XII/2018, G. Montesanto and J. Nardi leg., 1 ♀ (MSN-UNIPI ONI-29).

Remarks. *Agabiformius lentus* prefers dry environments and can now be considered an anthropophilic species.

Genus: *Porcellionides* Miers, 1877

10. ***Porcellionides pruinosus*** **(Brandt, 1833)**
(Fig. 3J)

Material examined. Calci (Pisa), Certosa Monumentale, 4/XII/2018, G. Montesanto and J. Nardi leg., 1 ♀ (MSN-UNIPI ONI-30).

Remarks. *Porcellionides pruinosus* can adapt to different biotopes, as long as they are not too humid or too cold. It is an anthropophilic species.

Family: Armadillidiidae

Genus: *Armadillidium* Brandt, 1831

11. ***Armadillidium depressum*** **Brandt, 1833**
(Fig. 3K)

Material examined. Calci (Pisa), Certosa Monumentale, 10/V/2018, G. Montesanto and J. Nardi leg., 2 ♀♀ (MSN-UNIPI ONI-15).

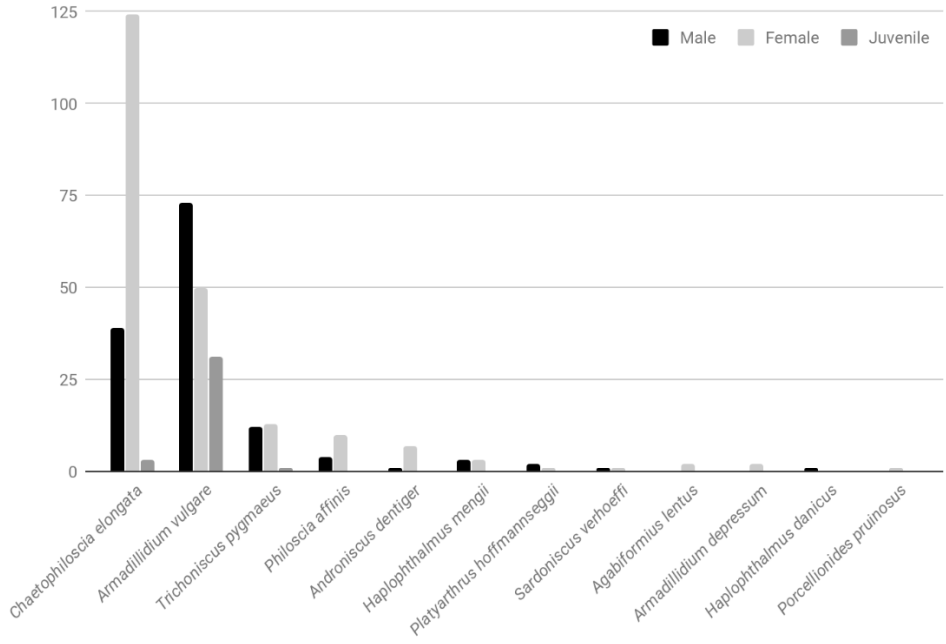



Figure 2. Number of males, females and juveniles for each species.

Remarks. *Armadillidium depressum* is a species with a high ecological value, it is found from the coastal zones up to the hinterland, also in anthropic sites.

### 12. ***Armadillidium vulgare*** **(Latreille, 1804)**
(Fig. 3L)

Material examined. Calci (Pisa), Certosa Monumentale, 8/III/2018, G. Montesanto and J. Nardi leg., 4 ♂♂, 5 ♀♀, 1 *juv.* (MSN-UNIPI ONI-08); same locality, 10/IV/2018, G. Montesanto and J. Nardi leg., 3 ♂♂, 6 ♀♀ (MSN-UNIPI ONI-12); same locality, 10/V/2018, G. Montesanto and J. Nardi leg., 21 ♂♂, 13 ♀♀, 1 *juv.* (MSN-UNIPI ONI-14); same locality, 9/VI/2018, G. Montesanto and J. Nardi leg., 39 ♂♂, 16 ♀♀ (MSN-UNIPI ONI-16); same locality, 8/XI/2018, G. Montesanto and J. Nardi leg., 6 ♂♂, 8 ♀♀, 29 *juv.* (MSN-UNIPI ONI-22); same locality, 4/XII/2018, G. Montesanto and J. Nardi leg., 2 ♀♀ (MSN-UNIPI ONI-27).

Remarks. *Armadillidium vulgare* is an anthropophilic species diffused all over the world (Schmalfuss, 2003).

## Discussion

The 12 species that live within the Charterhouse compound belong to 6 families (Trichoniscidae, Philosciidae, Oniscidae, Platyarthridae, Porcellionidae, and Armadillidiidae) and 10 genera: *Haplophthalmus*, *Androniscus*, *Trichoniscus Philoscia*, *Chaetophiloscia*, *Sardoniscus*, *Platyarthrus*, *Agabiformius*, *Porcellionides*, and *Armadillidium*.

Three species have a cosmopolitan distribution: *Agabiformius lentus*, *Porcellionides pruinosus*, and *Armadillidium vulgare*. Five species are widespread in Europe: *Haplophthalmus danicus*, *Haplophthalmus mengii*, *Androniscus dentiger*, *Trichoniscus pygmaeus*, and *Platyarthrus hoffmannseggii*. Among the Philosciidae, *Philoscia affinis* has a West Mediterranean distribution, while *Chaetophiloscia elongata* is a species with a Holomediterranean distribution. *Sardoniscus verhoeffi* has an Alpine-Apennine distribution and *Armadillidium depressum* is a West Mediterranean-Atlantic type.

As regards specific abundance, the most represented species was *Chaetophiloscia elongata* with 166 specimens, most of which were females; *Armadillidium vulgare* was equally well represented with 154 specimens. *Trichoniscus pygmaeus* followed with 26 specimens, *Philoscia affinis* with 14, *Androniscus dentiger* with 8, *Haplophthalmus mengii* with 6, *Platyarthrus hoffmannseggii* with 3, *Agabiformius lentus*, *Sardoniscus verhoeffi*, and *Armadillidium depressum* with 2 specimens each, *Porcellionides pruinosus* and *Haplophthalmus danicus* with a single specimen each. The graph in Figure 2 summarises the number of specimens collected for each species, also reporting the number of males, females and juveniles.

Table 1 shows the list of species deposited in the collection and their distribution area.

Table 1 - List of terrestrial isopods from the Carthusian Monastery of Calci and their distribution. E: European; WM: West Mediterranean; HM: Holomediterranean; AA: Alpine-Apennine; C: Cosmopolitan; WMA: West Mediterranean-Atlantic (Ferrara & Taiti, 1989).

| Family | Species | Distribution |
|---|---|---|
| Trichoniscidae | *Haplophthalmus danicus* | E |
| | *Haplophthalmus mengii* | E |
| | *Androniscus dentiger* | E |
| | *Trichoniscus pygmaeus* | E |
| Philosciidae | *Philoscia affinis* | WM |
| | *Chaetophiloscia elongata* | HM |
| Oniscidae | *Sardoniscus verhoeffi* | AA |
| Platyarthridae | *Platyarthrus hoffmannseggii* | E |
| Porcellionidae | *Agabiformius lentus* | C |
| | *Porcellionides pruinosus* | C |
| Armadillidiidae | *Armadillidium depressum* | WMA |
| | *Armadillidium vulgare* | C |

The dichotomous keys for the identification of the species listed in this work are presented in the Supplement S1.

## Conclusions

Inside the Charterhouse of Calci, as well as in urban and suburban centers, terrestrial isopod species are ubiquitous representatives of the epigeic soil fauna. They are widespread in greenhouses, urban parks, residential courtyards, uncultivated soil but are also found in the built environment. Usually, these communities are made up of a set of native species and more recently introduced species, often dominated by a few cosmopolitan and anthropophilic species that thrive in highly anthropized areas. The fragmentation and consequent isolation of these isopod communities is due to the urbanized landscape, which is itself highly fragmented. The diversity of these isolated spots is sometimes comparable to the richness of species in more naturally preserved areas (see also Szlavecz *et al.*, 2018).

From a brief comparison with a similar study conducted within the botanical garden of Pisa, a greater number of oniscid species was found within the perimeter of the Charterhouse. While eight species of terrestrial isopods were found in the botanical garden (Montesanto, 2015a), 12 species are listed in the present work. However, it must be considered that in 2015 the sampling at the Pisa botanical garden was carried out only manually, without the use of pitfall traps. Seven species are shared the two areas: *Chaetophiloscia elongata*, *Philoscia affinis*, *Sardoniscus verhoeffi*, *Agabiformius lentus*, *Porcellionides pruinosus*, *Armadillidium depressum* and *Armadillidium vulgare*. These species are all widespread in the alluvial plains of Tuscany (Taiti & Ferrara, 1989). Although the Charterhouse is located in a typical rural area, its higher species richness could indicate not only a greater diversity of environments compared to the botanical garden, but also a higher degree of naturalness. The presence of a riparian species, such as *Androniscus dentiger*, seems to confirm these hypotheses. On the other hand, the use that the monks made of natural springs and how these waters were channeled within the perimeter of the Charterhouse for the irrigation of crops is well known. These surface waters could have favored the presence of this species.

Twelve species is not a particularly high number when compared with other similar works on the diversity of terrestrial isopods in protected areas or in particularly preserved environments from a naturalistic point of view. As an example, in some protected areas of Sicily the presence of 23-24 species has been found (Messina *et al.*, 2011; Messina *et al.*, 2012; Messina *et al.*, 2014). The number of species listed here is slightly lower than that found for other similar studies in an urban environment. In a recent work carried out in the city of Budapest (Hungary) within the two botanical gardens, 17 species were found, of which only 3 were cosmopolitan (Vilisics & Hornung, 2009). In another paper (Vilisics *et al.*, 2012) the urban areas of three Swiss cities were studied, obtaining a list of 18 species. The areas examined in these studies are, however, far larger than the botanical garden in Pisa and the Charterhouse in Calci. Obviously, these differences may also be due to the different sampling methods used.

We cannot exclude that, in the future, the presence of some of these species may vary and this often happens due to changes in the surrounding environment and climate. Further research could also lead to the discovery of other species of terrestrial isopods not yet found. Recently, in subterranean and endogean environments, new species of terrestrial isopods have been discovered in Tuscany and in the Monte Pisano area (Taiti & Montesanto, 2018).

The idea that might follow this work and as its future development is to also to carry out exhibitions, training and scientific dissemination activities based on the knowledge of the diversity of terrestrial isopods within the Charterhouse, as well as their role as bioindicators of environmental quality (Agodi *et al.*, 2015).

In Italy there are already several carcinological collections and more strictly isopodological ones. The most important and richest in samples is deposited at the Zoology section of "La Specola" of the Natural History Museum of the University of Florence, managed by Dr. Stefano Taiti and Dr. Gianna Innocenti. Other smaller collections are present at the Museums in Genoa, Turin, Trieste, Rome, Catania and the Natural History Museum of Verona.

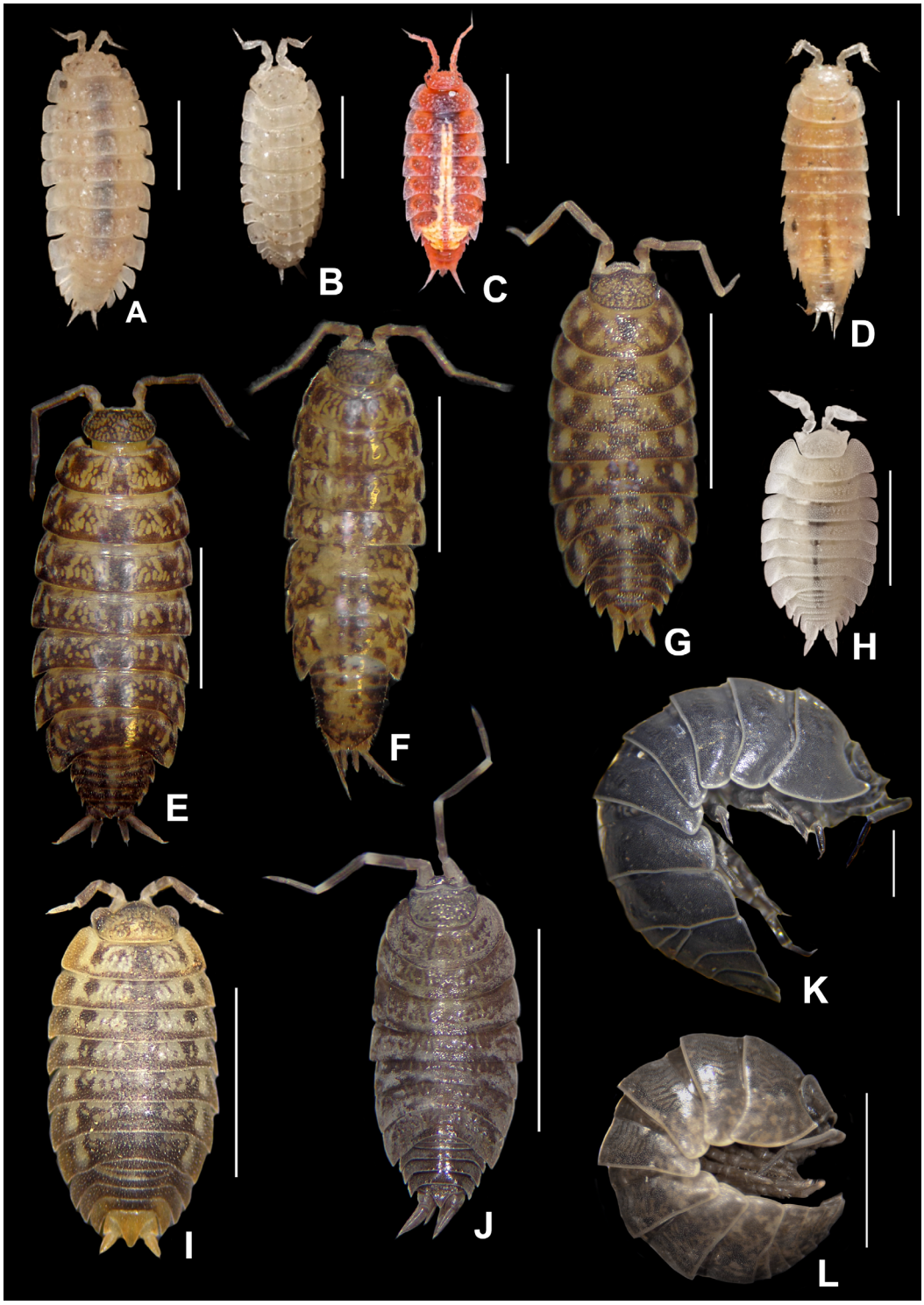



Figure 3. A, *Haplophthalmus danicus* Budde-Lund, 1880 (scale: 2 mm); B, *Haplophthalmus mengii* (Zaddach, 1844) (scale: 2 mm); C, *Androniscus dentiger* Verhoeff, 1908 (scale: 4 mm); D, *Trichoniscus pygmaeus* Sars, 1898 (scale: 1 mm); E, *Philoscia affinis* Verhoeff, 1908 (scale: 3 mm); F, *Chaetophiloscia elongata* (Dollfus, 1884) (scale: 3 mm); G, *Sardoniscus verhoeffi* (Ferrara & Taiti, 1978) (scale: 3 mm); H, *Platyarthrus hoffmannseggii* Brandt, 1833 (scale: 1 mm); I, *Agabiformius lentus* (Budde-Lund, 1885) (scale: 4 mm); J, *Porcellionides pruinosus* (Brandt, 1833) (scale: 5 mm); K, *Armadillidium depressum* Brandt, 1833 (scale: 3 mm); L, *Armadillidium vulgare* (Latreille, 1804) (scale: 5 mm).

Natural history museums are not only places where the evolutionary history of the Earth is preserved, but they are places where natural and biological sciences are allowed to progress culturally. The research activity carried out in museums, often the result of collaboration between different scholars and scientists, also has important effects on our daily lives. To give an example, consider that many museum researchers are taxonomists. Biological taxonomy is indispensable nowadays not only for the knowledge, description and conservation of biodiversity, but also for transferring this knowledge to other more applied scientific sectors (biological, food, pharmaceutical, medical, etc.) and which therefore have a strong impact within our society (Latella, 2007).

Acknowledgements

The authors would like to thank Prof. Roberto Barbuti (University of Pisa), director of the Museum of Natural History of the University of Pisa at the time of the sampling, for his availability and for the permissions received; Prof. Elena Bonaccorsi (University of Pisa), current director of the Museum of Natural History, for her continuous contribution and support to the research and dissemination activities of our Museum; Dr. Marco Zuffi (Museum of Natural History, University of Pisa) for his great kindness and for having guided us during the sampling inside the Charterhouse; our colleague Andrea Giovarruscio (University of Pisa) for having provided the plan of the entire perimeter of the Charterhouse shown in Figure 1. We also thank Dr. Stefano Taiti (IRET, CNR, Florence, Italy) for his constant commitment and the kind and daily sharing of his many skills in the field of terrestrial isopod taxonomy. Finally, a well-deserved thank you to the two reviewers who contributed significantly to correcting and improving the manuscript.

Conflict of interest statement

The authors declare under their own responsibility and in full knowledge of the criminal liability provided for false declarations that there are no situations, even potential ones, of conflict of interest, pursuant to current legislation.

Dichiarazione sul conflitto di interessi

Gli autori dichiarano, sotto la propria responsabilità ed in piena conoscenza della responsabilità penale prevista per le dichiarazioni false, l'insussistenza di situazioni, anche potenziali, di conflitto di interesse, ai sensi della normativa vigente.

## REFERENCES

Agodi A., Oliveri Conti G., Barchitta M., Quattrocchi A., Lombardo B.M., Montesanto G., Messina G., Fiore M., Ferrante M., 2015. *Validation of Armadillo officinalis Dumèril, 1816 (Crustacea, Isopoda, Oniscidea) as a bioindicator: In vivo study of air benzene exposure*. Ecotoxicology and Environmental Safety 114: 171-178. https://doi.org/10.1016/j.ecoenv.2015.01.011

Arcangeli A., 1914. *La collezione di isopodi terrestri del R. Museo di Zoologia degli Invertebrati di Firenze, con aggiunte ed annotazioni*. Atti della Società italiana di Scienze Naturali, 52: 445-486.

Arcangeli A., 1921. *Note isopodologiche. Il genere Platyarthrus Brandt*. Atti della Società italiana di Scienze Naturali 60: 189-210.

Bagnall R.S., 1909. *On Some Terrestrial Isopods from the Glasnevin Botanic Gardens, Dublin*. The Irish Naturalist 18 (2): 42-44.

Campos-Filho I.S, Bichuette M.E., Montesanto G., Araujo P.B., Taiti S., 2017. *The first troglobiotic species of the family Pudeoniscidae (Crustacea, Isopoda, Oniscidea) with descriptions of a new genus and two new species*. Subterranean Biology 23: 69-84. https://doi.org/10.3897/subtbiol.23.20963

De Smedt P., Arijs G., Segers S., Boeraeve P., 2017. *Woodlice of the green houses at Ghent Botanical Garden and Botanic Garden Meise with two new exotic species for Belgium (Isopoda: Oniscidae)*. Bulletin de la Société royale belge d'Entomologie/ Bulletin van de Koninklijke Belgische Vereniging voor Entomologie 153: 109-112. http://hdl.handle.net/1854/LU-8542623

Ferrara F., Taiti S., 1989. *Biogeography and ecology of terrestrial isopods from Tuscany*. Monitore Zoologico Italiano (Monogr.) 4: 75-101.

Flasarová M., 1995. *Isopoden Nordwestböhmens (Crustacea: Isopoda: Asellota et Oniscidea)*. Acta scientiarum naturalium Academiae Scientiarum Bohemicae, Brno 29 (2-4): 1-150.

Hoese B., Jansen H., 1989. *Morphological and physiological studies on the marsupium in terrestrial isopods*. Monitore zoologico italiano, Nuova Serie, Monografia 4: 153-173.

Holthuis L.B., 1945. *Notes on terrestrial Isopoda collected in Dutch greenhouses*. Zoologische Mededeelingen 25: 43-54.

Kontschán J., 2004. *Magyarország faunájára újászkarák (Reductoniscus costulatus Kesselyák, 1930-Crustacea: Isopoda: Oniscidea) előkerülése az ELTE Füvészkertjéből (Budapest). [Reductoniscus costulatus, a new isopod species found in the greenhouses of ELTE in Budapest (in Hungarian with English abstract)]*. Folia Musei Historico Naturalis Matraensis 28: 89-90.

Korsós Z., Hornung E., Szlavecz K., Kontschán J., 2002. *Isopoda and Diplopoda of urban habitats: New data to the fauna of Budapest*. Annales Historico-Naturales Musei Nationalis Hungarici 94: 45-51. http://publication.nhmus.hu/annales/cikkreszletes.php?idhoz=1650

Latella L., 2007. *Il Museo: luogo di collezione e ricerca. Riflessioni sull'importanza della tassonomia*. In: Dal Lago A. (a cura di), *Il Museo Naturalistico Archeologico di Vicenza a 150 anni dalla sua fondazione - collezioni e ricerca (1855-2005)*: 149-155. Ed. Musei Civici, Vicenza.

Messina G., Montesanto G., Pezzino E., Caruso D., Lombardo B.M., 2011. *Diversity of terrestrial isopods in a protected area characterized by salty coastal ponds (Vendicari, Sicily)*. Journal of Natural History 45 (35-36): 2145-2158. https://doi.org/10.1080/00222933.2011.587899

Messina G., Pezzino E., Montesanto G., Caruso D., Lombardo B.M., 2012. *The diversity of terrestrial isopods in the natural reserve "Saline di Trapani e Paceco" (Crustacea, Isopoda, Oniscidea) in northwestern Sicily*. Zookeys 176: 215-230. https://doi.org/10.3897/zookeys.176.2367

Messina G., Montesanto G., Pezzino E., Sciandrello S., Caruso D., Lombardo B.M., 2014. *Plant communities preferences of terrestrial crustaceans (Isopoda: Oniscidea) in a protected coastal area of southeastern Sicily (Italy)*. Biologia 69 (3): 354-362. https://doi.org/10.2478/s11756-013-0321-0

MESSINA G., CAZZOLLA GATTI R., DROUTSA A., BARCHITTA M., PEZZINO E., AGODI A., LOMBARDO B.M., 2016. *A sampling optimization analysis of soil-bugs diversity (Crustacea, Isopoda, Oniscidea)*. Ecology and Evolution 6 (1): 191-201. https://doi.org/10.1002/ece3.1765

MONTESANTO G., 2015a. *Gli isopodi terrestri dell'orto botanico di Pisa (Crustacea, Isopoda, Oniscidea)*. Atti della Società Toscana di Scienze Naturali, Memorie, Serie B 122: 171-178. http://www.stsn.it/AttiB2015/MONTESANTO.pdf

MONTESANTO G., 2015b. *A fast GNU method to draw accurate scientific illustrations for taxonomy*. Zookeys 515: 191-206. https://doi.org/10.3897/zookeys.515.9459

MONTESANTO G., 2016. *Drawing setae: a GNU way for digital scientific illustrations*. Nauplius, 24: e2016017. https://doi.org/10.1590/2358-2936e2016017

MONTESANTO G., CARUSO D., LOMBARDO B.M., 2007. *Taxonomic status of the Mediterranean terrestrial isopod Porcellio lamellatus Budde-Lund as inferred from genetic and morphological differentiation (Crustacea, Isopoda, Oniscidea)*. Crustaceana 80 (8): 917-938. https://www.jstor.org/stable/20107880

MONTESANTO G., CARUSO D., LOMBARDO B.M., 2008. *Genetic variability in parthenogenetic and amphigonic populations of Platyarthrus aiasensis from Sicily (Crustacea, Isopoda, Oniscidea)*. In: Zimmer M., Charfi-Cheikhrouha F., Taiti S., *Proceedings of the international symposium on terrestrial isopod biology, ISTIB-07*: 59-67. Ed. Shaker, Aachen.

PAOLI P., FERRARA F., TAITI S., 2002. *Morphology and evolution of the respiratory apparatus in the family Eubelidae (Crustacea, Isopoda, Oniscidea)*. Journal of Morphology, 253 (3): 272-289. https://doi.org/10.1002/jmor.10008

RASBAND W.S., 1997. *ImageJ*. U. S. National Institutes of Health, Bethesda, Maryland, USA, http://imagej.nih.gov/ij/

SCHMALFUSS H., 2003. *World catalog of terrestrial isopods (Isopoda: Oniscidea)*. Stuttgarter Beiträge zur Naturkunde A, 654: 1-341. http://www.oniscidea-catalog.naturkundemuseum-bw.de/Cat_terr_isop.pdf

SZLAVECZ K., VILISICS F., TÓTH Z., HORNUNG E., 2018. *Terrestrial isopods in urban environments: an overview*. ZooKeys 801: 97-126. https://doi.org/10.3897/zookeys.801.29580

TAITI S., FERRARA F., 1989. *Biogeography and ecology of terrestrial isopods from Tuscany*. Monitore Zoologico Italiano (N.S.) Monografia 4: 75-101.

TAITI S., MONTESANTO G., 2018. *New species of subterranean and endogean terrestrial isopods (Crustacea, Oniscidea) from Tuscany (central Italy)*. Zoosystema 40 (11): 197-226. https://doi.org/10.5252/zoosystema2018v40a11

VILISICS F., BOGYÓ D., SATTLER T., MORETTI M., 2012. *Occurrence and assemblage composition of millipedes (Myriapoda, Diplopoda) and terrestrial isopods (Crustacea, Isopoda, Oniscidea) in urban areas of Switzerland*. ZooKeys 176: 199-214. https://doi.org/10.3897/zookeys.176.2153

VILISICS F., HORNUNG E. 2009. *Urban areas as hot-spots for introduced and shelters for native isopod species*. Urban Ecosystems 12 (3): 333-345. https://doi.org/10.1007/s11252-009-0097-8

ZIEGLER A., MILLER B., 1997. *Ultrastructure of $CaCO_3$ deposits of terrestrial isopods (Crustacea, Oniscidea)*. Zoomorphology 11 7 (3): 181-187. https://doi.org/10.1007/s004350050043

*(ms. pres. 13 novembre 2024; ult. bozze 29 agosto 2025)*

## SUPPLEMENT S1
### KEY TO THE TERRESTRIAL ISOPODS OF THE CHARTERHOUSE OF CALCI (PISA)

1. Flagella of antennae with two or three distinct segments (Fig. S1 A) . . . . . 5.
– Flagella of antennae with one distinct conical section which tapers to a point although under high magnification, up to six segments may be faintly visible (Fig. S1 B) . . . . . Family Trichoniscidae. 2.

2. Dorsal surface smooth or granulated, no longitudinal ridges or tubercles; outline of edges of pereon and pleon a stepped line (Fig. S1 C) . . . . . 3.
– Dorsal surface with pronounced longitudinal ridges and/or evident tubercles; outline of edges of pereon and pleon a smooth line (Fig. S1 D) . . . . . 4.

3. Eyes of three ocelli arranged in a triangle, dorsal surface smooth (Fig. S1 E) . . . . . ***Trichoniscus pygmaeus***
– Eyes of a single large ocellus, dorsal surface granulated (Fig. S1 F) . . . . . ***Androniscus dentiger***

4. Two paramedian prominent tubercles on dorsal surface of third segment of pleon (Fig. S1 G) . . . . . ***Haplophthalmus mengii***
– Tubercles on dorsal surface of third segment of pleon very feeble or absent (Fig. S1 H) . . . . . ***Haplophthalmus danicus***

5. Flagella of antennae with three distinct segments (Fig. S1 J) . . . . . 6.
– Flagella of antennae with two segments (Fig. S1 I) . . . . . 8.

6. Cephalon with no lateral lobes; pleon epimera small (or absent) and outline of edges of pereon and pleon a stepped line (Fig. S1 K) . . . . . Family Philosciidae. 7.
– Cephalon with prominent lateral lobes; pleon epimera well developed and outline of edges of pereon and pleon a smooth line (Fig. S1 L) . . . . . Family Oniscidae. ***Sardoniscus verhoeffi***

7. Pleon epimera III-V reduced (Fig. S1 M) . . . . . ***Chaetophiloscia elongata***
– Pleon epimera III-V well developed (Fig. S1 N) . . . . . ***Philoscia affinis***

8. Uropod exopodite cylindrical in shape and protruding beyond the posterior margin of the telson (Fig. S1 O); live specimens not able to roll up into a ball . . . . . 9.
– Uropod exopodite flattened, outline of edges of pleon and telson a smooth line (Fig. S1 P); live specimens able to roll up into a ball . . . . . Family Armadillidiidae. 11.

9. Body depigmented, blind (no ocelli); maximum length 4 mm; always associated with ants . . . . . Family: Platyarthridae. ***Platyarthrus hoffmannseggii***
– Pigmented body and eyes present; maximum length more than 4 mm . . . . . Family Porcellionidae 10.

10. Cephalon with suprantennal line visible and V-shaped (Fig. S1 Q) . . . . . ***Porcellionides pruinosus***
– Cephalon with suprantennal line absent . . . . . ***Agabiformius lentus***

11. Cephalon with scutellum not protruding over the vertex (Fig. S1 R); distal part of male pleopod 1 endopodite curved outwards (Fig. S1 T); live animals form a perfect ball when rolled up, with no gap (Fig. S1 V) . . . . . ***Armadillidium vulgare***
– Cephalon with scutellum distinctly protruding over the vertex (Fig. S1 S); distal part of male pleopod 1 endopodite straight and not curved outwards (Fig. S1 U); live animals leave a gap when rolled up due to their inability to form a perfect ball (Fig. S1 W) . . . . . ***Armadillidium depressum***

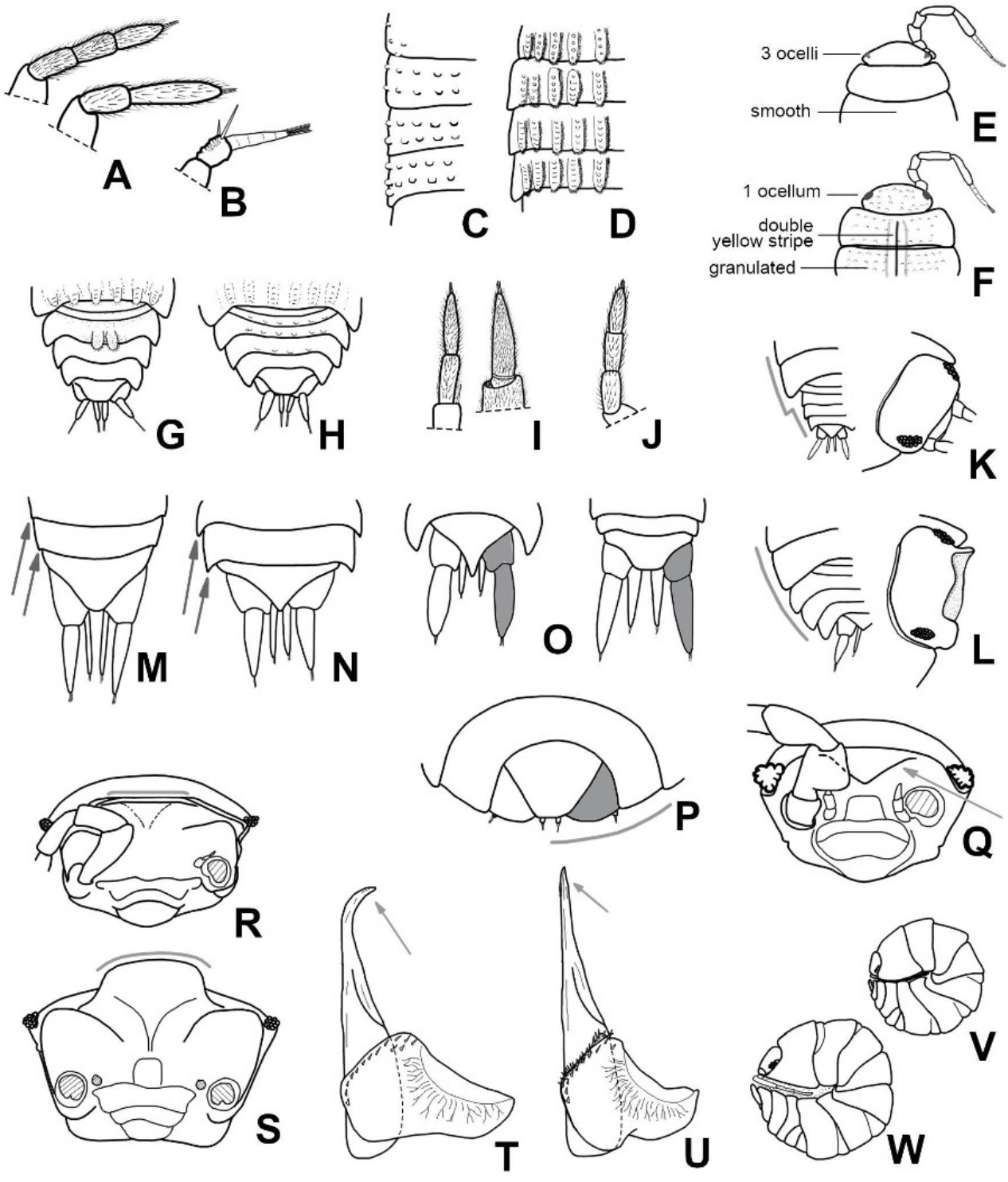



Figure S1. Morphological characters used for dichotomous keys for terrestrial isopods from the Charterhouse of Pisa.