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Alien terrestrial crustaceans (Isopods and Amphipods) Chapter 7.1

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Abstract

A total of 17 terrestrial crustacean species aliens *to* Europe of which 13 isopods (woodlice) and 4 amphipods (lawn shrimps) have established on the continent. In addition, 21 species native to Europe were introduced in a European region to which they are not native. The establishment of alien crustacean species in Europe slowly increased during the 20th century without any marked changes during the recent decades. Almost all species alien *to* Europe originate from sub-tropical or tropical areas. Most of the initial introductions were recorded in greenhouses, botanical gardens and urban parks, probably associated with passive transport of soil, plants or compost. Alien woodlice are still confined to urban habitats. Natural habitats have only been colonized by three amphipod species in the family Talitridae.

Keywords

Woodlice, lawnshrimps, Europe, alien

7.1.1. Introduction

The orders in the arthropod subphylum Crustacea are mainly composed of aquatic-living species, at least during part of their life-cycle. Most alien terrestrial crustaceans belong to the order Isopoda, suborder Oniscidea, commonly named woodlice. But

several species recorded in Europe belong to the order Amphipoda, and are commonly known as “lawn shrimps” or “landhoppers”.

In 2004, the total number of valid Isopod species worldwide was 3637 (Schmalfuss 2003). Woodlice are adapted to various terrestrial environments from sea shores to deserts and have established on all continents. As decomposers of organic plant material, isopods play an important role in ecosystems (Holthuis et al. 1987, Zimmer 2002). Most European species prefer humid and moist micro-habitats (Vandel 1960) like soil, leaf litter, mosses and decaying wood. Several species are known for their myrmecophylic nature.

Amphipods are generally marine or limnicolous, and only a few species can live permanently on land (mainly in the family Talitridae). Some live near the sea, on beaches where they hide under logs and dead algae and vegetation. The true terrestrial amphipods live on the surface of mulch and moist ground (Fasulo 2008). Many of the habitat features of terrestrial amphipods are similar to those of isopods. These little animals are most commonly noticed by their strong, rapid jumps upon being disturbed.

7.1.2. Taxonomy of alien terrestrial crustaceans

Thirty-eight species belonging to ten different families were recorded during this study. The four most commonly represented families (all belonging to Isopoda) are Trichoniscidae (seven species), Porcellionidae (five species), Philosciidae and Armadillidiidae, both with five species (Figure 7.1.1.). Two main categories were considered:

- Aliens *to* Europe, including 17 crustacean species originating from other continents (Table 7.1.1).
- Aliens *in* Europe, represented by 21 crustacean species native to a region of Europe but introduced in another European region to which they are not native. Several other species considered as cryptogenic or cosmopolitan are probably also aliens in some parts of Europe. However, in most cases it was not possible to distinguish their alien range from the native one. Below only those species we classify as aliens *in* Europe:

Armadillidiidae: *Armadillidium assimile* Budde-Lund, 1879, *Armadillidium kossuthi* Arcangeli, 1929, *Armadillidium nasatum* Budde-Lund, 1885, *Armadillidium vulgare* (Latreille, 1804);

- Oniscidae: *Oniscus asellus* Linnaeus, 1758;
- Philosciidae: *Chaetophiloscia cellaria* (Dollfus, 1884);
- Platyarthridae: *Platyarthrus schoblii* Budde-Lund, 1885;
- Porcellionidae: *Porcellio dilatatus* Brandt, 1833, *Porcellio laevis* Latreille, 1804, *Porcellio scaber* Latreille, 1804, *Porcellionides pruinosus* (Brandt, 1833), *Proporcellio vulcanius* Verhoeff, 1908;
- Schiziidae: *Paraschizidium coeculum* (Silvestri, 1897);

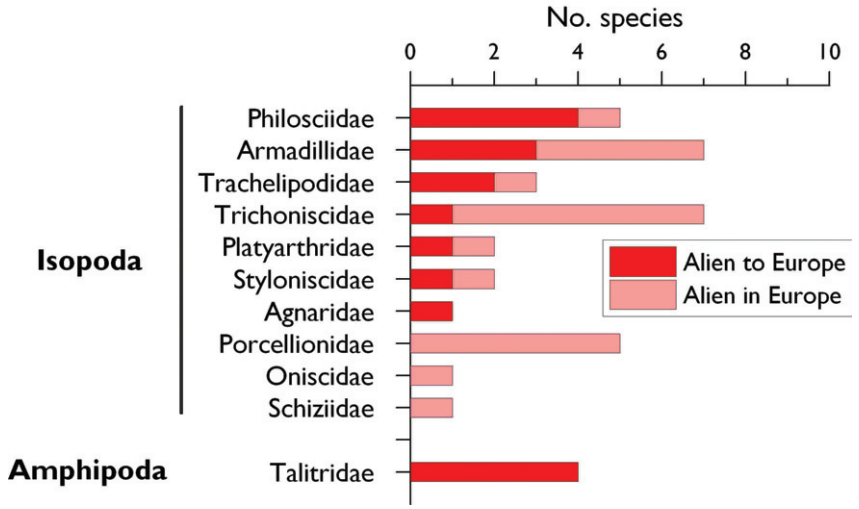

Figure 7.1.1. Taxonomic overview of the Isopoda and Amphipoda species alien *to* and Alien *in* Europe.

- Styloniscidae: *Cordioniscus stebbingi* (Patience, 1907);
- Trachelipidae: *Agabiformius lentus* (Budde-Lund, 1885);
- Trichoniscidae: *Androniscus dentiger* Verhoeff, 1908, *Buddelundiella cataractae* Verhoeff, 1930, *Haplophthalmus danicus* Budde-Lund, 1880, *Metatrichoniscoides leydigi* (Weber, 1880), *Trichoniscus provisorius* Racovitza, 1908, *Trichoniscus pusillus* Brandt, 1833.

Some of the species above have proved to be very successful colonizers and are currently considered as part of the native fauna in parts of Europe, e.g. in Hungary. However, their synanthropic nature and their extremely wide distribution range suggest a long colonisation history as it is the case for *Armadillidium vulgare*.

In the remainder of this chapter, we will focus mainly on the species alien *to* Europe.

7.1.3. Temporal trends of introduction in Europe of alien terrestrial crustaceans

The total number of crustaceans alien *to* Europe has slowly increased during the 20th and the early 21st centuries, but without any acceleration in the rate of arrival. Two alien species were first discovered in Europe in the 19th century, about nine species in the first half of the 20th century and only five species since then. The majority of these alien species have been found in several other countries after their discovery in Europe. However, the number of occupied countries over time has grown steadily rather than exhibiting exponential growth.

A similar pattern is apparent for woodlice species alien *to* Europe. However, because of sparcer information on this group, the date for the first introduction is roughly known for only approximately 50% of species. To our knowledge, at least six species of

woodlice classified as aliens of Europe were noticed in the first half of the 20th century and only five more species since then.

Thus, unlike many other invertebrate phyla, the temporal trend in alien crustaceans (both intra-European and alien) has shown no marked changes during recent decades. As "silent invaders" (Hornung et al. 2007) no terrestrial crustaceans are classified as pests in Europe; they are elusive animals. We suspect frequently a large gap between the date of introduction and "discovery" of alien woodlice species. For example, during an intense eight year survey of the isopod fauna in a large region representing 15% of Hungary, three new alien species for this country were found (Farkas 2007).

To conclude, the atypically gradual trend in the number of alien terrestrial Crustacea in Europe could be an artefact of incomplete knowledge. Because of both the increasing worldwide trade in ornamental plants and the general ecology of terrestrial crustaceans (i.e. often hidden in soils), it is more realistic to expect a future exponential increase in the number of alien species (especially intra-European aliens).

7.1.4. Biogeographic patterns of the alien Crustaceans

7.1.4.1. Origin of the alien species

Species alien *to* Europe almost all originate from sub-tropical or tropical areas (Table 7.1.1.). Only one species – *Protracheoniscus major* (Dollfus, 1903)- is likely to be native from Central Asia. For several species, their ranges are poorly known (they are also often introduced in other tropical areas). However, several species do have a precise origin. The most widely distributed alien woodlouse in Europe is the tropical American *Trichorhina tomentosa* (Budde-Lund, 1893), while the most widely distributed amphipod is *Talitroides alluaudi* Chrevreux, 1901. It should be noted that a least six of the seventeen alien species were originally described from Europe (Great Britain, France and Germany) after their introduction.

The crustaceans alien *in* Europe generally originate from the Mediterranean basin (seven species), from western and south-western Europe (five species).

7.1.4.2 Distribution of the alien species in Europe

Within Europe, Crustaceans of alien origin have mainly been recorded in western countries, where they appeared first. The four countries with most species are Great Britain (11 species), the Netherlands (10 species) and Germany (nine species) (Figure 7.1.2). Comparatively few alien species have been recorded in central and eastern Europe to date (e.g. only four species in Hungary). In this part of Europe, the Central-Asian *P. major* is one of the most widespread alien crustaceans. The high number of aliens in western European countries may be linked to the high number of scientists and the intensity of soil research (Hornung 2009).

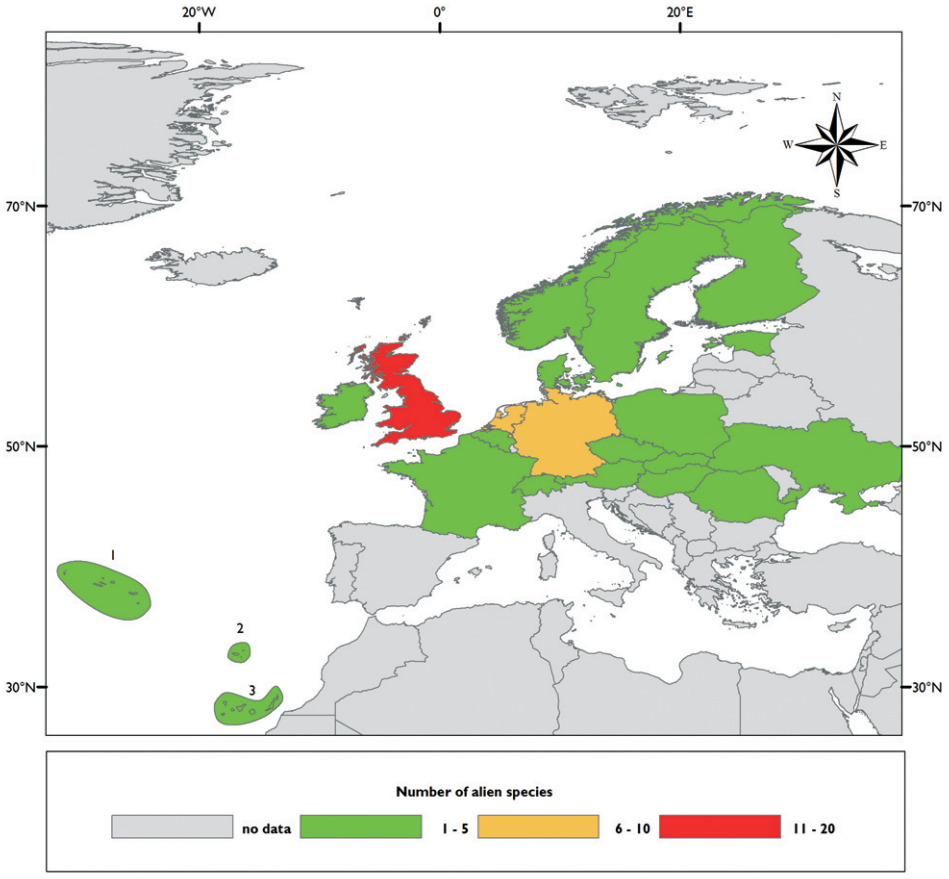

Figure 7.1.2. Colonization of continental European countries and main European islands by myriapod species alien to Europe. Archipelago: **1** Azores **2** Madeira **3** Canary islands.

There are only very few records of alien crustaceans on European islands. *Trichoniscus pusillus* has been reported from the Azores and Madeira, *T. provisorius* and *A. assimile* from the Azores but these species are native of Continental Europe. To our knowledge, the only alien aliens recorded on islands are talitrids, *Arcitalitrus dorrieni* (Hunt, 1925) in Scilly and Guernsey, *Talitroides topitotum* (Burt, 1934) in the Azores and Madeira, and *T. alluaudi* in the Azores and the Canaries. All these species occur outdoors and are therefore considered as naturalised. The rarity of alien terrestrial crustaceans on European islands is likely to be due to the primarily introduction route being major greenhouses in large metropolitan cities (see below).

Crustaceans classified as aliens of Europe are typically species which have expanded their range approximately northwards and eastwards. The eastern and central countries have a higher number of these species than more westerly countries of Europe. For example, Germany and the Czech Republic, taken together, have nine species of alien woodlice of European origin, about 45% of the total in this category.

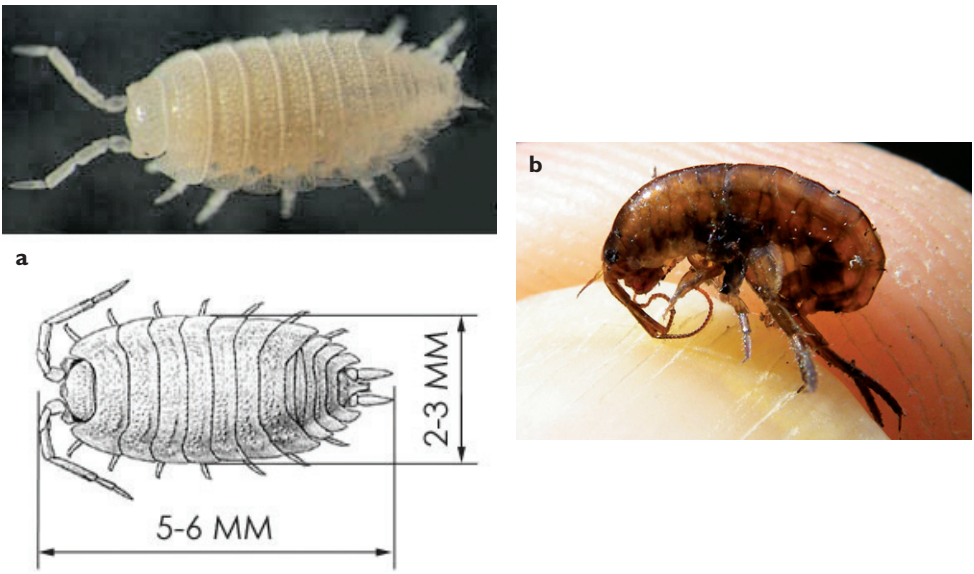

Figure 7.1.3. Alien terrestrial crustaceans. **a** *Trichorhina tomentosa* (Isopoda, woodlice) (credit: Vassily Zakhartchenko) **b** *Arcitalitrus dorrieni* (Amphipoda, lawn shrimp) (Credit: John I. Spicer).

A striking example of successful colonization and establishment of such species is given by *A. nasatum*. This woodlouse is believed to be native to Italy, southern France and Spain (Vandel 1962). Since the start of the 20th century, it has been introduced into greenhouses in a number of additional countries of Northern and Central Europe (e.g. Denmark, Finland, Germany, Hungary, Poland, Slovakia, Sweden), making this species one of the most widely distributed alien woodlice of Europe. Moreover, numerous reports highlight the successful establishment of outdoor populations in several western and central European countries (e.g. the Netherlands, Czech Republic, Romania, Slovenia) (Berg et al. 2008, Giurginca 2006, Navrátil 2007, Vilisics and Lapanje 2005).

Some of the aliens of Europe have also invaded other continents and can be considered as very successful invaders. The most notable ones are *A. vulgare*, *P. scaber* and *P. pruinosus*. *Armadillidium vulgare* and *P. pruinosus* are probably native from Mediterranean regions. In northern temperate parts of Europe, these species are restricted to synanthropic habitats (e.g. gardens, cellars, compost heaps). *P. pruinosus* is one of the woodlice that has been spread most by man across the world (Vandel 1962) and can now be considered as "synanthropically cosmopolitan" (Schmalfuss 2003).

A consequence of the dominance of Mediterranean origin for species classified as aliens of Europe is their decreasing number towards the north of the continent (Vilisics et al. 2007). In the northernmost countries of Europe (e.g. Finland (Vilisics and Terhivuo 2009)) only the most tolerant habitat-generalists, as well as intra-European aliens, are able to become successfully established.

7.1.5. Pathways of introduction of alien terrestrial Crustaceans

Because a great majority of the first isopod introductions were recorded in greenhouses, botanical gardens or urban parks, it is clear that many were associated with passive transport of soil, plants or compost. With few visible effects in such biotopes, terrestrial crustaceans colonize and spread as undetected "silent invaders" (Hornung et al. 2007). Thus, most introductions were unintentional. The one known exception is the spreading of *T. tomentosa*, commonly sold as pet food, triggered by trading activity in Europe. This probably explains why, among all the alien crustaceans, *T. tomentosa* is the most widespread species in Europe.

Another interesting case is the Mediterranean species *P. schoblii*. This myrmecophylous woodlouse is a commensal of the ant *Lasius neglectus* Van Loon, Boomsma & Andrásfalvy, 1990 and was first recorded in Hungary in 2001, a few years after the introduction of the ant. *P. schoblii* was probably introduced at the same time as its ant host (Tartally et al. 2004). It has since been found regularly (Hornung et al. 2005, Tartally et al. 2004, Vilisics 2007, Vilisics et al. 2007) and is now considered established, as is *L. neglectus*.

7.1.6 Ecosystems and habitats invaded in Europe by alien terrestrial Crustaceans

To our knowledge, the only alien crustaceans invading natural habitats are three talitrid species. *Arcitalitrus dorrieni* has invaded leaf litter understoreys of deciduous woodlands in Great Britain and Ireland (Cowling et al. 2003, Vader 1972). *Talitroides alluaudi* is known outdoors in the Canary Islands, and *T. topitotum* in the Madeira Islands, both species in the Azores (Vader 1972). All other species are generally limited to highly artificial habitats and artificial ecosystems: mostly greenhouses, urban parks and houses (especially cellars). The proportion of introduced isopods can be very high in urban areas. A study in Budapest revealed that 35% of the total species (n = 28) were introduced (Vilisics and Hornung 2009). The major settlements of Hungary were characterised as "hotspot for non-native species" (Hornung et al. 2008). This could certainly be applied to many major cities in other European countries.

For the tropical species, especially those recorded only once or twice in Europe, they may not be considered as established (Table 7.1.1.) since their survival is completely dependent on warm greenhouses.

Among all alien woodlice, none have spread to more natural habitats. However, the situation is different for intra-European woodlice native to southern or Mediterranean Europe. These established aliens can successfully expand by dispersal from very disturbed areas (where they were originally introduced) to more semi-natural habitats in rural-suburban zones (Vilisics and Hornung 2009). With global warming and the large-scale disturbance of biomes in Europe, that trend could increase, especially for the species with large ecological spectra.

7.1.7. Ecological and economic impact of alien terrestrial Crustaceans

Alien crustaceans in Europe are not known to carry diseases or to have an impact on native species and natural habitats. Further, they have no economical impact. Based on existing literature, the occurrence of alien woodlice is strictly bound to the urban environment (e.g. greenhouses, botanical and private gardens); alien terrestrial isopods do not yet seem able to survive or to expand to more natural ecosystems.

The case of the alien amphipod *A. dorrieni* is quite different. Terrestrial amphipods are known to have many effects on the soil and leaf litter (Friend and Richardson 1986). *Arcitalitrus dorrieni* has invaded deciduous and coniferous woodlands in western parts of Great Britain. In Ireland, a study showed that 24.7% of annual litter fall in a coniferous woodland was ingested by this species. It is suggested that "this introduced species plays a more important role than native macrofaunal species in nutrient turnover in this particular woodland habitat" (O'Hanlon and Bolger 1999). It is possible that other, as yet undetected, ecological impacts are likely.

Terrestrial crustaceans can represent a large percentage of biomass and abundance in the soil macrofauna (Gongalsky et al. 2005). Thus any successful invasion by a terrestrial alien crustacean could induce some disturbance if it established in relatively natural habitats. For example, in a forested area of Florida, a study on the introduced European woodlouse *A. vulgare* showed that this species' activity "had a strong effect on the chemistry of the mineral layer" (Frouz et al. 2008) and concluded that in some cases it may significantly alter soil conditions".

Woodlice classified as aliens *of* Europe are usually associated with synanthropic habitats and often gain dominance in urban environments (e.g. urban parks, villages, private gardens). The successful colonisation of human- influenced biotopes may lead to the uniformity of local Isopod assemblages. With the decrease of native species in the urban isopod fauna, an ongoing process of biotic homogenisation is prevalent in cities across Europe (Szlávecz et al. 2008, Vilisics and Hornung 2009).

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Table 7.1.1. List and main characteristics of the Crustacean species alien *to* Europe. Country codes abbreviations refer to ISO 3166 (see appendix I). Habitat abbreviations refer to EUNIS (see appendix II). Only selected references are given. Last update 16/10/2009.

Order *Family*	*Species*	Regime	Native range	1st record in Europe	Invaded countries	Habitat	References
Isopoda							
Agnaridae							
	Protracheoniscus major (Dollfus, 1903)	Detritivorous	Central Asia?	1903, PL/UA	AT, CZ, DE, EE, HU, PL, RO, SK, UA	J	Dudich (1926),Dudich (1933), Dyduch (1903), Dominiak (1970), Flasarová (1986), Flasarová (1988), Flasarová (1995), Forró and Farkas (1998), Frankenberger (1959), Ilosvay (1985), Schmölzer (1974), Semenkevitsh (1931), Strouhal (1929), Strouhal (1951), Verhoeff (1930)
Isopoda							
Armadillidae							
	Reductoniscus costulatus Kesselyák, 1930	Detritivorous	Pacific islands	1930, DE	DE, FR, GB, HU, NL	J	Berg et al. (2008), Grüner (1966), Holthuis (1947), Holthuis (1956), Kesselyák (1930a), Kesselyák (1930b), Kontschán (2004), Schmalfuss (2003), Soesbergen (2003), Vandel (1962), Verhoeff (1937)
	Synarmadillo pallidus Arcangeli, 1950	Detritivorous	Congo	2003, NL	NL	J	Berg et al. (2008), Schmalfuss (2003), Soesbergen (2003), Soesbergen (2005)
	Venezillo parvus (Budde-Lund, 1885)	Detritivorous	Tropical regions	2003, NL	GB, NL	J	Berg et al. (2008), Gregory (2009), Schmalfuss (2003), Soesbergen (2003)
Isopoda							
Philosciidae							
	Anchiphiloscia balssi (Verhoeffff, 28)	Detritivorous	East Africa	1928, DE	DE, NL	J	Berg et al. (2008), Ferrara and Taiti (1982), Holthuis (1945), Schmalfuss (2003), Verhoeff (1928)
	Benthana olfersii (Brandt, 1833)	Detritivorous	Brazil (Southeast)	?, DE	DE	J	Schmalfuss (2003)
	Burmoniscus meeusei (Holthuis, 1947)	Detritivorous	Asia	1947, GB	GB	J	Harding and Sutton (1985), Holthuis (1947)

Order *Family*	*Species*	Regime	Native range	1st record in Europe	Invaded countries	Habitat	References
	Burmoniscus orientalis Green, Ferrara & Taiti, 1990	Detritivorous	Asia	2005, AT	AT	J	Uteseny (2009)
Isopoda ***Platyarthridae***							
	Trichorhina tomentosa (Budde-Lund, 1893)	Detritivorous	America (Tropical)	1896, FR	AT, CH, BE, CH, CZ, DE, FR, GB, HU, IE, NL, NO, PL[1]	J	Berg et al. (2008), Dollfus (1896a), Foster (1911), Foster and Pack-Beresford (1913), Harding and Sutton (1985), Holthuis (1945), Jedryckowsky (1979), Korsós et al. (2002), Meinertz (1934), Olsen (1995), Pack-Beresford and Foster (1911), Polk (1959), Schmalfuss (2003), Verhoeff (1937), Wouters et al. (2000)
Isopoda ***Styloniscidae***							
	Styloniscus spinosus (Patience, 1907)	Detritivorous	Madagascar, Mauritius	1907, GB	GB	J	Edney (1953), Harding and Sutton (1985), Patience (1907), Schmalfuss (2003)
Isopoda ***Trachelipodidae***							
	Nagurus cristatus (Dollfus, 1889)	Detritivorous	Pantropical	1956, NL	DE, GB, NL, RO	J	Allspach (1992), Berg et al. (2008), Harding and Sutton (1985), Holthuis (1956), Oliver and Meechan (1993), Radu (1960), Schmalfuss (2003)
	Nagurus nanus Budde-Lund, 1908	Detritivorous	Tropical regions	1985 GB	GB, IE	J	Foster (1911), Foster and Pack-Beresford (1913), Harding and Sutton (1985), Schmalfuss (2003), Sutton (1980)
Isopoda ***Trichoniscidae***							
	Miktoniscus linearis (Patience, 1908)	Detritivorous	USA (East) ?	1908,GB	DE, GB	J	Kesselyák (1930a), Patience (1908), Schmalfuss (2003), Vandel (1962)

Order *Family*	*Species*	Regime	Native range	1st record in Europe	Invaded countries	Habitat	References
Amphipoda							
	Talitridae						
	Arcitalitrus dorrieni (Hunt, 1925)	Detritivorous	Australia (East)	1925, GB	GB, IE, NL	G1, J	Cowling et al. (2003), Cowling et al. (2004a), Cowling et al. (2004b), Hunt (1925), Moore and Spicer (1986), Peart and Lowry (2006), Spicer and Tabel (1996)
	Brevitalitrus hortulanus Calman, 1912	Detritivorous	Tropical regions?	1912, GB	GB, NL	J	Calman (1912), Friend and Richardson 1986, Vader (1972)
	Talitroides alluaudi (Chevreux, 1896)	Detritivorous	Tropical regions, Seychelles Isl.?	1896, FR	BE, CH, CZ, DE, DK, ES-CAN, FI, FR, GB, HU, NL, PL, PT-AZO, SE	G1, J	Chevreux (1896), Dudich (1926), Friend and Richardson (1986), Hunt (1925), Vader (1972)
	Talitroides topitotum (Burt, 1934)	Detritivorous	Indo-Pacific	1942, DE	DE, GB, NL, PT-AZO, PT-MAD	G,J	Friend and Richardson (1986), Stock and Biernbaum (1994), Vader (1972)

1 *Trichorhina tomentosa* is on sale as reptile food in many European pet shops.

After this table was established, Gregory (2009) mentioned the presence of two more alien species in Great Britain, *Styloniscus mauritiensis* (Barnard, 1936) (Styloniscidae) from Hawaii and Mauritius and *Setaphora patiencei* (Bagnall, 1908) (Philosciidae) from The Réunion and Mauritius islands.