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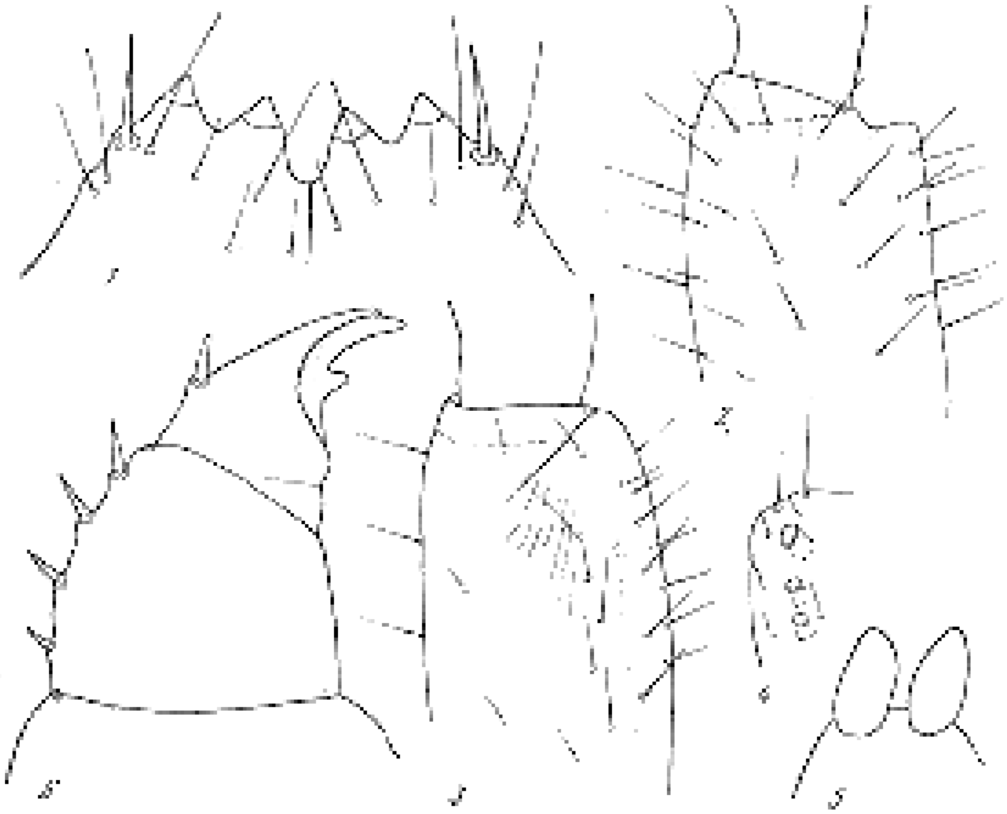

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Bulletin of the British Myriapod & Isopod Group: Volume 34 (2022)

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Editorial

As we have celebrated the first BMIG field meeting for three of years, several articles in the 2022 edition of the Bulletin help to put our British fauna in a wider context. Artsiom Ostrovsky discusses woodlice in Belarus, listing several species that are very familiar to us, but some that have a more eastern distribution and therefore (as yet) unknown to British workers. Several articles add to our knowledge of the British fauna. Keith Lugg, Steve Gregory and Mike Pennington celebrate the re-finding of *Geophilus proximus* on Shetland after almost 50 years, Nicola Garnham and Steve Gregory report on the re-finding of *Lamyctes africanus*, first collected in 1986 in Edinburgh and not seen since and the woodlouse list is increased by the identification of *Armadillidium arcangelii* from the Eden Project. In contrast, Jean Jacques Geoffroy, Helen Read and Henrik Enghoff have demonstrated that the long forgotten millipede *Cylindroiulus bouvieri* is in fact *C. parisorum*.

An article by David Cabanillas and Jairo Robla looks at the number of legs and body length in *Pachymerium ferrugineum* in the Iberian Peninsula and the Balearic Islands, examining if any ecological variables are able to explain these differences. In 1902, Verhoeff had distinguished a form of *Pachymerium ferrugineum* with a higher number of leg-bearing segments as "*insulanum*" and there have been a number of other studies regarding segment numbers of this species, and other geophilomorphs, in Europe. In the British Isles we have two types, referred to as "short form" and "long form" here, the latter being found by Andy Marquis from Guernsey, see *Bulletin* Volume **32**: 72-83.

The topic of segmentation and the number of leg-bearing segments in geophilomorphs has continued to be of interest in the British Isles. Ted Eason recognised that *Geophilus carpophagus* in Britain appeared to have two distinct populations based on the range of numbers of leg pairs. This ultimately led to the separation of *G. easoni* from *G. carpophagus* sensu stricto by Wallace Arthur and his colleagues. Many years earlier, Ted Eason had described the British population of "*Nesoporogaster souletina brevior*" – what we now call *Stigmatogaster souletina* – because it had fewer leg pairs than those from Mainland Europe. Despite the *brevior* epithet, the species has more legs than any other British centipede!

This *Bulletin* is a bumper edition for centipedes which is a fitting tribute to Tony Barber. In November 2021 Tony was presented with the Marsh Award by the British Entomological and Natural History Society at their annual exhibition, for his work on centipedes over the last 50 years. In 1970 Tony had attended the first meeting of the British Myriapod Group (as it was then) convened by Gordon Blower, with Colin Fairhurst, John Lewis and others. The British Myriapod Survey developed from this meeting for which Colin Fairhurst (millipedes) was working on a common habitat recording card for myriapods and isopods with Stephen Sutton and Paul Harding (isopods), and Tony joined in to cover centipedes. Tony has been the centipede recording scheme organiser ever since! Tony has edited the *Bulletin* since 1985 when he helped revive its publication and has also served on the BMIG Committee including as Chairman for several years. Helping people to learn to identify centipedes has always been a high priority for Tony, by producing keys and running training events, helping to boost the number of records submitted to the centipede recording scheme. In his activities Tony has built on the previous work by Colin Fairhurst, John Lewis, Gordon Blower and Desmond Kime – all of whom he would like to pay tribute too. He would also like to thank everyone who has contributed to centipede recording, the *Bulletin* and BMIG in general.

The forthcoming atlas will be testament to his hard work over many years.

Re-discovery of *Geophilus proximus* C.L.Koch, 1847 in Shetland (Chilopoda: Geophilomorpha, Geophilidae)

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Abstract

The only confirmed record of *Geophilus proximus* C. L. Koch, 1847 in Britain refers to a single specimen collected from Unst, Shetland in 1974. Here we report the rediscovery of this species, close to the original find site almost 50 years later. Several specimens, all female, were collected on three separate occasions suggesting that it is well established at the site. It may prove to be more widespread in Unst, or even elsewhere in northern Scotland.

Introduction

In Britain and Ireland many older references to '*Geophilus proximus*' have been shown to refer to *Geophilus impressus* C. L. Koch, 1847 (formerly known as *G. insculptus* Attems, 1895 and more recently as *G. alpinus* Meinert, 1870) and it is quite probable that all older records do so (Eason, 1964; Barber, 1986; Barber & Jones, 1999). The only confirmed record of the true *Geophilus proximus* C. L. Koch, 1847 was of a single female specimen, with 49 leg pairs, collected from near Queyhouse, Unst, Shetland (HP602113) in August 1974 by a team from ITE, Merlewood Research Station (Barber, 1986). This is the first, and only, British record for this centipede. This specimen was collected from beneath boulders in the bottom of a nettle-filled hollow in a limestone hillock covered in closely grazed turf, near the shore of the freshwater Loch of Cliff, Unst, Shetland. This archipelago of islands lies some 170 km north east of the Scottish mainland and 300 km west of Norway.

Geophilus proximus is a widespread Scandinavian centipede (Andersson *et al*., 2005) where it may be the most frequently encountered geophilomorph centipede found in all types of forest and in open land. A description of *G. proximus*, based on Norwegian material, is given by Barber & Jones (1999) and this information is included within the identification keys by Barber (2008; 2009). There had been no subsequent records of *G. proximus* from Shetland and Lee (2015) raised the possibility that it may be regionally extinct, but also acknowledged that few myriapodologists visit the Northern Isles. Thus, there is a high probability that it may be under recorded there and Lee (2015) designated it Nationally Rare, but Data Deficient.

Here we report the re-discovery of *Geophilus proximus* on Shetland after almost half a century.

The rediscovery

On 18th July 2021 KL and MP, accompanied by their respective wives, visited the limestone outcrop near the shore of Loch of Cliff, Unst, Shetland (c. HP601108), about 400 m south of the original 1974 site (Fig. 1A-D). Upon reaching the limestone area and passing through a gap in a stone wall some of the scattered stones were turned to reveal that the soil seemed finer and more friable than in other areas examined on route. Due to the recent dry weather the soil beneath the stones had cracked and MP saw an unrecognised beetle (Coleoptera) disappear down a crack. During an attempt to dig it out with a widger a small pale centipede was seen in the excavated soil. In light of this discovery, additional large partly embedded stones were turned over and the soil underneath then carefully dug over. This method turned up three specimens; two juveniles (including the first specimen found) and one adult female.

Figure 1: The survey area near the shore of Loch of Cliff, Unst.
A) Gap in dry stone wall with the loch in background; B) The limestone outcrop; C) MP hand searching; D) The stone beside wall where the first adult was found. Images © Keith Lugg.

The adult (Fig. 2A & 3A-D) is 24 mm in length, bears 49 leg pairs and readily keyed to *Geophilus proximus* using Barber (2009); an identification confirmed by Tony Barber from images. All the mentioned identification characters (Barber, 2009) for *G. proximus* were present (Fig. 2) including the second maxillae bearing a distinct claw (Fig. 2B; absent in *G. impressus*), the absence of an isolated coxal pore on the last trunk segment (Fig. 2D; present in *G. impressus*) and the sternal pore areas being diamond shaped (spindle shaped in *G. impressus*).

A return visit to the same location to take some site photographs and to begin to assess the range of the population one week later, on 25th July, resulted in four more adult specimens being found, all from under stones at the base of limestone walls. No specimens were found outside of the area of limestone, including a brief search of an abandoned croft, though further fieldwork is needed. Another return visit to the same location on 6th October 2021, in the company of Kevin Clements, resulted in the collection of three additional specimens from beneath stones fallen stones from adjacent limestone walls in just under three hours' searching. Searches were not undertaken away from the limestone walls.

Other species recorded during the three surveys include the centipedes *Lithobius forficatus* (Linné) and *L. melanops* Newport; the millipedes *Brachydesmus superus* Latzel and *Cylindroiulus latestriatus* (Curtis); and the woodlice *Trichoniscoides saeroeensis* Lohmander, *Oniscus asellus* Linné and *Porcellio scaber* Latreille.

Figure 2: *Geophilus proximus*, live females from Unst.
A) Specimen collected 18th July 2021; B) Specimen collected 25th July 2021. Images © Keith Lugg.

Discussion

After an absence of almost 50 years *G. proximus* has been re-discovered in Britain within a few hundred metres of the original 1974 record. It is of note that the species was readily found on the first attempt in less than ideal conditions in July, being abnormally dry for Shetland with very little precipitation since January and February, and again during the return visits to the same spot later in July and the following October. Given the long time period between the original record and its re-discovery it does seem to be well established in the area. The lack of records during the intervening decades are most likely due to under-recording on Shetland and it may prove to be more widespread on Unst, but the outcrops of limestone are limited in extent.

The original 1974 record was of a single female specimen and all six adult specimens collected and examined by KL also proved to be female. Only females have been recorded from the Nordic Countries (Barber & Jones, 1999) and it is quite likely that *G. proximus* is parthenogenetic in Unst as it is in the Nordic Countries. The current rural nature of the sites suggest that it may be a native species, but in the past there has been more human influence on the area, for examples with a near-by (now abandoned) croft and an old limekiln. Historically Shetland was under the control and influence of Norway for a long period of time. Thus, it is possible that *G. proximus* may have been accidentally transported to Unst from Norway and its parthenogenetic habits facilitating its establishment. It is possible that it may be

Figure 3: ***Geophilus proximus*** **specimen from Unst, collected 18th July 2021.**
A) Head, ventral view (note distinct claw on second maxilla, arrowed); B) Close up of second maxilla showing distinct claw; C) Carpophagus fossae on anterior sternites; D) Coxal pores (note absence of isolated pore). Images © Keith Lugg.

found in other similar habitats on Orkney or on the northern Scottish mainland and, if so, additional information on its habitat preferences (e.g. whether it favours synanthropic or semi-natural sites) would help clarify the status of this rare centipede in the UK.

Acknowledgements

We thank Tony Barber for help and advice on the details of the exact site of the original 1974 find, encouragement to try to re-find *Geophilus proximus*, and for verifying the adult specimen found on 18th July 2021.

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Re-discovery of *Lamyctes africanus* (Porath, 1871) in Britain (Chilopoda: Lithobiomorpha: Henicopidae)

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Abstract

Lamyctes africanus (Porath, 1871) was collected from glasshouses at the Royal Botanic Garden Edinburgh in 1986, but there have been no subsequent records from Britain or Ireland. Here we report the re-discovery in December 2021 of a colony *L. africanus* from an inside a plant propagator inside a domestic dwelling in northern England. An immature specimen collected from the same propagator three years previously suggests that this is a well-established population, possibly feeding upon the sciarid fungus gnat larvae present therein. It is highly likely that *L. africanus* has been overlooked elsewhere in Britain or Ireland, both inside glasshouses and in outdoor synanthropic localities.

Introduction

Specimens referred to *Lamyctes africanus* (Porath, 1871) by Ted Eason were collected by Charles Rawcliffe from glasshouses at the Royal Botanic Garden, Edinburgh in 1986 (Barber, 1992). However, the species was not included within the standard identification guides by Barber (2008; 2009) and there have been no additional British or Irish records for this species. Recently, *L. africanus* has been recorded from several sites across continental Europe as an introduction. This includes seven outdoor sites in Denmark, where it is typically associated with railways (Enghoff *et al*., 2013), within plant pots in a garden in France (Iorio, 2016), from greenhouses at Olomouc, Czech Republic (Dányi & Tuf, 2016) and from seven localities of various types in Germany (Decker *et al*., 2017).

Here we report the re-discovery of *Lamyctes africanus* from an indoor location in Lancashire, northern England.

The re-discovery

On 9th December 2021 NG found a *Lamyctes* centipede within a pot of compost inside a heated plant propagator located inside a domestic dwelling (Fig. 1A, B) in Lancashire (SD504679, VC60). However, the antennae seemed to comprise 28 antennal articles and the widespread *L. emarginatus* (Newport, 1844) usually has about 25 (Barber, 2008; 2009). On 16th December two additional specimens were seen, also with about 28 antennal articles, suggesting that they could be *L. africanus*.

These three specimens, preserved in 75% ethanol (specimens 1, 2 & 3 in Figs. 1-3), were sent to SJG for examination. They are between 8.5 and 9.0 mm in length. The ocelli are noticeably pale and surrounded by a darkened area (described as a ‘racoon mask’ by Enghoff *et al*., 2013). The antennae comprise 28 or 29 articles (Fig. 2A) (about 25 in *L. emarginatus*), but it proved difficult to count articles precisely as although some articles were quite distinct other appeared to be weakly defined and open to interpretation, though clearly more than 25. There are 2+2 prominent forcipular teeth, with the third outer ‘tooth’ barely discernible (Fig. 2B, C) (3+3 distinct teeth in *L. emarginatus*). Leg 12 bears a triangular projection on the tibia (Fig. 3A) (absent in *L. emarginatus*). Leg 15 is relatively long and slender (Fig. 3B); with the ratio of length/width of 15th tibia between 5.0-5.1; length/width of 15th tarsus 1 between 7.4-7.6 and length/width of 15th tarsus 2 between 8.9-9-2 (leg 15 shorter and stouter in *L. emarginatus*). On leg 15 the two accessory claws are almost half the length of the central claw and the posteroventral (pv) spine is over half the length of central claw (Fig. 3C) (these are shorter in *L. emarginatus*). These characters are all in keeping with the detailed description of *L. africanus* in Enghoff *et al*. (2013) and confirm the presence of this species in the UK.

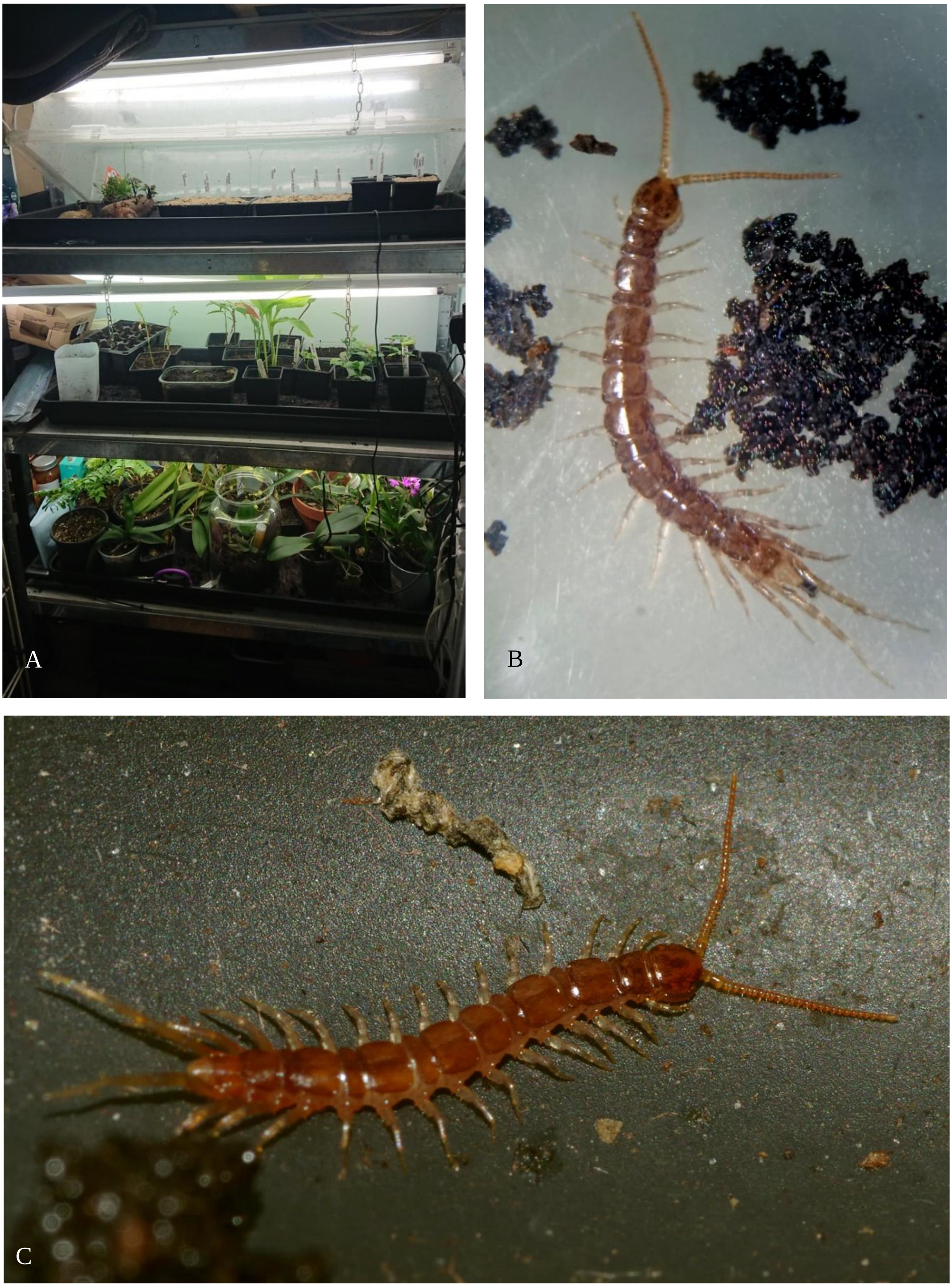

Figure 1: *Lamyctes africanus* from Lancashire
A) Plant propagator supporting the colony; B) Specimen 1, live habitus, collected on 9th December 2021; C) Live specimen observed on 26th January 2022. Images © Nicola Garnham.

Figure 2: ***Lamyctes africanus*** **from Lancashire, head features**
A) Specimen 1, head showing pale ocelli and 29+29 antennal articles; B) Specimen 1, forcipular coxosternite bearing 2 + 2 'teeth' (with a hint of a third); C) Specimen 2, forcipular coxosternite and forciples (ventral view).

Discussion

There are a number of shelves within the propagator on which plants are grown under artificial light (Fig. 1A). The first *Lamyctes* specimens were found in pots on the top row which is heated with a thermostatically controlled heat mat recently set to 25°C. There is a plastic tray with wool based capillary matting and usually there is a lid is to control humidity. The lower shelf is used for orchids, many originating from the Netherlands (which may be a potential source of introduction?). Specimens have been observed in pots of compost and under the cap matting. The compost used is a peat free and made in the UK from coir (imported as dehydrated and compressed blocks). It is of interest that specimens of an unidentified sciarid fungus gnat larvae (Diptera: Sciaridae), a potential food source, are also present within the propagator. A number of sciarid species are commonly found in household plant pots and greenhouses (Freeman, 1983).

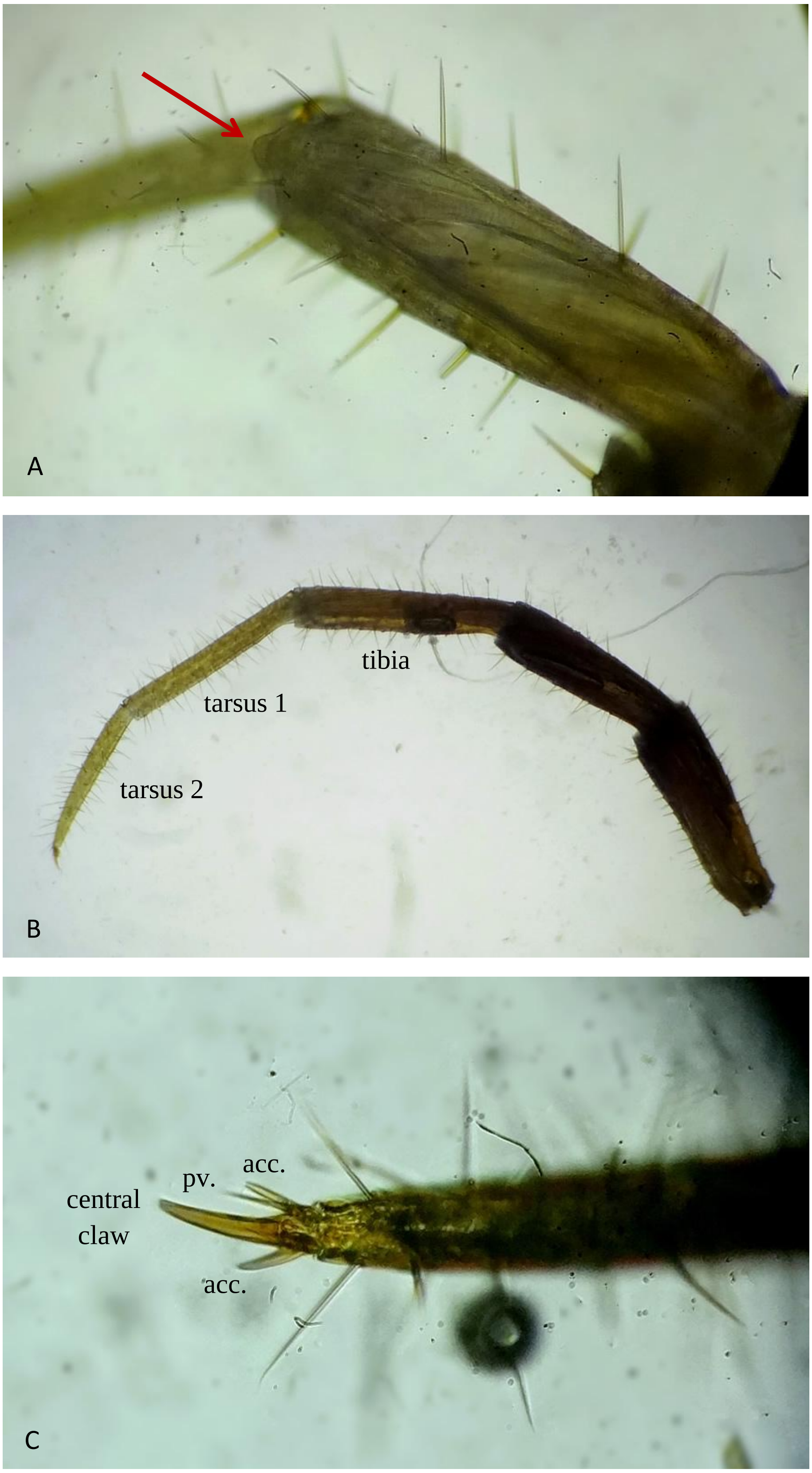

Figure 3: *Lamyctes africanus* from Lancashire, leg characters
A) Specimen 2, leg 12 with triangular projection on tibia (arrowed); B) Specimen 3, leg 15, indicating tibia, tarsus 1 and tarsus 2; C) Specimen 3, leg 15, central claw, accessory claws (acc.) and posteroventral spine (pv).

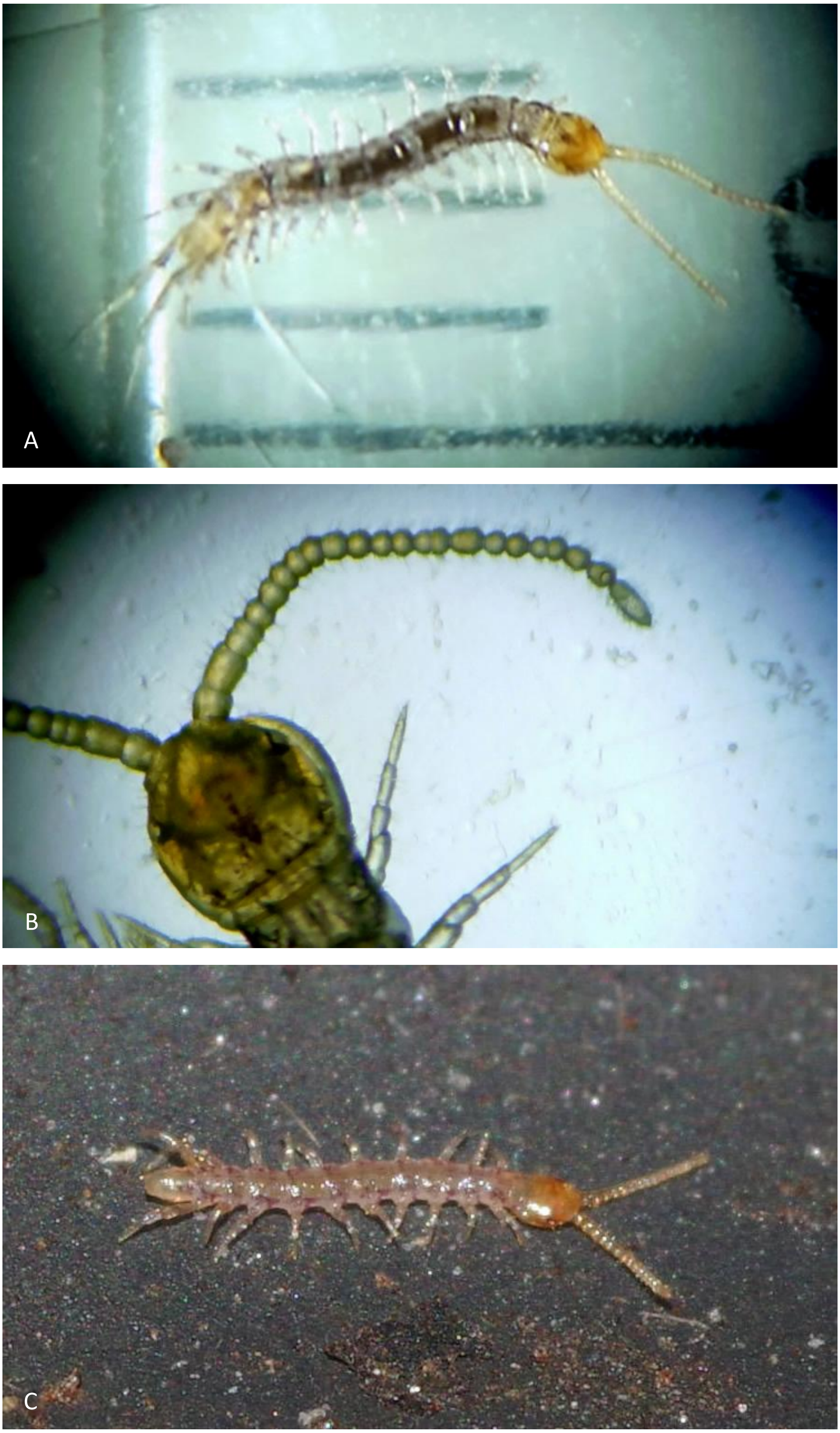

Figure 4: ***Lamyctes africanus*****, immature specimens from Lancashire.**
A) Specimen observed 13th January 2019, body length c. 3.5 mm; B) Ditto, head and right antenna bearing 23 articles; C) 3rd larval stadium observed 10th March 2022. Images © Nicola Garnham.

There appear to be at least six individuals of *L. africanus* remaining in the propagator (three additional specimens having been collected for examination). This is not a large population but being a parthenogenetic species will facilitate recolonisation from just a single female. Indeed, on 10th March 2022 three 3rd larval stadia (with 10 leg pairs; <3 mm in length) were observed (Fig. 4C), in addition to several adults. Three years earlier, on 13th January 2019, a 3.5 mm long *Lamyctes* specimen with both antennae comprising 23 antennal articles was collected from within the same plant propagator (Fig. 4A, B). This was collected by NG and examined by SJG and at the time was thought most likely to be an immature *L. emarginatus*. However, the number of antennal articles is in keeping with observations by Iorio (2016) that immatures between 6 mm to 7.1 mm in length have 25-26 articles. Thus, with hindsight this also appears to be an immature *L. africanus* and, if so, the species is clearly well established at this site for a number of years. Later in spring 2022 a single specimen was found outdoors in the garden and it will be interesting to see if the species becomes widely established outside.

Lamyctes africanus is of very similar appearance to *L. emarginatus* and it is has become apparent that on several occasions in continental Europe the former species has been mis-identified as the latter (Enghoff *et al*., 2013; Iorio, 2016, Decker *et al*., 2017). Thus, it is highly likely that *L. africanus* has been overlooked in indoor or outdoor localities in Britain or Ireland. Synanthropic sites, such as gardens, garden centres and glasshouses are perhaps the most likely place to look, but other outdoor locations should not be dismissed. The glasshouses at RBG Edinburgh were re-surveyed in April 2015 during the BMIG field meeting but *L. africanus* was not refound (Sivell, 2021). It may that the species is no longer present there, or perhaps it is seasonal in a similar way to *L. emarginatus* (which has a one year life cycle; Barber, 2009). In Germany *L. africanus* was found to favour sparsely vegetated sandy or gravel habitats (Decker *et al*., 2017), which is in keeping the association with railway lines noted in Denmark (Enghoff *et al*., 2013). It is also worth checking voucher specimens held in collections. Many records for *L. africanus* in Europe are from collections where specimens have been previously mis-identified as *L. emarginatus.*

Surely, in Britain the only known extant population of *L. africanus* cannot be confined to just a single house in northern England.

Acknowledgements

We thank Tony Barber for providing much relevant information and for his helpful comments.

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Lithobius curtipes (Chilopoda: Lithobiomorpha), a centipede with an enigmatic distribution

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Abstract

Lithobius curtipes is one of Britain's less common centipedes and is apparently absent from Ireland. It is, however, widespread across Northern Europe to the Urals and as far east as Mongolia and occurs far north to inside the Arctic Circle. In Britain it is known from a variety of habitats including up to 1,000m in Snowdonia but is unrecorded from Scotland apart from two records from the south. As well as being able to survive, and in some cases, be, the only lithobiid present in northern latitudes in Europe, overwintering in the frozen state. Amongst other habitats, *L. curtipes* is also associated with floodplains, notably in Central Europe, and may co-exist there with *Lamyctes emarginatus* on the basis of their different life-cycles.

Introduction

Lithobius (*Monotarsobius*) *curtipes* C.L.Koch, 1847 is a relatively small (11mm), chestnut brown species of *Lithobius* distinguished from a number of other British species of that genus by its 2+2 teeth on the forcipular coxosternite, the lack of posterior projections on its tergites and single claws on the last pair of legs. Along with *Lithobius.crassipes* L. Koch, it is one of the two British representatives of the sub-genus *Monotarsobiu*s, recognised, amongst other characteristics, by having only about 20 antennal articles. *Lithobius* (*Sigibius) microps* Meinert has about 25 (23-27) and other British & Irish species (subgenus *Lithobius*) rather more (26-34 in *Lithobius lapidicola* Meinert to 49-54 in *Lithobius piceus* L.Koch). Although Ganske *et al.* (2021) indicate that these subgenera are not monophyletic, it is convenient to see these two *Monotarsobius* as distinct from the remainder of the British *Lithobius* species.

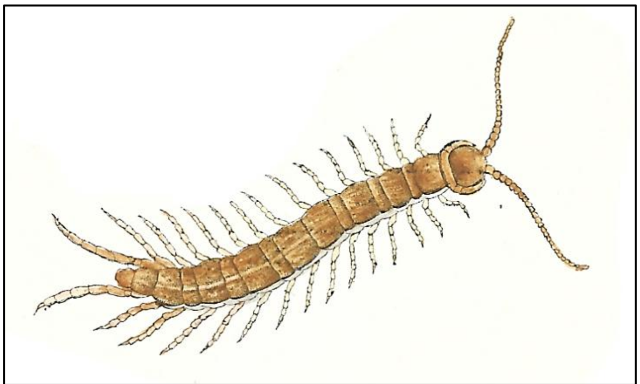


Figure 1: *Lithobius curtipes* C.L. Koch
(From C.L. Koch, Die Myriapoden, 1863)

Lithiboius curtipes and *L. crassipes* are not always easy to distinguish and it is quite possible that in the past the former has been occasionally overlooked although, even allowing for this, the total numbers of records of the two species obtained by the BMIG Centipede Recording Scheme for Mainland Britain up to the end of 2018 are strikingly different. There are only 171 for *L. curtipes* compared with more than 2,500 for *L. crassipes* and no records of the former from Ireland. Adult males are fairly easy to distinguish by the flattened projection on the posterodorsal extremity of the tibiae of the ultimate (15th) legs in *L. curtipes* (Figs. 2 & 3). There are also differences in the arrangement of the ocelli, 1, 1 + (usually incomplete) rosette compared with 1 + 2 or 3 straight rows, of the forcipular coxosternal teeth and the gonopods but these characters are not always clearly definitive so spinulation might need to be looked at. In addition to these morphological characters, *L. curtipes* also has a reputation for a much greater tendency for curling up when disturbed (as in *L. microps*). The distribution of *L. crassipes*, both in Britain and in Mainland Europe, very much overlaps with that of *L. curtipes* and extends to both Ireland and to Southern Europe.

Once regarded as a lowland, possibly ancient woodland, species in Britain (Barber & Keay, 1988) further records of *L. curtipes*, including its discovery by Richard Gallon at 1,000m asl in Snowdonia (Barber & Gallon, 2020) along with its apparent absence from most of Scotland even though its range extends far north in Europe, prompted a review of aspects of its distribution and ecology by reference to some of the sources in which it is listed. Reports of some other non-British sites from which centipedes were collected but from which *L. curtipes* was not found are included also as part of the context. It must be emphasised that this account does not attempt to be a comprehensive survey of all the literature relating to the species but refers to some of the available published sources from across its known distribution area, notably from the Nordic countries, Germany, Poland and Russia and from Austria, Hungary, the Czech Republic and Slovakia.

Nomenclature

The species was first described by Koch from Nuremberg (Nürnberg), Germany and its status reviewed by Eason (1972) from specimens in the Natural History Museum (London). He also reported specimens from Lithuania and the (present) Czech Republic. A list of synonyms and the names of three subspecies are given in Chilobase (Bonato *et al.*, 2016). Of these latter, *Lithobius curtipes turkestanicus* Attems, 1904 and *Lithobius curtipes taurica* Ellingsen, 1910 are, apparently, synonyms of *Lithobius ferganensis* (Trotzina, 1894) and *Lithobius curtipes diversipes* Verhoeff, 1901 is identified as *L. curtipes* (probable but uncertain synonymy).

There has been some confusion in the past regarding the name of the species that we currently know as *Lithobius curtipes*. In 1947, Loksa, as cited in Chilobase (Bonato *et.al*, 2016), described a species *Lithobius* (*Monotarsobius*) *baloghi* from Romania and in a subsequent paper (Loksa, 1955a) listed both *M. curtipes* and *M. Baloghi*, the latter of which he described as a high-alpine type, recording it at 1800m in the Carpathians. However his drawings (p 10; Abb. 96 & 97) of the tibia of a *L. curtipes* ♂ show a tubercle as is characteristic of *L. ferganensis* which his *L. Baloghi* ♂ (now known to be synonymous with *L. curtipes*) does not have (Abt. 98; see previous comments). From Russia, he subsequently described a subspecies *Monotarsobius baloghi rybinskianus* (= *L. curtipes*) from Rybinsk, at the confluence of the Volga and Sheksna Rivers, NNE of Moscow (Loksa, 1962).

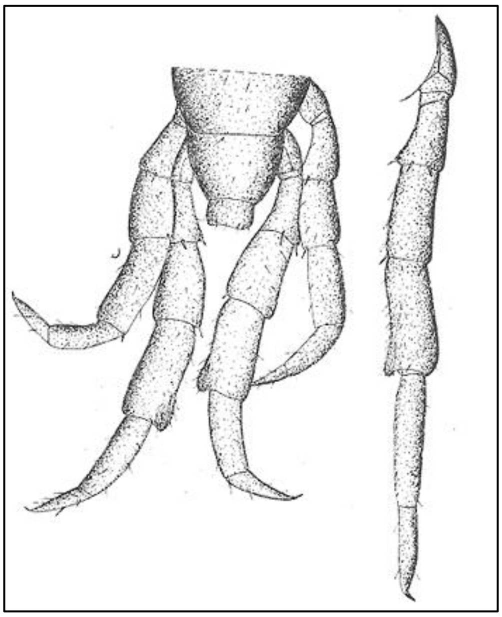


Figure 2: *Lithobius curtipes* ♂ posterior region (dorsal) & 15th leg
(From Matic, 1966, as *Monotarsobius baloghi* Loksa)

Matic (1966) in his account of the anamorph centipedes of Romania (1966) described and illustrated *L. curtipes* under the name *L.* (*Monotarsobius*) *baloghi* Loksa, 1947 and *L. ferganensis* under the name *L.* (*Monotarsobius*) *curtipes* C.Koch 1847 (see Dányi, 2006; Eason, 1972, 1997). It also seems likely that the drawing of the ♂ ultimate leg in *Pareczniki Polski* (Kaczmarek, 1979: Fig. 35) was based on that of Matic and shows the features of *L. ferganensis*. However, the description of *L. curtipes* in that key (p 55) is correct (M. Leśniewski *pers.comm.*). Zalesskaja (1978) treats *L. baloghi* as a synonym of *L. curtipes*.

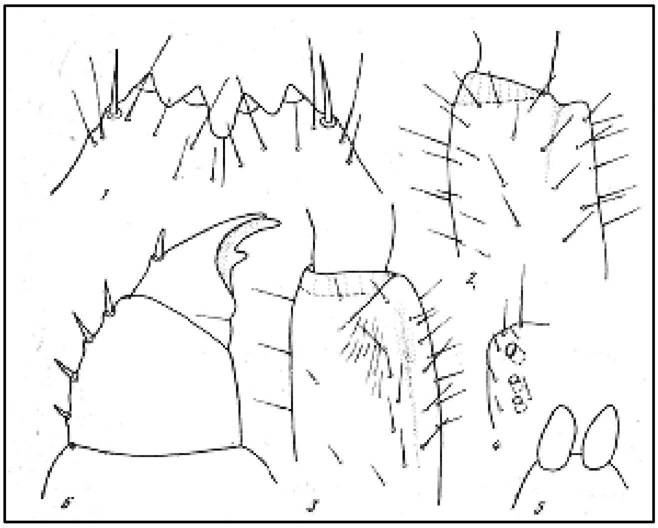
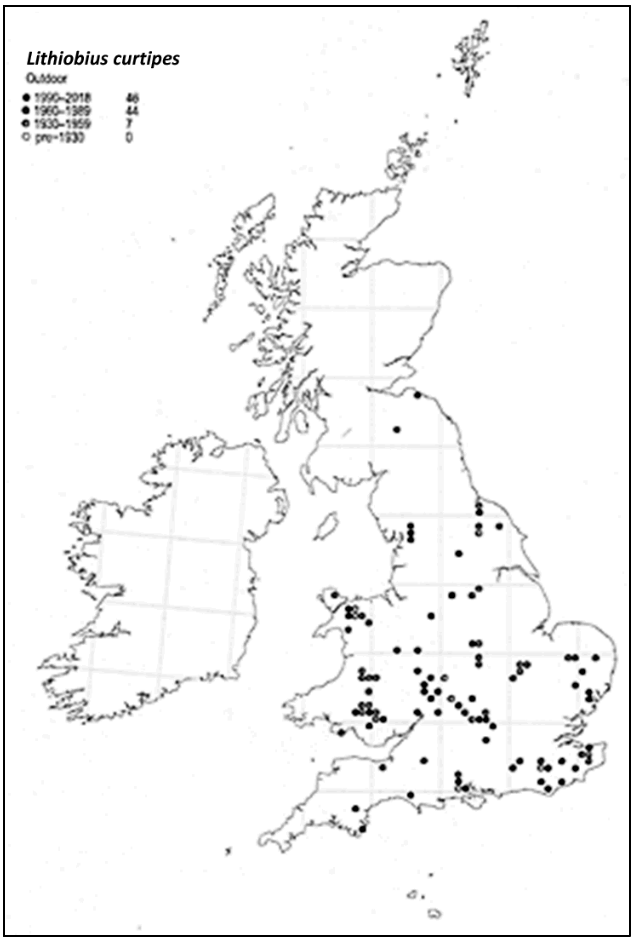


Figure 3: *Lithobius curtipes* (after Zalesskaja, 1978)

1. Forcipular coxosternite teeth
2. Femur of 15th leg ♂, distal end (ventral)
3. Femur of 15th leg ♂, distal end (dorsal)
4. Coxal pores, 15th leg
5. Gonopod spurs ♀
6. Gonopod claw ♀

Status in Britain

The first published report of *Lithobius curtipes* in the British Isles was by Brade-Birks (1934): "This species has been collected in Cambridgeshire by Dr F. Barton Worthington, but this is the first published record of the fact". No further details seem to be available. It was later reported from Coughton Park, Warwickshire by E.H. Eason (1951). There are scattered subsequent records, often from woodland, right across England and Wales but only a few records from Dorset, Somerset and South Devon, and none, so far, from Cornwall. To the north, it is recorded from south Westmorland (2 locations) and NE Yorkshire. From Scotland there are single records from Woodhall Dene (VC 82) and Wester Kershope (VC 79) only. No records have so far been obtained for Ireland, the Isle of Man or the Channel Islands (Map 1).



Map 1: Hectad (10km grid square) map for *L. curtipes*, pre 2019.
(From BMIG Centipede Recording Scheme)

During the 1950s there were two studies of centipedes in the New Forest by research students at Southampton University. H. Roberts (1956) looked at lithobiomorphs in Burley Wood, an area of mixed beech woodland. Although *Lithobius variegatus* Leach reached a peak density in summer of $10m^{-2}$ and over the period of a year he collected 238 identifiable individuals of *Lithobius microps* (known at the time as *L. duboscqui*), there were only four records of L. curtipes and a single isolated individual later. S. Vaitilingham (1960) worked at the Denny-Matley Nature Reserve and also at Chilworth Woods, Southampton Common and the University Grounds. As far as *L. curtipes* was concerned, he found it in five habitats (Table 1). For comparison, his results for his *Geophilus carpophagus* (*G.carpophagus* s.l. in the modern sense, most likely *G.easoni* Arthur *et al.* in this case, almost certainly so at Denny and Chilworth) are included in the table.

Table 1: Occurrence of *Lithobius curtipes* and "*Geophilus carpophagus*" in Denny Reserve and other sites (after Vaitilingham, 1960)
Sycam = Sycamore, Pine Plant'n = Pine plantation, CW = Chilworth Woods (Mature Birch).
Soton Comm = Southampton Common, Univ Gr'ds = University Grounds
Key: + = Litter, - = Soil, o = Cryptozoic

Species	Heath	Oak	Beech	Sycam	Ash	Birch	Conifer	Pine Plant'n	CW	Soton Comm	Univ. Gr'nds
L. curtipes		+	+	- o	o +		+				
"G.carpophagus"	- o +	- o +	- o +	- o +	- o +	- o +	o +	- o +	- o +	- o +	- o +

Vaitilingham also showed frequency indices for the centipede species he found, calculated as:

$$\frac{\text{Number of samples where species is present}}{\text{Total number of samples}} \times 100\%$$

An extract from this is shown in Table 2:

Table 2: Frequency indices for 6 species of centipedes in Denny Reserve & Chilworth Woods
(after Vaitilingham, 1960)

Species	Heath	Oak	Beech	Sycam	Ash	Birch	Conifer	Pine Plant'n
L. curtipes	0	21	17	98	66	5	22	0
L. borealis	0	0	18	8	7	42	28	5
L. microps	0	0	0	6	0	0	0	52
L. variegatus	13	100	100	100	80	84	100	79
L. forficatus	35	58	55	50	46	73	83	68
"G.carpophagus"	35	100	100	100	80	79	83	100

Table 3: Occurrence *of L. curtipes* in Whitley Wood samples, March 2002 to May 2014.
(from Soil Biodiversity Group data)

Dates	Mar. 2002	July 2004	Sept. 2004	July 2005	Aug. 2005	July 2008	May 2014
No. specimens	Start Date	1	1	1	1	1	End Date

Figure 4: *Lithobius curtipes* C.L. Koch, Britain.
Photo © Paul Richards

A much more recent New Forest study was that by the Soil Biodiversity Group (SBG) at the (London) Natural History Museum (Angela Lidgett, *pers. comm.*). At Whitley Wood, 1m^2 litter samples were taken every 7m along a 98m transect (15 samples) and sieved before being subjected to a three-day Winkler bag extraction at the museum. Over a period from March 2002 to May 2014 (126 monthly samples) only five specimens of *L. curtipes* were found.

Over the same period, excluding undetermined lithobiomorphs (including damaged & juveniles), some 320 specimens of *Lithobius variegatus*, 230 *L. muticus* C.L.Koch, 117 *L. microps* along with various numbers of *L. borealis* Meinert (6), *L. crassipes* (28), *L. maci-lentus* L.Koch (5), *L. melanops* Newport (1) and *Lamyctes emarginatus* Newport (2) were recorded. The only apparent pattern of occurrence for *L. curtipes* seems to be that all specimens were all found over the months of July to September.

A further study, using litter sampling, soil pits and pitfall trapping in another New Forest habitat Ocknell Inclosure, in 2010/2011 yielded two further examples of *L. curtipes*.

The same group also surveyed of a variety of woodland types in Berks, Bucks, Cambs, Devon, Essex, Lancs and East Sussex variously designated under the National Vegetation Classification (Hall *et al.*, 2004); 10 of these were classified as wet woodland (Types W1 – W7) and 12 as dry (Types W8 – W17). A similar procedure to that at Whitley Wood was used with the woodlands being surveyed at around five yearly intervals between the years 2003 and 2016. In only one of these further woodlands was *L. curtipes* recorded and that in both survey years, 2005 and 2010. This was at Abbots Wood, East Sussex, a designated W10 (*Quercus robur* - *Pteridium aquilinum* - *Rubus fruiticosus*) woodland type with a total of 22 *L. curtipes* identified out of 85 centipede specimens collected in 2005 and 5 out of 58 in 2010. Also recorded there were *L. variegatus* and *L. muticu*s. None of the other 8 NVC Type W10 sites yielded *L. curtipes* although there were various combinations and numbers of the two larger *Lithobius* (*L. variegatus, L. forficatus* (Linn,)) and the "smaller" *L. muticus, L. borealis, L. crassipes* and *L. microps*.

The results of the British Myriapod Group / British Myriapod & Isopod Group Centipede Recording Scheme, which included historical as well as recent records, showed that, up to the end of 2018, *L. curtipes* had been found in 97 10km grid squares (hectads) in a total in 45 of the 111 vice-counties of Mainland Britain. The regional distribution of these hectads is shown in table 4 and the overall distribution pattern in Map 1. There are no records from Northern Scotland, the Isle of Man, Channel Islands or Ireland.

Lithobius curtipes is very distinctly a rural animal - of the 129 records with appropriate data, nearly 95% (weighted) are reported as from rural sites with the remainder (two records) from suburban/village ones and none at all from sites described as urban, a rural:other sites ratio higher than that for any other British centipede. 88.8% (weighted) of the 89 records with appropriate data were recorded as being more than 1km from the sea, the remainder less than 1km with no splash zone / seashore ones. It was recorded in all months of the year.

Table 4: Regional occurrence of hectads from which *L. curtipes* has been recorded (weighted percent). (Taken from the Centipede Recording Scheme data).

Key: SE = South-east England, SW = South-west England, East = Eastern England, W&N Midl's = West & North Midlands, Yk, La, Wm = Yorkshire, Lancashire &, Westmorland, NE & SS = Northern England & Southern Scotland, NS = Northern Scotland

Region	**SE**	**SW**	**Wales**	**East**	**W&N Midl'ds**	**Yk, La, Wm**	**NE & SS**	**NS**	**IOM**	**Ireland**	**CI**
Weighted percent	16.1	7.3	25.9	14.6	14.8	2.1	2.9	0	0	0	0

With less than 200 records from less than 100 hectads over a period of eighty years since Eason's 1951 report, the data suggests that it is not a common animal in Britain and Lee (2015) gives its GB Rarity Status as "Nationally Scarce". As can be seen from the from the SBG data, however, it could, in fact, be most likely present in a site over a period of years without necessarily being found in a survey at any particular time. It seems difficult to predict its occurrence and specimens may turn up, apparently at random in surveys. On the other hand, as for instance in Vaitilingham's work and in the SBG collection from Abbots Wood (above) relatively large numbers might be found in a particular site at the time of a survey.

Lithobius curtipes in Britain seems to be found in a variety of rural habitats, both lowland and upland, and recent studies by Richard Gallon (Barber & Gallon, 2020) reveal it as being characteristically present in upland sites in scree and felsenmeer in Snowdonia between 700 m and more than 1,000 m (1,024 m, Carnedd Dafydd). The following table indicates the actual numbers or records at different altitude ranges collected by the recording scheme. Because of the relatively small number of records for the species and the small numbers of overall centipede records for higher altitudes, weighting the data is of limited value and could be misleading so such data is not presented and similarly for the principal habitats data where there are very limited records from certain types of habitat.

Table 5. Records for *Lithobius curtipes* for different altitude ranges.
(Taken from the Centipede Recording Scheme data).

Altitude range (m)	0-49	50-99	100-149	150-199	200-249	250-299	300-349	350-399	400-499	500-599	600-699	Over 699
Records (Actual)	19	15	13	225	12	2	1	2	3	1	2	9

Table 6. Records for *Lithobius curtipes* for different types of habitat.
(Taken from the Centipede Recording Scheme data).
Key: Decid WL = deciduous woodland, Conifer WL = coniferous woodland, Mixed WL = mixed woodland, Woodl NS = woodland (not specified/other).

Habitat	**Wet land**	**Heath / Moor**	**Grass-land**	**Decid WL**	**Conifer WL**	**Mixed WL**	**Woodl NS**	**Rock**	**Exca-vation**	**Waste**	**Various**
Records (Actual)	4	7	1	31	2	9	6	10	3	1	1

It will be noted that woodland of various types has been the habitat with most records (48) but woodland is a habitat that is probably the one most frequently sampled by recorders.

Distribution in Europe and elsewhere

Latzel (1880) refers to 125 adults with other stages all collected in Bohemia, Moravia and Silesia. According to Porath, he says, the animal, which inhabits the highest points and the gorges of the Sudeten and Reisengebirge Mountains, is common in Sweden, while it had not yet been found in the Alpine region. He also notes that L. Koch had said that it especially loved moorland/peat soil and was often found in quite wet sphagnum. Porath (von Porat, 1889) described *L. curtipes* as among the most common species in central Sweden; otherwise found in the Scandinavian peninsula as far north as the Varangerfjord, as far west as Kristiana (Oslo), and as far south as northern Skane. He also lists Belgium, Bavaria, Silesia and Austria. However, Würmli (1972a) in his account of Middle European and South Italian cryptozoic macro-arthropods does not refer to *L. curtipes* at all.

Zapparoli (2009) shows a distribution map by country of its European occurrence from France to South European Russia although this does not include its currently known occurrence in North European Russia, Latvia, Lithuania, Austria or Slovenia. Chilobase (Bonato *et al.*, 2016) currently lists *L. curtipes* from within Europe as from Austria; Belgium; Czech Republic; Denmark; France; Germany; Great Britain; Hungary; Lithuania; Netherlands; Norway; Poland; Romania; Slovakia; Sweden; Switzerland and Ukraine. It is also reported from Slovenia (Kos, 2001), Latvia and Belarus (Maksimova, 2014; Tuf *et al.*, 2015), Estonia (Sammet *et al.*, 2018), Finland, Moldova, Bulgaria, Luxembourg, Georgia, Armenia, Azerbaijan, European Russia as far east as the Caucasus, the Russian Caucasian Republics and the Urals, western and eastern Siberia, the Near East (Egypt, Israel, Jordan, Lebanon, Syria, Turkey) and the Arabian Peninsula (Nefedief *et al.*, 2016) and Kazakhstan (Bragina *et al*, 2020). There are no records of it from Ireland or Iceland and I have been unable to locate any relevant papers referring to the Kalinigrad Oblast (Russia) but it would be reasonable to assume that *L. curtipes* would be found there in suitable locations as it is in the adjacent states of Poland and Lithuania. The furthermost east records seem to be from Mongolia (Doboruka, 1960; Loksa, 1978; Poloczek *et al.,* 2016).

Lithobius curtipes has been variously referred to as mainly a central and East European species (Sammet *et al.,* 2018), a Trans-Palaearctic polyzonal species (Bragina *et al.*, 2020), Centralasiatic-European (Zapparoli, 1999, Stoev, 2002) and a polyzonal eurytopic (Zenkova, (2016).

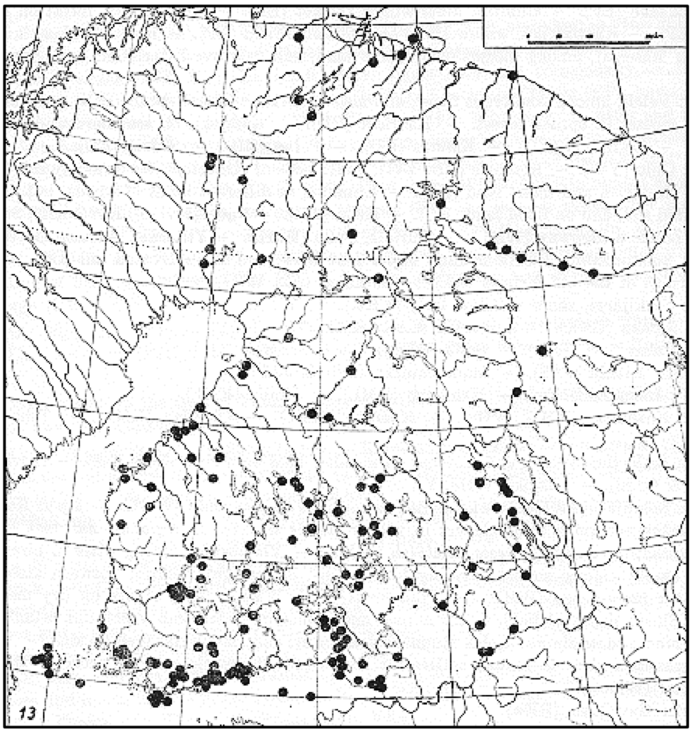
Northern Europe

Lithobius curtipes appears to be relatively limited in its occurrence in NW Europe. In France, it has been recorded from only seven départements, mostly in the northern half of the country and, of these, only three are post-1980 records. It is described from there as a species "sténoèce très hygrophile" (Iorio, 2014). In Belgium, where it occurs in humid to very humid woodland and peat swamps, it is noted as a fairly rare species although the map shows records from most provinces (Lock, 2000) but it was not recorded from the forests of Flanders (Lock *et.al.*, 2001) or the inland dunes of East Flanders (Lock & Dekoninck, 2001). In the Netherlands, according to the distribution map, most records seem to be from mid and eastern areas and it is recorded from 7 out of 12

Map 2: Distribution of *L. curtipes* in Europe by country (Britain and France only are shown with a regional pattern)

provinces (Berg *et al*, 2008). For the Grand Duchy of Luxembourg, Remy & Hoffmann (1959) had described *L. curtipes* as "parait être rare", only knowing it from two localities and Spelda (2001) did not record it from the mountainous, sandy woodland Muellertal region. In Denmark it has been recorded from six out of eight provinces but, seemingly, from only two of these post-1949 (Andersson *et al.*, 2008). On the map of Andersson *et al.* (2005) it is shown as on the western part of the Danish mainland plus one outlier, much as in the more detailed map of Enghoff (1983) where that author's map also shows *Lithobius borealis* Meinert as present in the east by contrast. In the northern part of Sweden (Norrland) it is described as the most common *Lithobius* in all provinces, a woodland and inland species and significantly more common in localities with no human influence (Andersson, 1985).

In his classic study of the centipedes of Eastern Fennoscandia, Palmen (1949) had more than 130 mapped records of *L. curtipes* from right across Finland and adjacent areas of Russia including the Kola Peninsula (Map 3). He remarked that, among northern chilopods, *L. curtipes* was least restricted in its choice of habitats. It was very abundant in the luxuriant groves occurring occasionally in southern Finland but also seemed to be rather abundant in the subalpine and alpine regions of the fjelds in the northernmost parts of Eastern Fennoscandia and clearly it could survive a great climatic range. It was a very characteristic species of almost all woodland types and, although pine heaths had only scattered populations, on moist land and in groves it was an almost regular inhabitant. It also occurred on various types of bogs, especially on wet pine peat-moors. It occurred in the moss and lichen cover of rocks where they were surrounded by forest vegetation, in decaying wood, at shore localities where there is a well-developed layer of drift or wrack, and when overlying loose stones cover the soil surface. It seemed not to be favoured by cultivation or to occur in greenhouses.



Map 3: Palmen's records of *L. curtipes* in Eastern Fennoscandia, 1948 (Finland & NW Russia)
(from Palmen, 1949)

Zalesskaja (1978) in her account of the Lithobiomorpha of the, then, USSR had written about *L. curtipes* (as *Monotarsobius curtipes*) and listed a number of localities although, she did not include a distribution map. Zalesskaja & Golovatch (1996) note the species as Palearctic and occurring from the tundra to the mountainous lands south of the Russian Plain.

Germany

Schubart (1964) listed the species as an eastern one that penetrated to France as far as the Seine and in North Germany, but from Hanover and Schleswig-Holstein not reported. He described it as missing in Mid and South Germany with the exception of a relict occurrence at Badener Höhe. The first published records from NW Germany appear to be those of Jeekel (1964) where he records it from two locations in 1932 & 1935.

Verhoeff (1925, cited by Vossel & Aßmann, 1995) had said that the main occurrence was moist or even boggy forests and these authors, noting Jeekel's reference to its hygrophilia, commented that perhaps in the NW German lowlands it was a typical species of oak-hornbeam forests whilst in the German

Mittelgebirge (mid-range mountains/upland) it is a widespread and common species of different types of forest. In this 1995 study they looked at areas of wood pasture and planted oak-hornbeam forest in SW Lower Saxony, recording it from the former and describing it as a relic species of ancient woodlands in the lowlands of NW Germany.

Albert (1976) investigating at a 150 year-old woodrush/beech woodland at Solling (NW of Gőttingen) calculated the mean annual abundance of *L. curtipes* there as 32 individuals m^{-2} and noted a generally inverse relationship between biomass of this species and that of spiders. Other German locations for the species include forest nature reserves, sampled by a combination of pitfall traps and litter samples, in Hessen (Central Germany) where 11 species of *Lithobius* were recorded (Spelda, 1999a), Oberreichenbach, Landkreis Calw, Baden-Wurttemberg, (Spelda, 1993) and the Brocken area (Voigtländer, 1999). In the latter, the author comments that *L. curtipes* prefers deciduous and coniferous forests, but is also found in open sandy and meadow areas, as well as in bogs and that, according to laboratory experiments (Rossolino & Rybakov, 1997), *L. curtipes* is a hygro- and thermophilic species.

Jabin *et al.* (2004) investigating the influence of dead wood in a managed oak-beech forest in Rhineland-Palatinate, reported the dominant centipedes as *L. crassipes*, *L. curtipes* and *Lithobius mutabilis* (L. Koch) with geophilomorphs being represented only by *Strigamia acuminata*. Reip & Voigtländer (1996), in their list for Thuringia, listed *L. curtipes* from Thüringer Becken and Thüringer Wald, describing it as having a central Asiatic-European distribution. A study of myriapods in twelve sites in the vicinity of Lebus near Frankfurt/Oder where there was remnants of flood-plain forest (Voigtländer, 2010) showed *L. curtipes* to be present in only two of these. Voigtländer & Lindner (2017) in a nature park in Lower Saxony, from 13 habitat types found *L. curtipes* only in deciduous woodland and alder swamp forest.

Voigtländer (1996) commented that *Lithobius curtipes ist in Deutschland weit verbreited und nicht selte* (is widespread and not uncommon in Germany). There are, however a number of reports of collections been made in different parts of Germany where the species was not reported. These include a study in the Bausenbergs and Östlichen Eifel (Becker 1982), a survey of river bank and stream islands in the northern Upper-Rhine using pitfall traps and stem eclectors (Decker & Marx, 2017), investigation of ecological differences of SW German lithobiids (Spelda, 1999b) and a combination of pitfall trapping, hand-sorted quadrat samples and ground-photoelectors in beech forest (Stadtwald Ettingen) during 1977 to 1985 (Fründ, 1991). Karin Voigtländer, herself, has published reports on studies, often from Eastern Germany, where *L. curtipes* was apparently not found including effects of pollution on a spruce forest at Dubringer Moor NR (Voigtländer, 1995), dry grassland near Halle (Voigtländer, 1996), North Hesse basalt area (Voigtländer, 1998) and the Leutratal NR near Jena (Voigtländer & Dunger, 1998). In all of these various other species of *Lithobius* were found. Unsurprisingly, given its apparent avoidance of synanthropic sites, *L. curtipes* does not feature in a study of primary colonisation of reclaimed land by Dunger & Voigtländer (1990)

Poland

Jadwiga Kaczmarek in her monograph on Polish centipedes (Kaczmarek, 1979), describes *L. curtipes curtipes* as an East European subspecies, known from all over Poland, living in various types of forests, staying in litter and under stones. In a companion volume (Kaczmarek, 1980), of the 25 divisions and sub-subdivisions of the country as mapped, she has definite records of the species from 16.

There have been a number of studies of various habitats in Poland including various types of woodland (including riparian forests), urban greens and forest steppe. A comparison of of linden-oak-hornbeam with thermophilous oak forests in the Mazovian Lowland (Wytwer, 1990) found *L. curtipes* in two sites in one of the five former but not at all in the oak-woods. The same author (Wytwer, 1992), looking at approximately hundred year-old stands in natural sites of fresh pine in three forest complexes in different regions found only four centipede species in all regions, *Lithobius lapidicola*, *L. forficatus*, *L. erythrocephalus* and *L. curtipes* with the latter being found in all stands examined and occurring abundantly in all study sites. *L. curtipes*, when sampled by sieving or soil sampling gave much higher values of dominance structure percentage than from pitfall-trapping whereas *L. mutabilis*, in the two areas where it occurred, showed very much the reverse. Comparing forests in Mazovia and urban greens in Warsaw, by the same author (Wytwer, 1995), dominance structure charts show *L. curtipes* as 14.1% in edaphic communities, the second most abundant centipede, in linden-oak hornbeam forests (*L. mutabilis* was 70.3%), in pine forest 12.2% but not in oak forest. In Puszcza Białowieska in Eastern Poland (Wytwer, 2000) a study of centipede communities in forest habitats (fresh pine, pine-spruce, mixed, lime-oak-hornbeam, ash-alder floodplain, bog alder), the edaphic component of each community was dominated by *L. curtipes* with *L. mutabilis* dominant in the epigeic except in bog alder where *L. curtipes* had that role.

In qualitative and quantitative studies in the Roztocza Upland, Kaczmarek & Leśniewska (1998), found *L. curtipes* to be the second most frequent centipede species, being found in almost all habitats but in a beech forest in the (Carpathian) Magura National Park (Leséniewska & Taborska, 2003), *L. curtipes* appears to be absent. However, this particular paper also tabulates differences between centipede species occurrence in beech woodlands between Wielkopolska, Pieniny, Roztocze and Beskid Niski with total species numbers of 19, 17, 13 and 24 respectively with *L. curtipes* only present in Wielkopolska and Rostocza.

A comparison of four alder stands in wetlands of three national parks in NE Poland, only four species of centipede in total were found and only one, *Lithobius curtipes*, was present in all four, at a density of 3.2 to 28.8 m^{-2}. (Tajovský & Wytwer, 2009). Comparing this with data obtained on the same type of swampy alder habitat in Slovakia by Guliča (1960, cited by the authors), only one species was common to both (*L. mutabilis*) and *L. curtipes* was replaced there by *Lithobius aeruginosus* L. Koch.

In the Ojców National Park (predominantly beech) *L. curtipes* was recorded from a single specimen in hornbeam forest out of six woodland types (Leśniewska *et al.*, 2011). In 15 sites in the Bielinek reserve on a calcium rich escarpment on the Odra River (Leśniewska & Leśniewski, (2016), 7 species of *Lithobius* were recorded but no *L. curtipes* whereas in a beech forest, in the Buckzyna reserve in Western Poland following wind-damage (Leśniewska & Skwierczyriski, 2018), *L. curtipes* was one of the most frequently found centipedes and (with *L. forficatus*) was found in all the sampled sites.

The Baltic Republics

In the Baltic Republics (Lithuania, Latvia and Estonia), *L. curtipes* is widespread. As noted earlier, material in the Natural History Museum contains four specimens from Lithuania (Eason, 1972). Trauberg (1929) recorded it from Latvia, reporting it as often being found unter verwesenden Blättern, Gras, verwesenden Bäumen, z.B. an den Ufern des Flusses (under decomposing leaves, grass and decomposing trees, for example on river-banks).

Tuf *et al.* (2015) in their checklist for Lithuania list 8 sites for *L. curtipes*, some associated with the Curonian Spit, others inland with habitats including old-growth mixed forest, replanted pine plantation, bog, wet forest and hornbeam forest. Sammet *et al.* (2018) map *L. curtipes* as occurring in all areas of Estonia and comment that it is one of the two most common centipede species in different habitats, favouring more fresh habitats than *L. forficatus*.

Belarus

Lithobius curtipes was recorded from Belarus by Zalesskaja (1978) and is listed by Maksimova (2014) who describes it as the most common and numerous species, abundant on the forest floor, in stumps and under the bark of trees. Detected in pines and spruce, birch and black alder.

Austria

Würmli (1972b, cited in Szucsich *et al.*, 2011) had recorded *L. curtipes* at the exit of the Zillertal at Straß-Schlittens, a record that seems to date from Attems' (1949) *Myriopoden der Ostalpen* but, as already indicated, not referred to in Würmli's (1972a) paper on the cryptozoic fauna of Central Europe and South Italy. Neither is it included in Moser's (1999) account of the Innsbruck area, by Koren (1992) in his account of the chilopod fauna of Carinthia and East Tyrol, by Voigtländer *et al.* (1994) from Western Styria or in Zapparolli's (2009) Fauna Europaea. However, Zulka (1991, 1992) studied its biology and life cycle in floodplains of the River Morava near Vienna.

Hungary

Szalay (1940) did not record *L. curtipes* amongst the 11 lithobiids that he listed from the Kőszegi mountains. Loksa (1955a), as previously noted, had described *L. curtipes* under the name *Monotarsobius Baloghi*, remarking of it "Interessant ist sein Vorkommen in Bátorliget, wo er wahrscheinlich den Charakter eines Reliktes hat" (Interesting is its occurrence in Bátorliget, where it probably has the character of a relic). He did not include it in his account of the centipedes and millipedes of the environs of Lake Velence (Loksa, 1955b).

Dányi & Korsós (2002), reporting what they described as only the third Hungarian record of *L. curtipes*, noted that at Szigetköz (NW Hungary) it occurred in 6 sites, in both hard and softwoods, sometimes as a dominant species. It is reported from two Hungarian National Parks, Fertő-Hanság and Aggtelek (Korsos & Dányi, 2002; Novak & Dányi, 2010). In the first of these it was found in small numbers in every locality but in the second from only one site. However, in a survey of the Hungarian "lower mountains" (c400-1,000m asl), Dányi (2006) did not find *L. curtipes* which, he says, occurs more frequently in the plains although, he comments, there is no support in the literature that it avoids mountainous regions anywhere else.

Czech Republic

Already referred to are specimens from what is now the Czech Republic (Eason, 1972) in the Natural History Museum and the report of it from Bohemia and Moravia by Latzel (1880). Referring to the latter, Folkmanova (1928), who had included *L. curtipes* in his monograph, commented that "although this species was found abundantly by Latzel in Bohemia and Moravia, I myself have never found it".

Using pitfall traps, heat extraction, sieving and hand collecting Pavelcová, (2008) in nine types of Carpathian localities recorded a total of 31 species (48% of the Czech centipede fauna) but recorded *L. curtipes* (described as eurytopic) in only two of these. Pižl *et al.* (2013/2014), using pitfall traps, recorded it (amongst 24 centipede species) from one location in ravines in the Bohemian Switzerland National Park (České Svýcarsko).

Tajovský (1998), using a combination of hand-sorting, soil-sampling and pitfall trapping in the Labské Piskovce PLA in north Bohemia, in a variety of habitat types, recorded 23 species of centipede (1,104 individuals) but no *L. curtipes* and Božanič *et al.* (2013) sampling bryophytes in the Litovlvelské Luhy NNR recorded 5 species of *Lithobius* but not *L. curtipes*.

Tuf & Tufová (2008) in their proposed ecological classification for habitat quality evaluation in the Czech Republic, classify *L. curtipes* as E (eurytopic species), species with widest ecological valence.

Slovakia

There have been several records of *L. curtipes* from Slovakia but, correspondingly, it is not reported in various surveys.

Using a combination of sifting and pitfall traps, Országh & Orszaghova (1995) monitored the impact of the hydroelectric structures Gabcivikovo on centipedes. Of 28 species, they observed a decline in some but an increase in the dominance of eurytopic ones such as *L. forficatus* and *L. mutabilis* and the appearance of some not previously found. They found that the community of species of the Danubian floodplain forest represented by *L. curtipes*, *L. crassipes*, *L. aeruginosus* and *Pachymerium ferrugineum* (C.L. Koch) remained preserved and in a study of centipede and millipede communities of hedgerows of upland agricultural landscape in the Carpathians, Stašiov *et al.* (2017) recorded *L. curtipes* from two locations only (total 3 specimens) compared with *L. mutabilis* in all 20 sites.

Several studies of oak-hornbeam forest in Slovakia (Holecová *et al.*, 2005; Holecova *et al.,* 2012; Országh & Országhová, 2005) or in the Boky National Nature Reserve, also oak-hornbeam (Stašiov *et al.,* 2012) did not record *L. curtipes* and it was also not recorded in sub-mountain beech by Stašiov & Svitok (2014). This is despite the fact that Országh & Országhová (2005) had recorded 17 other species of *Lithobius* in the Malé Karpaty Mts and Trnavská Pahorkatina Hills and Stašiov & Svitok (2014) 13 in the Kremnickévrchy Mts.

Romania

There has been some lack of clarity about the status of *L. curtipes* in Romania. Matic (1966) described *L. curtipes* as a montane species, usually found at heights between 1,500-2,000m but Negrea (2006) commented that in Romania it was very rare (only in the reported sites and only a single male). As Dányi (2008) points out, *Lithobius* (*Monotarsobius*) *baloghi* Loksa, 1947, from a few locations, as included in Matic's account and mapped from five locations there, is a junior synonym of *L. curtipes* whilst Matic's drawings of *L. curtipes* (his Fig.86) show clearly the characters *of Lithobius ferganenis*.

Bulgaria

Kaczmarek (1975), in her account of lithobiid centipedes of Bulgaria, did not include *L. curtipes* amongst the species of *Monotarsobius* she referred to although *L. aeruginosus* and *L. crassipes* are both there. However, in Stoev's (1997) checklist of the centipedes of the Balkan peninsula, the only country of that region of Europe for which *L. curtipes* is listed is Bulgaria and in his account of Bulgarian species (Stoev, 2002), it is described as occurring at 400-700m in the East Stara Planina and the Sredna Gora Mountains. It is not recorded in the survey of the Rila or Central Balkan National Parks (Deltshev *et al.*, 1999a; b) nor that of the Myriapoda of Shumen City and Shumen Plateau (Bachvarova, 2011).

Slovenia

Kos (1988) did not include *L. curtipes* in his account of the Lithobiomorpha of Slovenia nor was it listed in his review of the centipedes of the then Yugoslavia (Kos,1992) as being present in Slovenia, Croatia, Bosnia-Herzegovina, Montenegro, Serbia or Macedonia.

According to Kos (2001), in Slovenia the species has been preserved in relict populations and is known from three locations. It is not listed in a study of centipede diversity in different developmental phases of a beech forest near Ljubljana (Grgič & Kos, 2003).

Europe: far north

The occurrence of *L. curtipes* in the far north of Europe is notable, being found right up to the northern coastline of Norway (Finnmark) beyond the Arctic Circle (66° 34' N) with a record from Berlevåg at 70° 52' N (Andersson *et al.*, 2005, Bergersen *et al.,* 2006. Interestingly, its occurrence in that country, apart from Oslo and a few other records, is restricted to the northern part of Finnmark whereas it is common in both Sweden and Finland. The only other European centipedes extending regularly this far north are *Geophilus proximus* C.L. Koch and *Pachymerium ferrugineum*. These same three species extend across the Kola Peninsula and around the White Sea Area (Palmen, 1949, A. Przhiboro *pers. comm*., I. Zenkova, *pers. comm*.). Zenkova (2016) described *L. curtipes* as a "polyzonal eurytopic" species on the Kola Peninsula; by comparison she cites but a single record of *L. forficatus* from taiga on the continental part of that area.

Korobushkin *et al.* (2016), citing Zalesskaja (1978), describe *L. curtipes* as the most common and abundant centipede species in the European part of Russia. According to Zenkova (2016) records from Vaygach (Вайга́ч) Island in the Arctic Ocean (69-70°N) and those from Finnmark are the northernmost records for centipedes. *L. curtipes* is the only species of myriapod found in arctic Finnish Lapland (69°45’N) where it inhabits birch forest-tundra 70km from the Arctic Ocean with an average annual temperature of +2.5°and the lowest recorded by local weather stations at -48°. It is widespread in natural and anthropogenic ecosystems on the Kola peninsula up to tundra ecosystems along the coast of the Barents Sea. On the Hibiny Mounts, in high mountain rocky desert with fragmentary moss and lichen cover at more than 1,000m asl the density is higher than in most lowland ecosystems. Here air temperatures above 0 °C are recorded on less than 40 days a year.

Zenkova & Petrashova (2008) studied the population structure and dynamics of *L. curtipes* in the Murmansk Oblast where it was dominant of the soil macrofauna; it completes several developmental stages within the short growing season and has a long development involving several overwinterings. Kolesnikova & Konakova (2021) from the Komi Republic (N European Russia) recorded *L. curtipes* as dominant in pine whilst Taskaeva *et al.* (2020) in mixed grass communities near hydrogen sulphide springs in the Adak Nature Reserve (Komi Republic) listed a single species of centipede, *L curtipes*, which they record from four out of five sampling sites.

The Urals

Including the Cis- and Trans-Urals, *L. curtipes* is the only centipede common in all mountain provinces of the Urals up to the Polar Ural and it also occurs in the arctic tundra (Farzalieva & Esyunin, 2008, 2010, Konakova *et al.*, 2017, Zenkova, 2016). Farzalieva & Esyunin (2010) report on population structure of lithobiomorphs, notably *L. curtipes*, in Trans-Ural forest steppe where the population in forests was an order of magnitude higher than in the steppe and, in these, in birch-aspen groves, a mosaic distribution was demonstrated.

A situation where mountain density of centipedes is higher than the plains has also been reported for the Northern Urals (Farzalieva & Esyunin, 2008). From the Kozhym river basin in the sub-polar Urals (Konakova *et al.*, 2017) only two lithobiids are listed with *L. curtipes* recorded from mountain forests, larch forest, stunted birch, mountain tundra and other biotopes (coastal, sub-tundra meadows) whereas *L. crassipes* is reported at much lower levels and only from the mountain forest and the “other biotope” categories. Habitats for *L. curtipes* include elfin woodland, low-bush tundra, birch with grass, spruce-pine forest, alpine meadow, mountain tundra, dark coniferous mountain taiga, etc. In the Southern Urals it is reported from oak-lime, pine, and birch forest, birch wood-meadow, oak, birch and birch-oak forests, rocky steppe, birch forest with poplar, chalky plateau, deserted village, etc. The centipede fauna of the Urals and Cis-Ural area comprised 11 species in 4 genera, the number of species being 5-7 in all zones from steppe to southern taiga. Only *L. curtipes* reached to the forest-tundra and tundra. This compared with more than 50 species in the Caucasus and 48 in the Russian Plain.

A study of soil macroinvertebrates along a contamination gradient in the Central Urals (Vorobeichik *et al.*, 2022) recorded *L. curtipes*, along with *Arctogeophilus macrocephalus* (Folkmanova & Dobroruka) and *Polyzonium germanicum* Brandt as the dominant myriapod species; numbers declined as the smelter (copper) was approached but with centipedes common even in the heavily contaminated area.

Southern European Russia

In Southern European Russia, in the region of Rostov-on-Don, a region with considerable anthropogenic transformations, there had been several previous records of centipedes before the more recent ones of Zuev & Evsyukov (2016) who reported *L. curtipes* from various habitats including steppe (under stones), river & lake banks and island, plantations, nature park, etc.

There are also records from the Caucasus such as the area of Stavropol which include a number of records from different habitats including various forests (including mountain forest), steppe, pasture, conifer plantations, floodplain forest, a botanical garden and bird & mammal nests (Zuev, 2016). In the Abrau Peninsula, *L. curtipes* is reported only twice by Korobushkin *et al.* (2016), whereas there are 27 records for *L. ferganensis*; *L. curtipes* is described as being found in the upper soil layer (0-10cm) and litter in the Caucasus.

Ukraine

There are records of the species from Ukraine with Kunah (2013) describing *L. curtipes* and *L. forficatus* as the most typical centipede species in the Steppe Upper Dnieper area; Zhukov *et al.* (2018a; b) recorded a relatively low density of 1.52 (± 0.54) m^{-2} in floodplain forest of the Dnipro River where *L. curtipes* and *L. aeruginosus* were found in litter and a beta density of 1.83 (±0.59) m^{-2} in deciduous woodland in the same river's arena terrace. However, it was not included in the list of 16 lithobiids in the paper by Kos'janenko & Chumak (2008) for primeval beech forests in the Carpathian Biosphere Reserve.

Asian Russia

In recent years there have been a number of publications dealing with aspects of the centipede fauna of various areas of Siberia and many of these (and probably others) include reference to aspects of *L curtipes* with shorter or longer lists of locations and habitats. What emerges is not only its wide distribution but the wide diversity of habitats that it has been recorded from.

The lowland Altais are a transition zone between the plains of SW Siberia and the mountainous region of Southern Siberia (Nefediev *et al.*, 2018) and *L curtipes* was recorded here from birch-aspen and bird cherry-birch from hand searching and soil extraction. An earlier paper had reported on the Lake Teletskoye area (434m asl) in the Altai State Biosphere Reserve (Nefediev, Farzalieva & Tuf, 2017) where it was found at a number of locations above 1,800m and in a diversity of habitats with a variety of tree types, pine (*Pinus sylvestris, P.sibirica*), larch (*Larix sibirica*), fir (*Abies sibirica*), birch, aspen and alder.

In the Omsk area, a part of the West Siberian Plain, bordering Khazakhstan with marshy taiga in the north, gradually replaced by forested or grassland in the south (Nefediev, Knyazev *et al.*, 2017), *L. curtipes* was found in aspen – birch - dark conifer forest, mixed herbaceous meadow, aspen-birch, flood meadow, edge of dark coniferous forest, pine (*Pinus sylvestris*) – birch, birch-grass and in birch stand. Sergeeva (2013) had previously looked at centipedes in the Irtysh River valley in this same area and reported *L. curtipes* from taiga, folious, meadow, meadow-field, xerophytic, grassy, overflowed meadows and river forests biotopes but not from river water meadows (from which no centipedes were recorded). In the Kemerovo area, also in SW Siberia (Nefediev, Farzalieva, Tuf & Efimov, 2020), a small sample of material yielded *L. curtipes* from mixed forest, lime (*Tilia sibirica*), birch-aspen forest, aspen and birch forests.

Nefediev & Farzalieva (2020) include an additional list of localities and habitats for *L. curtipes*, a map of its distribution and a list of references to other work. They list its known occurrence in Siberia as the Altai and Krasnoyarsk provinces, the Novosibirisk, Omsk, Tyumen and Tomsk and Kemorovo areas, the Khanty-Mansi and Yamalo-Nenets autonomous regions and the Republic of Altai. Reports of surveys where *L. curtipes* was not found include the Khakassia Republic, Central Siberia from a small sample taken there (Nefediev *et al.*, 2021)

Kazakhstan & Mongolia

Bragina *et al.* (2020) recorded *L. curtipes* from birch forest, in litter, in the Kostanay district in Kazakhstan and also referred to it from steppe landscapes and birch-aspen forest.

As noted, Mongolia seems to represent the furthermost eastern known records for *L. curtipes*. Doboruka (1960) reported *L. crassipes baloghi* from Ulan Bator (Ulaanbataar), whilst Loksa (1978) recorded it, as *L. baloghi*, from a location north of there at 1,700m and from another site at 1,600m. Poloczek *et al.* (2016) looked at three locations in the Khentey Mountain Range where the vegetation was mostly "light taiga" (mostly *Larix* dominated), with "dark taiga" of shade tolerant trees such as *Pinus sibirica* and *Picea obovata* at higher altitudes and southern slopes having steppe-like vegetation. At one of the sites, Khonin Nuga, at 900-1,600m with light, dark and mixed taiga and riverine forest and the greatest species diversity, they collected 19 specimens of *L. curtipes*, 6% of the total number of centipedes found there.

Turkey (Anatolia)

In his 1990 paper on distribution patterns and taxonomic problems of the centipede fauna of the Anatolian Peninsula, Zapparoli (1990) commented that *L. curtipes* showed a scattered distribution there but that the geographical data was still very incomplete. In a subsequent paper (Zapparoli, 1999) he referred to it in his table as being a Centralasiatic-European chorotype, and recorded it from 5 out of 9 natural regions in Anatolia.

The (sometimes) apparent rarity of *L. curtipes*

As noted, even in countries where *L. curtipes* appears to be widespread, it is not always collected in every apparently favourable habitat/location sampled. There are a number of possible reasons for this, including the fact that rarer species are less likely to turn up in samples than common and abundant ones and that, in any case, there is always a certain element of chance. Andersson (1983) remarked that, in a certain site, if there had been no change in species composition over the period 1970–81, then, using a combination of hand sorting and sieving, on average, 50% of the species in the locality were being found each time. In addition, anyone who has collected myriapods to any extent will be aware of the effect of seasonal changes and present and recent past local weather conditions.

Christian (1998) commented on possible aspects of apparent rarity in zoological and biospeleological records. Such aspects of apparent rareness could include local endemism, patchy distribution of habitat, regional stenotopy, a misleading search image ("suchbild"), inadequate sampling, polymorphism and misidentification, regional stenotopy (regional stenoecy) resulting from a species' ecological demands and the presence and extension of suitable habitats. A species which inhabits a variety of biotopes in one part of its area may find in another part, tolerable conditions solely in scattered special biotopes. The author observed that increasing stenotopy is typically observed beyond the border of the more or less evenly populated area and in exclaves.

There is always the possibility that, although there has been extensive collecting in an area, the sampling method used is not the best for the species concerned and/or the local conditions or of appropriate microsites or that the population was low such that the likelihood of it being found in small number of samples was correspondingly low. For example, Vaitilingham's (1960) study gave different results for *L. curtipes* depending on both the sampling technique and the litter type (Table 2) and looking through much of the habitat data listed gives an impression that although *L. curtipes* may be found in pitfall traps, it tends to be a litter animal, most likely to be collected by extraction, hand sorting or sieving. The situation described in Whitley Wood by the Soil Biodiversity Group (SBG) where 126 monthly samples yielded only 5 specimens of the species (Table 3) would suggest that there was clearly a population of the species, however small or dispersed, present throughout the year. Five specimens of *L. curtipes* in 126 months means that, apparently, the chance of finding it at all in any particular month in the area studied would be about 4%, and in any particular sample about 0.26%.

In practice, one of the most commonly used sampling method in the past for work on centipedes has been pitfall trapping. However, Iorio & Petillon (2020), referring to the work of both Gerlach *et al.* (2009) and Tuf (2015) comment that this is not the most reliable method for assessing centipede diversity and numbers of individuals. Gerlach *et al.* on the basis of experimental work with pitfall traps and using various epigeic arthropods (including one centipede species, *Lithobius mutabilis*), concluded that, as a method, it was inappropriate for quantitative investigations of arthropods living at a site.

Thiele (1956, quoted by Albert, 1978), using pitfall traps (Fallenfänge) and quadrat sampling in Burgholz (Wuppertaler Wälden) found examples of *Lithobius piceus* only in the traps, *Lithobius macilentus* L. Koch and *L. dentatus* C.Koch in both and *L. crassipes*, *L. curtipes*, *Lithobius microps* Meinert and *Lithobius tricuspis* Meinert only in the quadrat samples. In a subsequent paper, (Albert, 1982) she used extraction to collect seven species of *Lithobius* (including *L. curtipes*) plus *Lamyctes emarginatus* from Solling (NW of Göttingen) habitats, including both *L. curtipes* and *L. emarginatus* from meadow sites.

Pitfall trapping in selected ecotones in NW Poland by Tracz (2000) captured small numbers of centipedes with *L. curtipes* being found in those including rowan (15) and aspen (1) but not those with beech, broom or pine, a total of only 15 specimens compared with 47 for *L. mutabilis*. Much larger numbers of millipedes were collected e.g.1,159 for *Julus scandinavius* Latzel and 840 for *Ommatoiulus sabulosus* Linn.

In Tuf's (2000) study of centipedes in Litovelské Pomoravi (Czech Republic) he found no specimens of *L. curtipes* by pitfall trapping and a small number by soil sampling whilst *L. mutabilis* and *L. forficatus*, for example, were found by both methods. The same author (Tuf, 2015), using soil sampling, pitfall trapping, litter sifting and hand collecting in four localities in the same protected landscape area, assigned centipedes to five groups with *L. curtipes* being in the category "smaller soil lithobiomorphs", collected mostly by extraction and some in pitfall traps whilst *L. mutabilis* and *L. forficatus*, "larger abundant lithobiomorphs", were found by all techniques but more often in pitfall traps.

Fründ (1987) looked at the centipede community in a 140 year old beech forest near Würzburg and described *Lithobius lusitanus valesicus* Verhoeff as the most abundant species at the base of beech and oak trees but generally rare in litter whilst *L. crassipes* seemed to be confined to rotting logs (although known to inhabit a wide variety of habitats elsewhere). More than 95% of the centipedes in the litter belonged to the three species *Lithobius mutabilis* L. Koch, *L. curtipes* and *Strigamia acuminata* (Leach). Although *L. mutabilis* was mainly in the upper stratum of the litter and *L. curtipes* in the lower no spatial separation could be concluded as *L. mutabilis* was common in the litter too. Laboratory experiments showed all species having a preference for 100% humidity although a longer survival time in dry air for *L. mutabilis* than *L. curtipes* was recorded. *L. mutabilis*, which the author described as having a greater tendency to change resting places than *L. crassipes*, is also larger, 10-15mm as compared to 6.5-11mm as described by Brolemann (1930) for *L. curtipes*).

Habitats

As can be seen from the various accounts of collections from different areas of Europe and Asia, *L. curtipes* can be found in a wide diversity of habitats from arctic tundra and taiga to various types of coniferous and broad leaved woodland, mixed grass and trees, meadow and in montane situations up to 2,000m but no obvious preferences emerge other than the fact that it can be found in certain situations where few other centipedes survive, notably at high altitudes and in flood plains and associated with this is its tolerance of freezing over winter and its ability to survive immersion.

Floodplains & "wet" habitats

It is notable that there are a number of references in the literature to *L. curtipes* in floodplains and similar areas, including those in Middle Europe. These types of locations are subject to fast changes of flood and drought conditions (Marx *et al.*, 2012) and pose particular problems for survival of terrestrial arthropods. High levels of tolerance are shown by certain millipede species and by the overwintering eggs of *Lamyctes emarginatus***.**

In looking at the lithobiomorphs, isopods and millipedes in meadows and forests of the floodplain of the River Morava in Eastern Austria, Zulka (1991, 1992) noted that in non-flooded areas, the widespread *Lithobius forficatus* was found whereas in two flooded forests the species composition was completely different and the main species were *Lamyctes emarginatus* and *L. curtipes.* He studied the life-cycles and submersion tolerance of these two species, animals of similar size but with very different life history strategies, the former with a life cycle of several years and the latter an annual one.

In the floodplain of the Lower Oder Valley, Zerm (1997), using pitfall traps, 7 lithobiomorph species were collected but in the temporarily flooded locations *L. curtipes* was virtually the only lithobiid found and only in small numbers. However *L. fulvicornis* was caught in almost every study site although in higher numbers in the temporarily flooded ones. It seemed most likely that the latter survived the winter and inundation period in the egg stage.

Voigtländer (2005) notes that in Central Europe, *L. curtipes* shows a clear preference for wet and humid habitats with high vegetation cover whilst *L. emarginatus* is an inhabitant of humid to very wet habitats with low vegetation cover, later commenting (Voigtländer, 2011) on *L. curtipes*' occurrence in the litter layer of floodplain forests and its co-existence with *L. emarginatus*., the latter surviving unfavourable seasons in the egg stage. In a later publication, (Voigtländer, 2016) she notes that in recent years, an increasing number of surveys in floodplain forests have yielded a large number of new records of *L. curtipes*.

In the Litovelské Pomoravi Protected Landscape Area (Czech Republic) with floodplain forest, field, fallow, etc., Tuf and Ŏzanová (1998), using both pitfall trapping and litter extraction collected a number of specimens of *L. curtipes*, especially from litter with all but one from floodplain. Tuf (2000), used pitfall-trapping and soil sampling looked at centipede communities in three successional stages in floodplain forest in the same PLA. There was a larger number of species and greater abundance in older forest but a higher percentage of lithobiomorphs in the younger area but *L. curtipes* was only found in soil samples and only from the areas of 30 and 80 year-old trees. In a subsequent study, the same author (Tuf, 2003) looked at successional changes over four years following a disastrous summer flood lasting several weeks. He recorded *L. curtipes* by both pitfall trapping (epigeic part of the community) and soil sampling (endogeic) and concluded that the species was dominant in long-term flooded forest whereas in forest with regular brief flooding, *L. mutabilis* had that role. Tajovský (1999) had described *L. curtipes* and *L. emarginatus* as characteristically present in the fauna of the most flooded forests in a study of seven of these in the Dyje River alluvium.

Tufová & Tuf (2005, citing other authorities), note *L. curtipes* as dominant in a softwood floodplain in Litolvelské Pomoraví and in forests exposed to long lasting inundation near the confluence of the Rivers Morava and Dyje and typical of floodplain forests along the middle stretch of the Danube as well as of non-forested Central European floodplain areas. However, Grinvald (2011), using pitfall traps to study myriapods in different forest growths in a fragmented forest environment in the same PLA (87 y-o. oak/elm, 10 y.o. oak, 2 y.o. clear cut with seedlings, 127 y.o. oak/elm floodplain forests and the ecotones between them) failed to record the species although four other *Lithobius* species were recorded.

In Hungary, *L. curtipes*, (as *M. baloghi*), was described as the dominant species amongst the Chilopoda from Ócsa (Kiskunság National Park; swamp forest with ash and alder) (Sallai, 1993a, b). A previous study by the same author (Sallai, 1992) of Nagy-Szénás with grassland, mixed and hornbeam-oak woodland on dolomite near Budapest and using pitfall-trapping had failed to record *L. curtipes*, although finding five other species of *Lithobius*. Novák & Dányi (2010) reported *L. curtipes* from alder forest in the Aggtelek National Park. They note that Spelda (1999c) had found the species characteristically in wet habitats which is supported by their data.

In a comparative study of four alder stands in wetlands of three national parks in NE Poland, only four species of centipede in total were found and only one, *L. curtipes*, was present in all four, at a density of 3.2 to 28.8 m^{-2} (Tajovský & Wytwer, 2009). In the Bug River valley in the east of the same country, using pitfall trapping, Leśniewska *et al.* (2015) found that *L. curtipes* was one of the four most common and most numerous species. It was found in five out of seven habitat types with the highest number of specimens in riparian forest. This habitat was dominated (dominance value 87.8%) by *L. curtipes*, a species, according to the authors, that prefers wet and humid habitats with high vegetation.

This occurrence in flooded areas is not confined to Central Europe. In Estonia, Sammet *et al.* (2018) provide a graph showing relative abundances in different types of habitat. In this, carrs & swamp forests and bogs show the highest values followed by mesophilic boreal forests, broad-leaved (nemoral) forests, fens & waterlogged meadows and dry heathland forests. Lowest values are for coastal meadows & alvars (shallow alkaline soils) and arable fields. Ivask *et al.* (2019), reporting on centipedes and millipedes of semi-natural flooded meadows in Matsalu, mapped *L. curtipes* from the area furthest from the sea where floodplain meadow prevailed and not at all from the coastal/floodplain transitional area or locations closest to the sea.

Kolesnikova *et al.* (2016), referring to European NW Russia, comment that river floodplains are "oases of life" in the northern regions due to the warming effect of the river waters giving rise to highly productive meadows and deciduous forests with grassy groundcover. In their study of the Systola River valley in the middle taiga (Komi Republic, White Sea basin), they reported only two species of myriapod, *L. curtipes* and the millipede *Polyzonium germanicum* which have underwater survival times of 126.3 and 688.2 hours respectively (Tufova & Tuf, 2005). The authors comment on the paucity of species compared with alluvial soils in Central Europe.

Not all collections made from "wet" areas in Central Europe necessarily report the presence of *Lcurtipes*; one such is that by Decker & Marx (2017) as already referred to, from the floodplain of the Rhine near Ingelheim.

Humidity tolerance & survival under water

Vaitilingham (1960) in looking at humidity tolerances and immersion in water showed that after 72 hours only those specimens of *L. curtipes* at 100% RH all survived with none at all at 50 or 66% RH being still alive after this time. He obtained rather similar results for both *Lithobius crassipes* and *Brachyeophilus truncorum* (*Geophilus truncorum* (Bergsö & Meinert)) whereas "*Geophilus carpophagus*" (almost certainly *G.easoni* Arthur *et al.*) had much better survival rates. He commented that the RH of litter was 90-100% and that *L. curtipes*, *L. crassipes* and *G.truncorum* required a saturated atmosphere. Immersed in tap water at 19-21^{o}C, his geophilomorphs (*G.truncorum*, "*G.carpophagus*") showed much better survival rates than *Lithobius* species (*L. variegatus*, *L. forficatus*, *L. curtipes*, *L. duboscqui* Brolemann = *L. microps*) with the two latter, smaller, species performing better than the two larger ones (which, because of their size, could possibly move relatively quickly out of unfavourable situations). The mean survival time for *L. curtipes* obtained by Vaitilingham according to Tufova & Tuf (2005) was one day at c20°C.

According to Adis & Junk (2002, cited in Leśniewska *et al.*, 2015) *L. curtipes* was found alive after 34 days of inundation. Tufová & Tuf (2005) investigated survival of centipedes, millipedes and woodlice in a young floodplain forest in the Litolvelské Pomoraví PLA. In water at 10^o, 95% O_2, *L. curtipes* had the highest mean survival time of the three centipede species studied (5.3 days) compared with 43.6 hrs for *Lithobius mutabilis* and 23.0 hrs for *Lithobius agilis*. These were lower than the two isopods and a number of the millipedes; In the case of *Polyzonium germanicum* Brandt the last individual survived 72 days The respective dominance of the three *Lithobius* species in the community concerned were 35.0, 25.0, 25.0% and there was a significant positive correlation between dominance and time of survival. Two specimens of *Lithobius forficatus*, excluded from the statistical test, survived for 32 and 47 hours.

As Zulka *et al.* (1996) pointed out, in neither Vaitilingham's or Tufová & Tuf's' procedures was the water aerated during the course of their experiments.

Altitude

L. curtipes is not listed in Beron's (2007) account of high- altitude Isopoda, Arachnida and Myriapoda in which species of *Lithobius* are listed as up to 5,545m in Nepal and a highest altitude on Earth for myriapods at 5,700m. However, Pavelcová, (2020) reported *L. curtipes* up to 1,994m at in Rozpadliny in the High Tatras, Negrea (2006, citing records from Loksa, 1947) refers to *L. curtipes* (described as *L. baloghi*) from 1,800m at Pitrosu in the Rodna Mountains, Romania and in the Altai Reserve, SW Siberia, Nefediev *et al.* (2017) recorded it at 2,030m in a sparse *Pinus sibirica* stand with *Betula rotundifolia* & *Salix glauca* bushes below screes in litter.

Mikhailov and Moiseev (2017) discuss the response of alpine biota to climate change using evidence from the Polar Urals summits. They report on the dominance structure of arthropods on Slantseveya summit (417m) as in 2008 and 2015 and show that *L. curtipes*, a "dominant" in 2008 no longer has that status in 2015, its place being taken by a mirid bug.

Table 7. Dominance structure of herpetobiotic arthropods on Slantseveya summit at species and family levels. (from Mikhailov and Moiseev, 2017)

	2008		2015	
Dominance class	**Species**	**Family**	**Species**	**Family**
Eudominant	*Chlamydatus opacus* *Calacanthia trybomi*	Miridae Saldidae	*Calacanthia trybomi*	Saldidae
Dominant	*Lithobius curtipes*	Lithobiidae	*Chlamydatus opacus*	Miridae
Subdominant	*Carabus truncaticollis* *Alopecosa hirtipes*	Carabidae Lycosidae	*Alopecosa hirtipes* *Pardosa septentrionalis* *Oedostethus simularius*	Lycosidae Lycosidae Elateridae
Number of Species	21		24	

Temperature adaptations

Survival of freezing conditions in animals depends upon one of two mechanisms, either avoiding freezing by supercooling of body fluids or by tolerating extracellular ice. In the latter case, freeze tolerant animals, freezing of extracellular fluids is promoted by protein nucleators and up to 50% or more of body water may be converted into ice (Block, 1990; Storey & Storey, 1996). Berman & Leirikh (2017), looking at cold-hardiness in common soil invertebrates in NE Asia, a region with winter temperatures extreme for the Northern Hemisphere, found that 34 species of insects overwintered in the supercooled state whereby they withstand temperatures of -12 to -35^o but 13 other species (insects, myriapods, slugs, earthworms and an amphipod) spend winter in the frozen state and survive temperatures from -5 to -46^{o}C.

Rybalov *et al.* (2000) who determined thermopreferends of three species of centipede in the Yenisey Region of Siberia found that individuals of *L. curtipes* (the most numerous species) from forest-tundra, had a wide range of temperature preferences from 14 to 25^{o}C, the majority in the range 17 to 22^o in summer (mean 18.2^o). In the autumn their preferenda were similar at 13-25^o (majority 16-21^o, mean 17.9^o). Individuals from taiga populations had preferenda of 16 to 26^o (July) and 15 to 25^o September with, at both times, the most preferred temperature being 16 to 24^o). All the species of lithobiomorph examined were frost tolerant and overwintered in the frozen state. The mean supercooling points (freezing points) for *L. curtipes* collected in forest-tundra was -4.5^o (July), -3.9^o (September) and -3.1^o (February); for specimens from middle taiga the values were -4.9^o, -3.2^o and -3.1^o). Because it overwinters in the frozen state, this may explain these very small changes in supercooling ability due to their particular nucleators remaining active all year round. The authors comment that relatively high freezing temperatures are common in animals surviving in sub-zero temperatures with extracellular ice in their bodies.

Urban areas

A fairly consistent pattern runs through records of *L. curtipes* in relation to rural as opposed to urban habitats with the species rarely being recorded from the latter – in other words, a strongly "urban avoider" as suggested by the British data. There are, however, a few papers that seem to specifically refer to *L. curtipes* in urban areas and Zalesskaya & Golovatch (1996) actually describe it, along with *Lithobius forficatus*, as known to very often occur in purely synanthropic habitats with this accounting for [their] vast distribution very recently, during the last few decades/centuries.

Zenkova (2016) refers to the species as being widespread in natural and anthropogenic ecosystems on the Kola peninsula. However, Palmen (1949) referring to Eastern Fennoscandia, had remarked that it seemed not to be favoured by cultivation or to occur in greenhouses. In the Bulgarian catalogue and key (Stoev, 2002) habitats are is given as "urban habitats: yard". It seems that this latter location, which is from Ribarov's original record reads (in Bulgarian) *under rotten logs in the museum's yard* and presumably refers to the Regional History Museum of Panagyurishte, a settlement not large, situated at the foot of the mountain so the rural influence is significant (Pavel Stoev, *pers.comm.*).

In the "urban greens" of Warsaw (wooded areas, parks, street lawns) it was not recorded at all by Wytwer (1995, 1996) even in the five wooded areas, from one of which *L. crassipes* was listed. However, in a study on the effect of urbanisation in the Wielkapolska-Kujawy lowlands of western Poland, maximum altitude 200m, most of the area being under cultivation (Leséniewska *et al.*, 2008), *L. curtipes* was found both in Poznań and in one other built-up area as well as in deciduous forest areas. The rural area habitats for it were alder, beech, marshy, oak-hornbeam and oak but not oak-pine. In the city of Poznań it was collected only from wooded areas (Leséniewska, 1996).

In a paper on centipedes of urban areas in SW Siberia (Nefediev *et al.*, 2016) only a relatively few locations and habitats are listed; *Pinus sylvestris,* river bank (*Betula* & *Populus tremula*), river bank (*Betula* – in litter), "Nagornyi Park" (pitfall), "Izumrudnyi" Park (*Acer, Populus*), "Tomsknefteknim" (near acetylene plant, *Populus tremula*). All but the last (which is from the Tomsk area) are from Altai Province. A subsequent paper on Lithobiomorpha from anthropogenic habitats of Siberia (Nefediev, Farzalieva & Efimov., 2020) does not include reference to the species.

Habits and origins of the British population of *L. crassipes*

In comparison with many European and Asiatic countries referred to above, Britain, although having mountains up to 1,345m in Scotland lacks mountainous country comparable with that in many other areas of Europe. It extends to a latitude of more than 60^{o} N (Shetlands) / 58^{o}N (Mainland Britain) and at its southernmost mainland point is only just under 50^{o}N; for comparison, Oslo and St. Petersburg are both just under 60^{o}N and Edinburgh is almost exactly the same latitude as Moscow. However, Britain and Ireland are surrounded by sea which with its moderating effect on climate and its warming by the Gulf Stream / North Atlantic Drift which, together with its weather systems, gives an oceanic climate. Given that *L. curtipes* extends northwards to inside the Arctic Circle around 70^{o}N in both Scandinavia and NW Russia, its absence from Northern Britain, however, is notable.

There are not extensive seasonally flooded river floodplains as in Central Europe and elsewhere although there are areas alongside rivers in various parts of Britain where periodic or occasional flooding occurs and although *Lamyctes emarginatus* is generally considered a species favouring damp habitats (and has been recorded from river gravels in Wales), the sort of pattern described by Zulka (1991,1992) and Voigtländer (2011) has not yet been found in Britain. It will be noted, however, that there are a few British records from what are described as "wet" habitats. In vegetation terms, certainly there are no large areas of taiga or tundra comparable with those of Scandinavia or Russia. Clearly, however, as in the results from North Wales indicate, it can survive in relatively inhospitable upland environments here.

There has been much informal discussion amongst British myriapodologists over the years as to why particular species occur where they do. For any animal species there are a variety of factors that could influence their distribution patterns. Amongst others, these could include (a) lack of barriers (b) climate (c) acceptable habitats (d) competition (e) human activity. Centipedes are more or less generalist carnivores so presumably the presence or absence of possible prey, except in extreme conditions, might not be a major issue in most environments. What is much more likely is the presence of potential competitors, both other species of *Lithobius* or other arthropods in any particular habitat

So why does *L. curtipes*, an animal with a known wide choice of habitats and a high tolerance of extreme conditions, only occur where it does and not in other places? With our present knowledge of its current distribution and ecology in Britain, it is difficult to fit it into the pattern referred to by Christian (1998) since it does seem to occur in a variety of habitats here and does not presently clearly show the stenoecy predicted for a species on the edge of its range.

In mainland Europe, it is seemingly restricted to central and northern areas with apparently no records from southern France, Iberia, Italy, Croatia, Bosnia-Herzegovina, Serbia, Montenegro, Albania, Serbia, North Macedonia or Greece and, although it is recorded from Anatolian Turkey (and the Middle East), there seem to be no records from European Turkey. Its occurrence in Slovenia is described as "relict", only two locations are noted for Bulgaria and in Romania it is "rare". There have been a number of records of *L. curtipes* from Slovakia but, correspondingly, it is not reported in various surveys from there. In the Czech Republic, from where it has been found a number of times since its first discovery, there are surveys from possibly suitable sites where it has not been reported. All this suggests that conditions are more favourable to the species as one goes from south to north.

From west to east, it is not known from Ireland, is quite rare in France and its occurrence in Belgium and The Netherlands is patchy as also in Denmark and Norway as already described even though it is present in the north of the latter. Iceland, with its isolated location in relation to the rest of Europe has a very limited myriapod fauna (Andersson *et al.*, 2008) and Ireland has a smaller range of species than Britain, probably reflecting its earlier isolation from mainland Europe. The pattern we see suggest that there could be some factor, possibly climatic limiting the occurrence of *L. curtipes* (or favouring its competitors) in the West European "fringe" as we go from east to west and a similar situation in the south. As noted, its eastward limit extends as far as Mongolia and, again, suggests some limiting factor.

Barber & Jones (1996) reviewed the distribution pattern of British and Irish millipedes and how it might have originated following the last glaciation when, at its maximum, ice-sheets covered much of mainland Britain as far south as South Wales and Norfolk. Even outside the glaciated area, periglacial conditions would have tended to make the range of myriapod species very limited, if at all present. From about 10,000 years BP climatic improvement allowed the spread of forests and presumably with this the northward spread of myriapods from more southern areas, Britain and Ireland being joined to the European Mainland at the time. One might anticipate that *L. curtipes* with its tolerance of arctic conditions and the comparatively low-level of human activity (which the species seems not to favour) would make it one of the front-runners amongst colonisers or re-colonisers as far as our smaller lithobiids were concerned.

The breakdown of the land-bridge between Britain and Ireland could have been the factor that prevented *L curtipes* (along with some other species such as *Lithobius calcaratus* C.L. Koch) being present there. Subsequently, the loss of the connection between Britain and the mainland would prevent further "natural" spread of species from there into England and beyond. It is clearly possible that colonisation by such a "northern adapted" species could occur in the time period between the retreat of the glaciers and the breakdown of the land connection with *L. curtipes* being able to spread across the island of Britain. What it does not explain is its present absence from most of Scotland (although not Wales) whilst other species of *Lithobius* (including *L. crassipes* and *L. borealis* are present there.

Certainly, once the land connection to the mainland was lost, a significant barrier would exist towards further colonisation unless some form of passive transport across the English Channel (minimum width about 33 km), North Sea or other ocean barrier. There are two categories of modes of transport permitting (non-flying) terrestrial animals to cross such a barrier, those not involving human activity and those in which, in some way, accidentally or deliberately, human activity provides the mechanism.

Non-human transport includes the possibility of transport by, for instance vertebrates, the proverbial "birds' feet" of Blackburn *et al.* (2002). Certainly, attaching to birds' feathers (e.g. Anastacio *et al.* (2013) indicates the possibility of this for e.g. aquatic invertebrates – in that case recently hatched crayfish. Possible transport across ocean has been discussed by Barber (2009) in relation to littoral myriapods with reference to zoochory, aerial transport and rafting (hydrochory). Clearly littoral species of centipedes are in by far the most likely habitat to be accidentally transported in plant debris in this latter case but *L. curtipes* certainly does not fit into this category.

Accidental transport by human activity has undoubtably been going on for thousands of years and introduction of myriapods as well as other animals undoubtably takes place via such things as building materials, food sources, etc. in which they are accidentally picked up and transported elsewhere. However *L. curtipes*, despite the few references to it having an anthropogenic tendency, comes out from an overwhelming majority of reports both for Britain and elsewhere, as an animal that avoids the effect of human activity. Nevertheless, the possibility exists that postglacial human immigrants into Britain could bring in *L. curtipes* amongst timber, foodplants, etc. on a short sea voyage to a land having a low density of human population and consequential limited impact on it after the retreat of the ice; a land into which the species with its marked tolerances could well spread widely.

There remains another intriguing possibility and that is, that instead of being completely wiped out during the last glaciation, the species, with its marked capacity for survival in arctic conditions, could survive in one or more glacial refugia, perhaps in Wales or SW England and then, with improving climate, spread out across the country. Its apparent absence from the Isle of Wight, Isle of Man and other offshore islands, if this proves to be genuine, could, perhaps, tend to support the idea that we might have here a pre-glacial relict but, as noted, it is an elusive species and might even simply not be being recorded because of low density, habits and the collecting methods used. Conditions at the top of

Snowdonia, where it occurs today though, must be pretty tough and indicate its capacity for survival in Britain in situations very different from lowland deciduous woodland where it is also recorded.

Whatever its origin, it is certainly possible that the range of *L. curtipes* in Britain may have changed since its first post-glacial maximum in response to climate change, competition and/or human activity. The scattered distribution that we see today may be, perhaps, that of a species in decline or, at least, one that is more or less stable following an historical decline.

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Ecological revision of *Pachymerium ferrugineum* (C.L. Koch, 1835) (Chilopoda: Geophilomorpha: Geophilidae) in the Iberian Peninsula and the Balearic Islands

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Abstract

New population data for *Pachymerium ferrugineum* (C. L. Koch, 1847) from the Iberian Peninsula and the Balearic Islands are provided. Inland specimens had 49-55 leg-bearing segments (LBS) and 17-45 mm length while coastal specimens had 51-59 LBS and 28-60 mm length. Due to overlapping values in the number of leg-bearing segments, climatic and edaphic variables from the Ibero-Balearic region were studied. None of the tested ecological variables seemed to explain the differences in the number of leg-bearing segments or body length between inland and coastal populations. Nevertheless, the presence of coastal forms and 55 LBS inland specimens may be explained by the continental indicators BIO2 (mean of diurnal range) and BIO7 (temperature annual range). Additionally, specimens with the highest number of leg-bearing segments and the longest bodies were only detected in coastal hypersaline environments. Morphological and ecological differences between inland and coastal populations of the Iberian Peninsula and the Balearic Islands are discussed in depth.

Key words. Body length, coastal, cryptic species, forms, inland, latitudinal cline, leg bearing segments.

Introduction

Pachymerium C. L. Koch, 1847 is a diverse genus of chilopod myriapods belonging to the order Geophilomorpha and the family Geophilidae. It includes 22 valid species widely distributed throughout the world, with the exception of Australia and the Antarctic (Bonato *et al*., 2016). Nevertheless, most of them are only known from their type localities. *Pachymerium ferrugineum* (C.L. Koch, 1835) is one of the better-known species in this genus. This Palearctic species has been reported from European, Asian and North African regions and introduced to America (Nefediev *et al*., 2017; Barber *et al*., 2020; Cassar & Zapparoli, 2021; Dyachkov & Nedoev, 2021). Currently, *P. ferrugineum* is one of the most widely distributed *Pachymerium* species due to its dispersal by anthropochory, ecological tolerance and capability to colonise new environments (Bonato *et al*., 2005; Volkova, 2016; Nefediev *et al.*, 2017; Barber *et al.*, 2020). In the Iberian Peninsula, *P. ferrugineum* inhabits shrublands, grasslands, agricultural fields and forests (Carballo *et al.,* 1986; Carballo & Daza, 1991; Daza *et al.,* 1991; García-Ruiz & Santibáñez, 1995; García-Ruiz, 1999, 2003, 2009; Sammler *et al.,* 2006; Cabanillas, 2021). It is a frequent species in humid environments such as riparian forests and lagoons (Serra, 1978; Carballo *et al.,* 1986; Daza *et al.,* 1991; García-Ruiz & Santíbañez, 1995; García-Ruiz & Serra, 2003; Cabanillas, 2021). *P. ferrugineum* is also considered a synanthropic species, with records in urban parks and city gardens (García-Ruiz, 2009). Additionally, some authors reported the species in peninsular and insular coastal areas of Spain, for example in beaches and salt marshes (Negrea & Matic, 1973; Carballo & Daza, 1991; Sammler *et al.,* 2006). *P. ferrugineum* is one of the few centipede species able to tolerate sea water submersion (Schubart, 1929; Suomalainen, 1939; Lewis, 1981; Barber, 2011; Barber *et al.,* 2020). This suggests the existence of additional ways of dispersal in *P. ferrugineum* by floating trunks or plant remains (Barber *et al.,* 2020).

In the early 20th century, *Pachymerium ferrugineum insulanum* Verhoeff, 1902 was described from Bosnia-Herzegovina, Croatia, several Greek islands, Tunisia and Turkey. This subspecies is characterised by living in coastal environments and having higher numbers of teeth and fimbriae in the medial and lateral sides of the labrum, 49-61 leg-bearing segments (LBS) and a large body with yellowish tonalities. These criteria were followed by many authors in subsequent publications (Verhoeff, 1902, 1925, 1951; Manfredi, 1953; Kanellis, 1959; Kaczmarek, 1969; Negrea & Matic 1973; Simaiakis & Mylonas, 2003; Simaiakis *et al*., 2004; Sammler *et al*., 2006) but others questioned the validity of *P. f. insulanum* and listed it as a minor synonym of *P. ferrugineum* (Matic, 1972; Zapparoli, 1991, 1994, 2002; Vadell & Pons, 2009). *P. f. insulanum* was officially synonymized by Bonato & Minelli (2014) due to difficulties in detecting not-overlapping diagnostic characters between both subspecies. Other authors firmly support the hypothesis of the occurrence of two distinct forms in *P. ferrugineum* due to non-overlapping values of leg-bearing segments between inland and coastal specimens. In Crete, Simaiakis & Mylonas (2003) and Simaiakis *et al*. (2004) reported a short form with 41-47 LBS from inland environments and a long form with 55-59 LBS from coastal habitats and small satellite islands. An inland short form with 41-49 LBS and a coastal large form with 51-57 LBS are known from France (Blower, 1987; Iorio & Tiberghien, 2007; Barber *et al.*, 2020). Recently, a 57 LBS specimen was reported in a coastal environment of the Channel Islands (Barber *et al.*, 2020), a 57 LBS specimen was detected from a beach of Comino island and two 49 LBS specimens were reported from inland forests in Malta (Cassar & Zapparoli, 2021). Nevertheless, a short form with 41-45 LBS is known from coastal sites in mainland Britain (Lewis, 1960; Barber, 2009). Barber *et al.* (2020) also reported differences in the body length between the short and long form: typically 30-35 mm for the short form and 60 mm for the long form. Summarily, short forms usually occur in inland habitats and have 41-49 LBS, while long forms are frequently found in coastal environments and have 51-59 LBS (Barber *et al.*, 2020).

The Iberian Peninsula represents a suitable territory for the evaluation of both forms due to its location in the extreme south-west of Europe and the existence of both inland and coastal environments. Nevertheless, previous records of *P. ferrugineum* in the Iberian Peninsula and the Balearic Islands are ambiguous or do not provide reliable data about the number of leg-bearing segments. The main aims of this work are to compile previous records of *P. ferrugineum* and to provide new population data from inland and coastal environments of the Iberian Peninsula and the Balearic Islands. Additionally, some ecological variables that might determine the number of leg-bearing segments and body length between the Ibero-Balearic populations are assessed.

Material & Methods

Bibliographical revision

Published records and supplementary data of *P. ferrugineum* previously reported from the Iberian Peninsula, Balearic and Canary Islands were compiled (see Appendix 1). Localities, habitats and the number of leg pairs (when provided) were used to revise the ecology of the species.

Material examined

Surveys were undertaken in coastal and inland environments of the Iberian Peninsula from 2017 to 2021. Inland specimens were searched for underneath rocks, debris, leaf-litter or within soil in grasslands, forests and synanthropic environments. Coastal specimens were searched for beneath stones, pebbles and stranded logs in the supralittoral zone of sand beaches, coves and cliffs. Specimens were hand collected, killed by freezing and then fixed in ethanol 70%. Additionally, some colleagues kindly provided specimens for this study: Francisco Rodríguez-Luque (Almería), Joan Díaz-Calafat and Sebastià Jaume-Ramis (Mallorca) and Daniel Rojas (Cádiz). A binocular stereo microscope model AmScope SM-1TSZZ-144S-10M-3PL (3.5-180x) was used to determine the identity of specimens. Works on the morphology and taxonomy of *P. ferrugineum* and *P. f. insulanum* were consulted (Verhoeff, 1902, 1924; Bonato & Minelli, 2014; Bonato *et al*., 2014; Iorio & Labroche, 2015; Barber *et al*., 2020). Specimens are kept in the first author's collection. Additionally, photographs archived on the image database 'Biodiversidad Virtual' (https://www.biodiversidadvirtual.org/) were thoroughly reviewed. A useful character to distinguish *P. ferrugineum* from other Iberian Geophilidae is the presence of numerous small coxal pores on the ultimate coxae, although most photographs were not adequate for seeing this feature. The following morphological criteria were used to distinguish *P. ferrugineum* from other Iberian Geophilidae: antennae length (less than 4 times as long as breadth of head), head colour and shape (brownish red, almost rectangular and up to 1.4 times as long as broad), forcipules surpassing the cephalic plate, forcipular tergite shape (sides strongly convergent anteriorly), ultimate leg pair length (less than twice the length of the penultimate leg pair) and number of leg-bearing segments (41-59 LBS). Only specimens clearly showing this set of characteristics were considered for ecological tests.

Ecological revision

In order to detect patterns of distribution of the two forms of *P. ferrugineum* in the Ibero-Balearic region, ecological maps with climatic and edaphic variables were consulted. The interval of maximum and minimum values was set according to the climatic and edaphic characteristics of that region. All records were considered to assess the general ecology of the species. Only records with precise coordinates and number of leg-bearing segments per specimen were used to detect patterns of distribution in inland and coastal forms. The following variables were tested: mean diurnal range (BIO2), maximum temperature of warmest month (BIO5), minimum temperature of coldest month (BIO6), temperature annual range (BIO7), mean temperature of wettest quarter (BIO8), mean temperature of driest quarter (BIO9), mean temperature of warmest quarter (BIO10), mean temperature of coldest quarter (BIO11), annual precipitation (BIO12), precipitation of wettest quarter (BIO16), precipitation of driest quarter (BIO17), precipitation of warmest quarter (BIO18), precipitation of coldest quarter (BIO19), organic carbon content in the top soil (soil_oc), pH in the top soil (soil_ph), presence of brackish or salty soils (soil_salt), silt content in the top soil (soil_silt) and annual mean soil moisture index (BIO28). Maps were generated with ArcGis Desktop 10.8.1. Data on climatic and edaphic variables were obtained from WorldClim 2.1 for the 1970-2000 period (http://www.worldclim.org, see Fick & Hijmans, 2017) and the European Soil Data Center (https://esdac.jrc.ec.europa.eu/) at 30-second resolution (~1x1 km at the equator).

Abbreviations: *leg*. = *legit* (collector), LBS = leg-bearing segments, *phot*. = *photographavit* (author of the photograph), spec. = specimen (s). Authors: APF - Alejandro Pérez Ferrer, AR - Antonio Robledo, CE - Constantino Escuer, DG - Daniel García, FAE - Francisco Arnau Esbrí, FM - Fani Martínez, FRL - Francisco Rodríguez-Luque, JDC - Joan Díaz-Calafat, JM - Josefina Miralles, LF - Luis Fernández, MT - Mikel Tapia, MY - Miguel Yuste, SJR - Sebastià Jaume-Ramis, TR - Thomas Rickfelder. * = previously unreported.

Results

Pachymerium ferrugineum (C.L. Koch, 1835)

Material examined: Spain - Alicante*: Finestrat, Puig Campana - 1 spec. (DG *phot*.), 20/04/2013, in a shrubland (30S 742913 4275056). **Almería*:** El Ejido, Almerimar, Punta Entinas-Sabinar - 1♀ with 59 LBS and 45 mm, 1♀ with 59 LBS and 47 mm (FRL *leg*.), 14/12/2017; 1 spec. with 57 LBS (FRL *phot*.), 15/12/2017; 1♀ with 59 LBS and 33 mm (FRL *leg*.), 27/02/2019; 1♂ with 57 LBS and 30 mm

(FRL *leg*.), 22/03/2019; 1♀ with 57 LBS and 31 mm (FRL *leg*.), 18/07/2020, under rocks on a sand beach (30S 526926 4059879). El Ejido, Los Artos - 1♂ with 49 LBS and 30 mm, 1♂ with 51 LBS and 32 mm, 1♂ with 51 LBS and 34 mm (FRL *leg*.), 08/02/2019; 1 spec. with 49 LP (FRL *phot*.), 09/02/2020, under rocks near greenhouses (30S 518037 4067759). Roquetas de Mar, Aguadulce, Puerto Deportivo - 1♂ with 53 LBS and 28 mm, 1♀ with 59 LBS and 60 mm (FRL *leg*.), 03/12/2020, under a rock in a littoral plateau (30S 539776 4074774). Vícar - 1 spec. with 55 LBS (FRL *phot*.), 12/01/2017, under a rock in an abandoned crop field (30S 529519 4074423); 1 spec. with 53 LBS (FRL *phot*.), 04/02/2019, under a rock in a shrubland (30S 534399 4074615). **Asturias***: Villaviciosa, Selorio, Playa de Misiego - 1 spec. with 53 LBS, 24/09/2020, under the bark of a stranded log on dunes with rock sea-lavender (*Limonium binervosum* (G.E.SM.) C.E. Salmon) (30T 307679 4821644). Gozón, Llodero, Playa de Xagó - 1♀ with 55 LBS and 47 mm, 1♀ with 57 LBS and 41 mm, 1♀ with 57 LBS and 47 mm, 1♀ with 57 LBS and 55 mm, 10/10/2020, under stranded logs on a sand beach with sand couch-grass (*Elymus farctus* (Viv.) Runemark Ex Melderis) (30T 264632 4832194). **Balearic Islands:** Mallorca, Inca - 1♀ with 51 LBS and 45 mm (SJR *leg*.), 20/12/2021, under a garden tile near a vegetable growing patch (31S 492806 4396833). Mallorca, Marratxí - 1♀ with 51 LBS and 41 mm, 1♀ with 53 LBS and 43 mm (JDC & SJR *leg*.), 22/12/2021, under a rock in an urban Aleppo pine forest (*Pinus halepensis* Mill.) (31S 477758 4385688). **Barcelona*:** Manresa, Canyet - 1 spec. (APF *phot*.), 25/02/2021, in crop fields (31T 402545 4623396). Terrassa - 1 spec. (JM *phot*.), 31/03/2013, under a stone in a private garden (31T 417358 4601756). **Cádiz:** Puerto Real, Salina de San Pedro y San José-la Covacha - 1♀ with 51 LBS and 35 mm (DR *leg*.), 15/11/2020, under a rock near an abandoned salt pan (29S 750185 4045797). **Cantabria*:** Piélagos, Dunas de Liencres - 1 spec. (TR *phot*.), 18/02/2011, in maritime dunes (30T 421647 4810613). **Castellón*:** Alcossebre, Platja de Ribamar - 1 spec. with 55 LBS, 09/05/2021, under a rock on a pebble beach (31T 271177 4460862). Peníscola, Serra d'Irta - 2 spec. with 57 LBS (FAE *phot*.), 29/11/2021, in a sand and pebble beach (31T 272766 4462137); 1 spec. with 53 LBS (FAE *phot*.), 04/12/2021 and 1 spec. with 57 LBS (FAE *phot*.), 29/12/2021, in a sand and pebble beach (31T 272766 4462137). Torreblanca, Torrenostra, Turbera del Prat de Cabanes - 1 spec. with 53 LBS, 11/05/2021, under a rock near a bog shore (31T 262637 4453132). **Madrid:** Alcalá de Henares, Parque de los Cerros de Alcalá - 1♂ with 53 LBS and 26 mm, 18/11/2019, under an ornamental rock in a suburban park near a river (30T 455565 4463974). Madrid, Centro - 1 spec. with 55 LBS (MY *phot*.), 26/03/2011, in an urban garden (30T 440583 4474243). Madrid, Ciudad Lineal, Calle Idioma Esperanto - 1♀ with 49 LBS and 45 mm, 01/11/2018, under debris in urban grassland (30T 446813 4474443). Madrid, Ciudad Lineal, Parque El Sitio - 1 juvenile with 51 LBS and 17 mm, 23/03/2019, in soil in a holm-oak plantation (*Quercus ilex* L.) of an urban park (30T 446612 4474276); 1♀ with 51 LBS and 32 mm, 1♀ with 51 LBS and 43 mm, 29/03/2019, under a stone in an urban park with holm-oak and mimosa (*Acacia dealbata* Link) (30T 446520 4474182); 1♀ with 53 LBS and 32 mm, 29/03/2019, under debris in an urban grassland with Siberian elm (*Ulmus pumila* L.) (30T 446414 4474186). Rivas-Vaciamadrid, Soto de las Juntas - 1♀ with 55 LBS and 27 mm, 03/12/2016, under debris in a grassland between the rivers Manzanares and Jarama (30T 455565 4463974). San Fernando de Henares - 1 spec. with 51 LBS, 07/01/2017, under decaying wood in a riparian forest (30T 456729 4473760). Valdeolmos-Alalpardo, Alalpardo - 1♀ with 53 LBS and 45 mm, 24/10/2019, under a stone in an abandoned crop field near a stream (30T 460564 4497951). Valdeolmos-Alalpardo, Valdeolmos- 1♀ with 53 LBS and 29 mm, 08/01/2020, under a stone in an abandoned crop field (30T 461658 4498978). **Murcia*:** Cartagena, Cabo de Palos, Playa de la Calafría - 1♀ with 59 LBS and 34 mm, 06/12/2021, under a rock near the supralittoral line of a pebble and sand beach (30S 703844 4167633). Murcia, Cartagena, Rambla de Cobaticas - 1 spec. with 57 LBS (LF *phot*.), 23/12/2012, in a dry riverbed near the coast (30S 698552 4163942). Murcia, Cresta del Gallo - 1♀ with 53 LBS and 42 mm, 07/11/2021, under a rock in an Aleppo pine forest (30S 667682 4201357). Murcia, El Caracolero, Sierra de los Villares - 1 spec. with 51 LBS (AR *phot*.), 26/12/2012, in a shrubland (30S 666323 4194362). **Navarra:** Villafranca - 1 spec. with 51 LBS (MT *phot*.), 20/02/2010, underneath the bark of a poplar tree in an urban garden (30T 603318 4681425). **Sevilla:** Sevilla, Universidad Pablo de Olavide: 1♂ with 51 LBS and 30 mm, 26/02/2021, inside a decayed olive trunk (*Olea europaea* L.) in a grassland (30S 239429 4138444). **Valencia*:** Canals - 1 spec. with 51 LBS (FM *phot*.), 18/02/2011, in agricultural fields (30S 710115 4313860). **Zaragoza:** Perdiguera - 1 spec. (CE *phot*.), 09/10/2008, under a rock in crop fields (30T 696899 4625138).

Distribution and habitat preferences

P. ferrugineum was previously recorded in the Portuguese districts of Coimbra and Porto (Machado, 1952) and the Spanish provinces of Navarra (Salinas, 1990), Huesca and Zaragoza in Aragón (Serra, 1978), Ciudad Real, Cuenca and Toledo in Castilla-La Mancha (Brolemann, 1920; Attems, 1927; García-Ruiz & Santibáñez, 1995; García-Ruiz, 1999, 2003; García-Ruiz & Serra, 2003), Madrid (García-Ruiz, 2009; Cabanillas, 2021) and Cádiz, Granada, Huelva and Sevilla in Andalucía (Attems, 1927, 1952; Carballo *et al.*, 1986; Carballo & Daza, 1991; Daza *et al*., 1991). Additionally, *P. ferrugineum* was reported from insular Spain in Ibiza and Mallorca in the Balearic Islands (Verhoeff, 1924; Negrea & Matic, 1973; Sammler *et al*., 2006; Vadell & Pons, 2009) and Lanzarote in the Canary Islands (Machado, 1953). Regarding the material examined in this study, *P. ferrugineum* was found both in temperate and Mediterranean inland areas of the Iberian Peninsula, with records from the Cantabric region and Pre-pyrenean areas to the Meseta Central and the southern Iberian Peninsula. Additionally, *P. ferrugineum* was found in a previously unreported inland locality of the island of Mallorca (Balearic Islands). It is also present in Atlantic and Mediterranean coastal localities, apparently well-established from the northwestern to the southwestern Iberian coasts. An updated map of the known distribution of *P. ferrugineum* in the Iberio-Balearic region is given in Fig. 1. Iberian populations of *P. ferrugineum* can be found in a wide variety of habitats (Fig. 2A-B). Inland records include grasslands, shrublands, holm oak groves, pine forests and agricultural fields. Inland specimens are particularly common near streams, lagoons and synanthropic environments. Coastal records include hypersaline habitats such as pebble and sand beaches, dune systems, salt marshes and salt pans.

Inland and coastal forms

Most authors did not report any morphological or ecological data in their studies from Spain (see Appendix 1) but some of them did provide the number of leg-bearing segments. Iberian specimens with known ranges of leg-bearing segments were reported from the Portuguese districts of Coimbra and Porto (41-57 LBS, habitat unspecified) (Machado, 1952) and the Spanish provinces of Navarra (45-53 LBS, verified inland environments) (Salinas, 1990) and Madrid (49-53 LBS, verified inland environment) (Cabanillas, 2021). Balearic specimens were originally reported as belonging to the subspecies *P. f. insulanum* (53-57 LBS, habitat unspecified) (Verhoeff, 1924). Sammler *et al*. (2006) also reported *P. f. insulanum* specimens ranging from 53-55 LBS, both from inland and coastal habitats. Vadell & Pons (2009) identified as *P. ferrugineum* an inland specimen with 55 LBS from the island of Mallorca. Regarding the material examined in this study, inland specimens had 49-55 LBS, frequently 51 and 53 LBS (males 49-53 LBS, females 49-55 LBS) and body length 17-45 mm. Apparently, populations with 55 LBS specimens are uncommon in inland localities but may occur in certain continental sites. These specimens were found in synanthropic open areas of Madrid (Central Iberian Peninsula), namely in an agricultural field, a garden and a grassland with presence of construction debris. On the other hand, there is an apparent increase in the number of leg-bearing segments and body length in coastal specimens. These had 51-59 LBS, frequently 57 and 53 LBS (males 53 and 57 LBS, females 51 and 55-59 LBS) and body length 28-60 mm. Regarding the body colour (*in vivo*), inland specimens were commonly reddish brown or dark brown while coastal specimens were mostly yellowish-orange and often paler than inland forms (Fig. 2C-D).

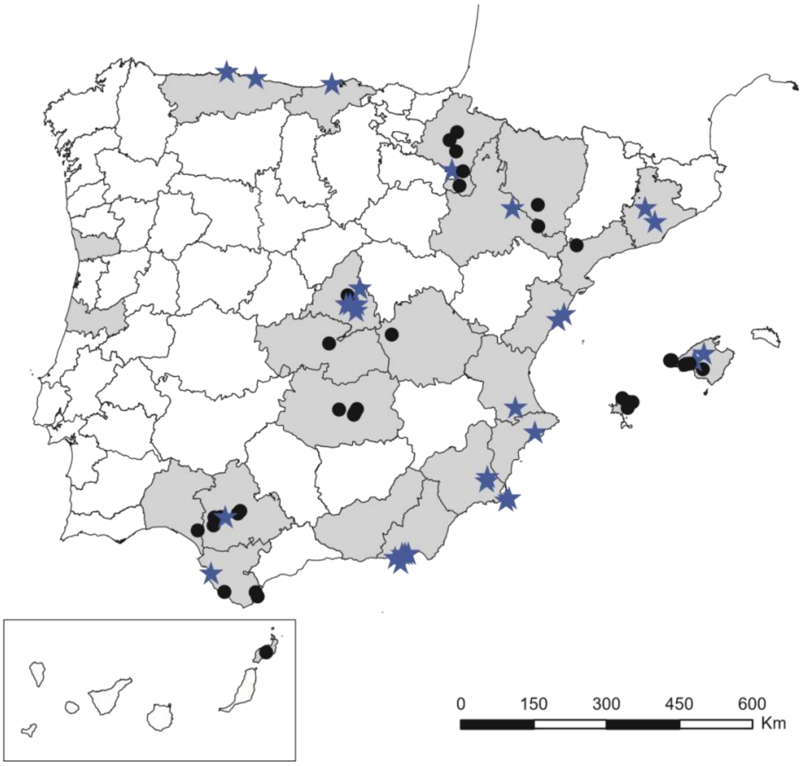

Figure 1: Records of *Pachymerium ferrugineum* in the Iberian Peninsula, Balearic and Canary Islands. (●) Bibliographic records. (★) New records.

Figure 2: Habitats and colour patterns of *Pachymerium ferrugineum*. A) Riparian forest in the central Iberian Peninsula. **B)** Sand and pebble beach in the eastern Iberian Peninsula. **C)** Typical *habitus in vivo* of inland specimens. **D)** Typical *habitus in vivo* of coastal specimens. Authors: A - Bernardo García Medrano, B & D - Francisco Arnau Esbrí, C - David Cabanillas.

Climatic and edaphic variables

The presence of *P. ferrugineum* is apparently not influenced by soil humidity, pH, amount of organic matter or silts. It lives in both coastal and continental sites, under climates with sub-zero temperatures or exceeding 40ºC. It is present in mild areas with high rainfall values (even in the driest season) but also in xeric areas. Regarding the tested climatic variables, the continental indicators BIO2 (mean diurnal range) and BIO7 (temperature annual range) may explain the presence of inland and coastal forms of *P. ferrugineum* in the Iberian Peninsula (Fig. 3A-B). Coastal forms occur in mild areas where annual and day-night temperature oscillation is smaller. This is particularly the case of the 55 LBS specimens from the central Iberian Peninsula and the 55 LBS inland specimen from Mallorca (Vadell & Pons, 2009), since they were found in an area with a mild climate and low values of BIO2 and BIO7 (Fig. 3C-D). The other climatic variables, for example temperatures and rainfall rates, do not seem to condition the number of leg-bearing segments or body length between inland and coastal populations (Appendix 2). Regarding the tested edaphic variables, the amount of organic matter, silt content, soil humidity or pH do not seem to explain the morphological differences between inland and coastal specimens (Appendix 2). Nevertheless, "long forms" of *P. ferrugineum* are only present in soils with high salt concentration (coastal sites), with the exception of the 55 LBS specimens from inland environments. Summarising, none of the tested variables seem to play a decisive role in the number of leg-bearing segments and body length between inland and coastal forms. Maps with edaphic and climatic tests are provided in Appendix 2.

Discussion

The present work represents a breakthrough in the ecological knowledge of *P. ferrugineum* in the Iberio-Balearic region. Although this centipede is a well-known species in Europe (Barber *et al.*, 2020), records from the study area were scarce and did not provide adequate morphological and ecological information. Previous studies on European populations of *P. ferrugineum* (Simaiakis & Mylonas, 2003; Simaiakis *et al.,* 2004; Simaiakis & Mylonas, 2006; Iorio, 2014; Simaiakis *et al.*, 2010; Barber *et al.,* 2020; Iorio *et al.,* 2020) make it possible to discuss in depth some ecological and morphological questions. The existence of two distinct forms of *P. ferrugineum* has been a matter of discussion in the last two decades. *P. f. insulanum* (closely related to the long form) was officially synonymized by Bonato & Minelli (2014) because consistent diagnostic characters could not be found to distinguish *P. f. insulanum* from the nominotypical subspecies. Nevertheless, several authors have reported non-overlapping ranges in the number of leg-bearing segments and differences in the maximum body length between inland and coastal populations (Barber *et al.*, 2020), with the exception of the British specimens (Lewis, 1960; Barber, 2009). Data from the Iberian Peninsula deserve a careful interpretation since they could result in a confirmation bias for both theses.

On the one hand, results from the Iberian Peninsula do not show two distinct forms of *P. ferrugineum* due to overlapping values in the number of leg-bearing segments. The previous European ranges were set between 41-49 LBS for the short form and 51-59 LBS for the long form (Barber *et al.*, 2020). Inland specimens from the Ibero-Balearic region have 45-55 LBS, frequently 51-53 LBS but reaching 55 LBS in certain localities of the central Iberian Peninsula and the Balearic Islands. The Iberian "short form" is longer than expected and frequently overlaps with the minimum number of leg-bearing segments of the long form (51-59 LBS), both in males and females. Additionally, none of the tested climatic and edaphic variables seemed to explain the distribution of inland and coastal forms in the Ibero-Balearic area (Appendix 2). Nevertheless, the continental indicators suggest a possible effect on the distribution of both forms (Fig. 3). *P. ferrugineum* populations with a higher number of leg-bearing segments were mostly found in both inland and coastal areas where annual and day-night temperature oscillation is smaller and almost constant during the year. European populations with the highest number of leg-

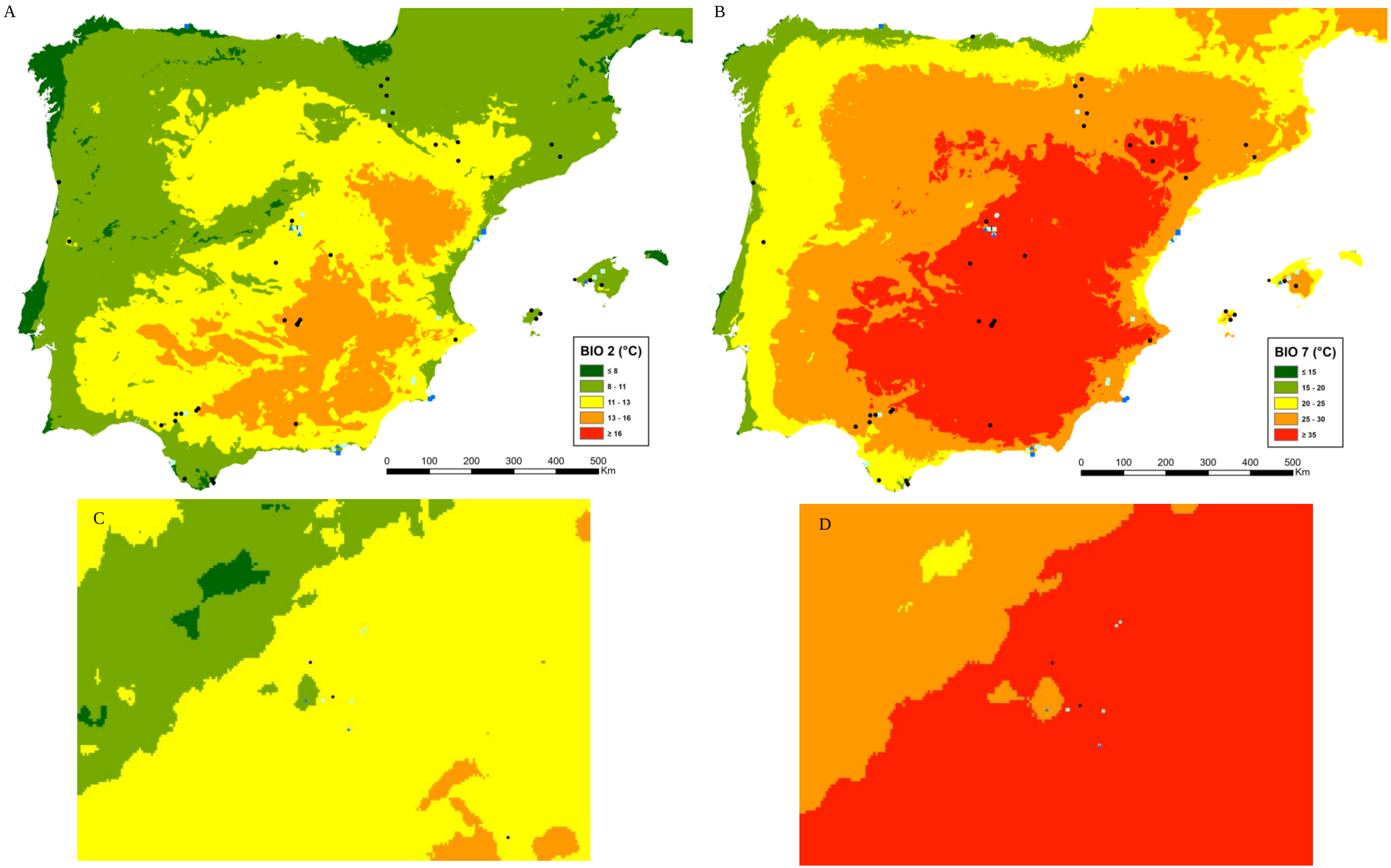

Figure 3: Climatic map with continental indicators in the Iberio-Balearic area. A) Mean diurnal range (BIO2). **B)** Temperature annual range (BIO7). **C)** Highlighted central area for the indicator BIO2. **D)** Highlighted central area for the indicator BIO7. Number of leg-bearing segments: 49 (cyan square), 51 (cyan triangle), 53 (cyan circle), 55 (blue square), 57 (blue triangle), 59 (blue circle), unknown leg-bearing segments per specimen or imprecise coordinates (black circle)

bearing segments have been reported from coastal environments where temperatures are softened influence of the nearby sea (Simaiakis & Mylonas, 2003; Simaiakis *et al*., 2004; Barber *et al*., 2020; Iorio *et al*., 2020, Cassar & Zapparoli, 2021). This has previously been suggested by some authors to explain the pattern of distribution of certain species in the Iberian Peninsula (Cabanillas *et al.*, 2020). Edaphic tests need to be carefully interpreted. The scale used (1 km^2 resolution) could have interfered with the expression of patterns of distribution since microenvironmental edaphic conditions are known to condition the presence of certain centipede species (Fründ, 1991; Dunxiao *et al*., 1999). Maps with higher resolution, for example at 1 m^2 scale, could provide valuable data to better interpret the influence of soil variables. Salinity indicator by itself seems not to be conditioning the number of leg-bearing segments or body length in *P. ferrugineum* populations. Nevertheless, specimens with a higher number of leg-bearing segments were only found in hypersaline soils of coastal areas. The possibility exists that increasing the number of leg-bearing segments may be a physiological response to exposure to hypersaline conditions. Other processes could be taking place since specimens with 55 LBS were also detected in non-saline inland environments of the central Iberian Peninsula and the Balearic Islands.

On the other hand, several facts seem to support the hypothesis of the existence of two forms of *P. ferrugineum* in the Ibero-Balearic area. Geographical differences in the number of leg-bearing segments are well-known to occur in *P. ferrugineum* (Meinert, 1870; Attems, 1902, 1929; Brölemann, 1930; Barber, 2009; Simaiakis *et al.*, 2010). According to Eason (1979), Geophilomorpha centipedes from colder regions usually have lower number of leg-bearing segments than those from warmer regions. Some authors have suggested that a temperature latitudinal cline could condition the number of leg-bearing segments in European *P. ferrugineum* populations (Simaiakis *et al.*, 2010). Apparently, there is also a gradient in the number of leg-bearing segments from northwestern to southwestern inland populations. French inland specimens have 43-49 LBS (Iorio & Tiberghien, 2007; Barber *et al*., 2020), populations from inland environments of the Ibero-Balearic region have 45-55 LBS (Salinas, 1990; Vadell & Pons, 2009; Cabanillas, 2021; present work) and African inland specimens from the High Atlas have 51-53 LBS (Brolemann, 1924). Conversely, coastal forms do not seem to be affected by this temperature latitudinal cline. The number of leg-bearing segments of coastal forms varies from 51-59 LBS at a local scale in every country (Iorio *et al*., 2020; Barber *et al*., 2020; present work), with the exception of the British specimens where the total numbers of specimens recorded are small (A. Barber pers. comm.) This suggests the existence of two ecotypes which, apparently, are not affected by the same ecological factors. The possibility exists that habitat segregation from inland to hypersaline environments could have led to the diversification of *P. ferrugineum* into two lineages ecologically independent. Several Geophilomorpha species are known to be restricted to littoral habitats since they have adapted to live exclusively under saline conditions (Barber, 2011). This may be the case of the coastal form of *P. ferrugineum*. Additionally, differences in body size between inland and coastal populations were also detected in the Iberian Peninsula and the Balearic Islands. Inland specimens had 17-45 mm body length while coastal specimens were usually longer (up to 60 mm), as reported by Barber *et al.* (2020) for the long form from the Channel Islands. Differences in body colour (*in vivo*) could also be detected (Fig. 3C-D). Coastal specimens were yellowish-orange and clearly paler than inland specimens, as reported by Verhoeff (1902) for the subspecies *P. f. insulanum*.

Summarily, this study provides data about an inland form of *P. ferrugineum* with 49-55 LBS (males 49-53 LBS, females 49-55 LBS) and up to 45 mm and a coastal form with 51-59 LBS (males 53 and 57 LBS, females 51 and 55-59 LBS) and up to 60 mm. Morphology and ecology are directly involved in this taxonomical issue and currently there are two theses, both supported by valid arguments. In our opinion, differences in habitat selection are consistent with the potential existence of two ecotypes in *P. ferrugineum*. Further studies should be focused on performing molecular analyses in order to end the debate about the two forms of *P. ferrugineum* in the myriapodological community.

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Appendix 1. Compilation of records of *Pachymerium ferrugineum* in the Ibero-Balearic and the Macaronesian Region.
IB - Islas Baleares (Balearic Islands), IC - Islas Canarias (Canary Islands), LBS - leg-bearing segments, POR - Portugal, pers. comm. - personal communication, SPA - Spain.

Country	District/Province	Municipality	Habitat	Sex	LBS	Body Length	Reference
POR	Coimbra	-	-	-	41-57	-	Machado (1952)
POR	Porto	-	-	-	41-57	-	Machado (1952)
SPA	Alicante	Finestrat	Shrubland	-	-	-	Present work
SPA	Almería	Roquetas de Mar	Littoral plateau	♂	53	28	Present work
SPA	Almería	Roquetas de Mar	Littoral plateau	♀	59	60	Present work
SPA	Almería	El Ejido	Shrubland	♂	49	30	Present work
SPA	Almería	El Ejido	Shrubland	-	49	-	Present work
SPA	Almería	El Ejido	Shrubland	♂	51	32	Present work
SPA	Almería	El Ejido	Shrubland	♂	51	34	Present work
SPA	Almería	El Ejido	Sand beach	♂	57	30	Present work
SPA	Almería	El Ejido	Sand beach	♀	57	31	Present work
SPA	Almería	El Ejido	Sand beach	-	57	-	Present work
SPA	Almería	El Ejido	Sand beach	♀	59	33	Present work
SPA	Almería	El Ejido	Sand beach	♀	59	45	Present work
SPA	Almería	El Ejido	Sand beach	♀	59	47	Present work
SPA	Almería	Vícar	Shrubland	-	53	-	Present work
SPA	Almería	Vícar	Crop field	-	55	-	Present work
SPA	Asturias	Gozón	Sand beach	♀	55	47	Present work
SPA	Asturias	Gozón	Sand beach	♀	57	41	Present work
SPA	Asturias	Gozón	Sand beach	♀	57	47	Present work
SPA	Asturias	Gozón	Sand beach	♀	57	55	Present work
SPA	Asturias	Villaviciosa	Dunar system	-	53	-	Present work
SPA	Barcelona	Manresa	Crop field	-	-	-	Present work
SPA	Barcelona	Terrassa	Garden	-	-	-	Present work
SPA	Cádiz	La Línea de la Concepción	Crop field	-	-	-	Carballo & Daza (1991)
SPA	Cádiz	San Roque	Grassland	-	-	-	Carballo & Daza (1991)

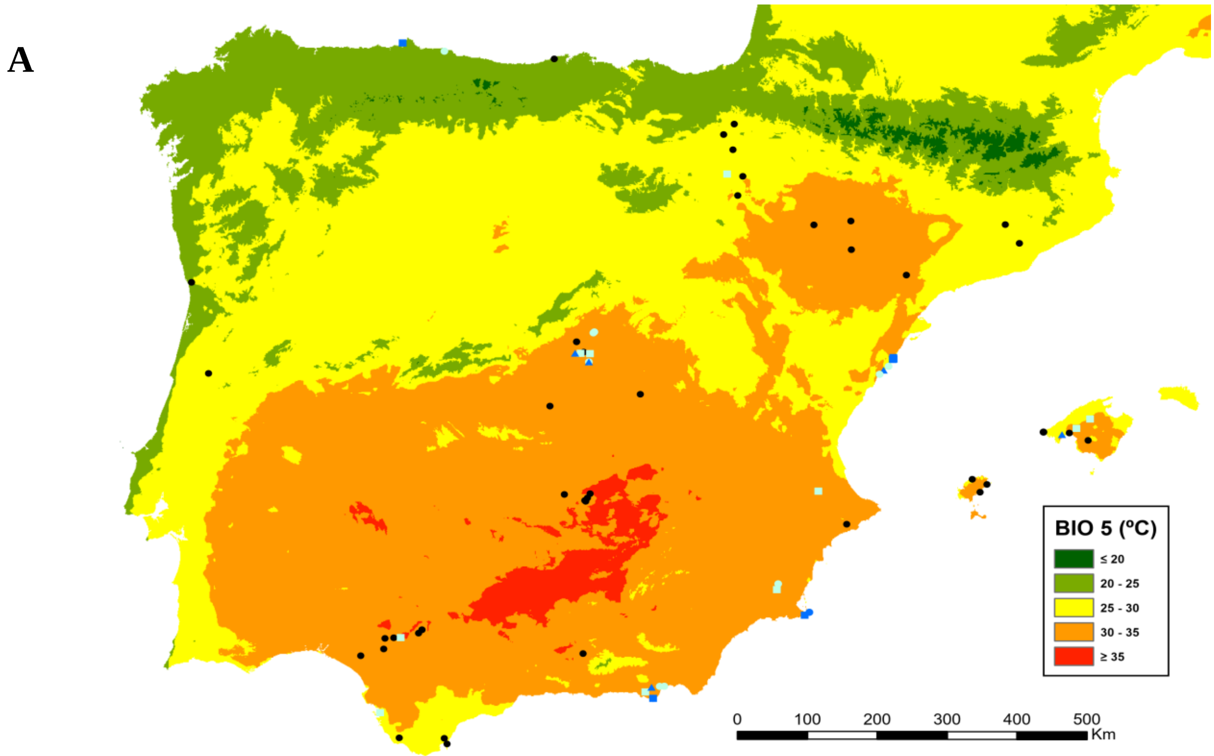
SPA	Cádiz	Vejer de la Frontera	Shrubland	-	-	-	Carballo & Daza (1991)
SPA	Cádiz	Puerto Real	Salt pan	♀	51	35	Present work
SPA	Cantabria	Piélagos	Maritime dunes	-	-	-	Present work
SPA	Castellón	Alcossebre	Pebble beach	-	55	-	Present work
SPA	Castellón	Peníscola	Sand and pebble beach	-	53	-	Present work
SPA	Castellón	Peníscola	Sand and pebble beach	-	57	-	Present work
SPA	Castellón	Peníscola	Sand and pebble beach	-	57	-	Present work
SPA	Castellón	Peníscola	Sand and pebble beach	-	57	-	Present work
SPA	Castellón	Torreblanca	Bog shore	-	53	-	Present work
SPA	Ciudad Real	"Calatrava"	-	-	-	-	Attems (1927)
SPA	Ciudad Real	Pozuelo de Calatrava	-	-	-	-	Brolemann (1920)
SPA	Ciudad Real	Moral de Calatrava	Kermes oak grove	-	-	-	García-Ruiz (1999)
SPA	Ciudad Real	Moral de Calatrava	Shrubland	-	-	-	García-Ruiz (2003)
SPA	Ciudad Real	Moral de Calatrava	Pine forest	-	-	-	García-Ruiz & Santibáñez (1995)
SPA	Ciudad Real	Moral de Calatrava	Riparian forest	-	-	-	García-Ruiz & Santibáñez (1995)
SPA	Ciudad Real	Moral de Calatrava	Shrubland	-	-	-	García-Ruiz & Santibáñez (1995)
SPA	Cuenca	Uclés	-	-	-	-	Attems (1927)
SPA	Granada	-	-	-	-	-	Attems (1927)
SPA	Huelva	Hinojos	Salt marsh	-	-	-	Carballo & Daza (1991)
SPA	Huesca	Sariñena	Saline lagoon	♂+♀	49-51	-	Serra (1978), pers. comm.
SPA	IB - Ibiza	Ibiza	Coastal plateau	-	53-55 (?)	-	Sammler *et al*. (2006)
SPA	IB - Ibiza	Ibiza	Maquis shrubland	-	53-55 (?)	-	Sammler *et al*. (2006)
SPA	IB - Ibiza	Ibiza	Maquis shrubland	-	53-55 (?)	-	Sammler *et al*. (2006)
SPA	IB - Ibiza	Ibiza	Pine forest	-	53-55 (?)	-	Sammler *et al*. (2006)
SPA	IB - Ibiza	Ibiza	-	-	-	-	Verhoeff (1924)
SPA	IB - Mallorca	Calvià	Ravine	-	55	-	Vadell & Pons (2009)
SPA	IB - Mallorca	Inca	Garden	♀	51	45	Present work
SPA	IB - Mallorca	Llucmajor	Coastal area		-	-	Negrea & Matic (1973)
SPA	IB - Mallorca	Marratxí	Pine forest	♀	51	41	Present work
SPA	IB - Mallorca	Marratxí	Pine forest	♀	53	43	Present work
SPA	IB - Mallorca	Palma	-	-	53-57	-	Verhoeff (1924)

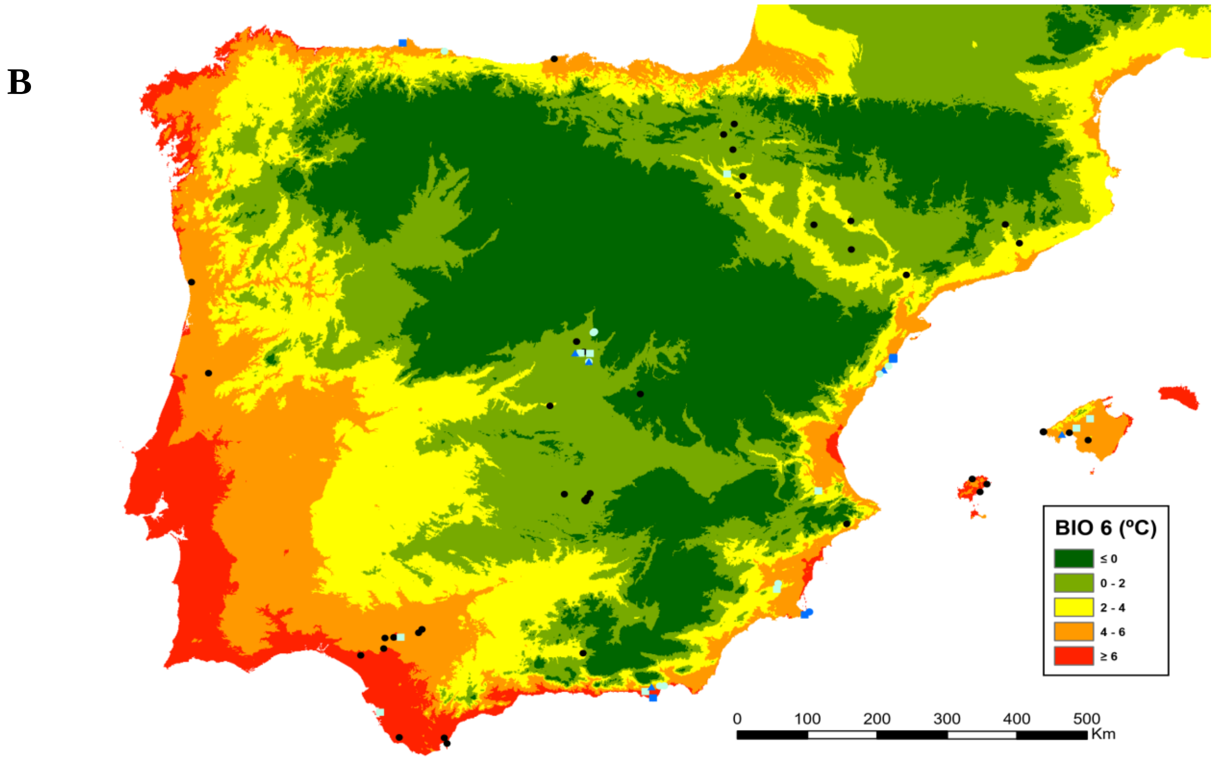
SPA	IB - Sa Dragonera	Andratx	Coastal cavity	-	-	-	Negrea & Matic (1973)
SPA	IC - Lanzarote	-	-	-	-	-	Machado (1953)
SPA	Madrid	Alcalá de Henares	Urban park at riverside	♂	53	26	Present work
SPA	Madrid	Madrid	Urban grassland	♀	49	45	Present work
SPA	Madrid	Madrid	Urban park	-	51	17	Present work
SPA	Madrid	Madrid	Urban park	♀	51	32	Present work
SPA	Madrid	Madrid	Urban park	♀	51	43	Present work
SPA	Madrid	Madrid	Urban park	♀	53	32	Present work
SPA	Madrid	Madrid	Urban garden	-	55	-	Present work
SPA	Madrid	Madrid	Holm oak grove	-	-	-	García-Ruiz (1999)
SPA	Madrid	Madrid	Pine forest	-	-	-	García-Ruiz (1999)
SPA	Madrid	Madrid	Grassland	-	49-53	-	Cabanillas (2021)
SPA	Madrid	Rivas-Vaciamadrid	Grassland	♀	55	27	Present work
SPA	Madrid	San Fernando de Henares	Riparian forest		51	-	Present work
SPA	Madrid	Valdeolmos-Alalpardo	Crop field	♀	53	29	Present work
SPA	Madrid	Valdeolmos-Alalpardo	Crop field	♀	53	45	Present work
SPA	Madrid	-	Built-up areas	-	-	-	García-Ruiz (2009)
SPA	Madrid	-	Grassland	-	-	-	García-Ruiz (2009)
SPA	Madrid	-	Suburban pine forest	-	-	-	García-Ruiz (2009)
SPA	Madrid	-	Urban park	-	-	-	García-Ruiz (2009)
SPA	Murcia	Cartagena	Dry riverbed near coast	-	57	-	Present work
SPA	Murcia	Cartagena	Pebble and sand beach	♀	59	34	Present work
SPA	Murcia	Murcia	Shrubland		51	-	Present work
SPA	Murcia	Murcia	Pine forest	♀	53	42	Present work
SPA	Navarra	Cendea de Galar	-	-	45-53	-	Salinas (1990)
SPA	Navarra	Obanos	-	-	45-53	-	Salinas (1990)
SPA	Navarra	Tafalla	-	-	45-53	-	Salinas (1990)
SPA	Navarra	Tudela	-	-	45-53	-	Salinas (1990)
SPA	Navarra	Valtierra	-	-	45-53	-	Salinas (1990)
SPA	Navarra	Villafranca	Urban garden	-	51	-	Present work
SPA	Sevilla	Bollullos de la Mitación	Stream	-	-	-	Daza *et al.* (1991)

SPA	Sevilla	Carmona	Olive grove	-	-	-	Carballo *et al*. (1986)
SPA	Sevilla	Carmona	Olive grove	-	-	-	Daza *et al*. (1991)
SPA	Sevilla	El Viso del Alcor	Grassland	-	-	-	Daza *et al*. (1991)
SPA	Sevilla	La Puebla del Río	Rice paddy	-	-	-	Carballo *et al*. (1986)
SPA	Sevilla	San Juan de Aznalfarache	Rice paddy	-	-	-	Daza *et al*. (1991)
SPA	Sevilla	Sevilla	Urban grassland	♂	51	30	Present work
SPA	Sevilla	-	-	-	-	-	Attems (1952)
SPA	Tarragona	Flix	-	-	-	-	Attems (1927)
SPA	Toledo	Toledo	Riparian forest	-	-	-	García-Ruiz & Serra (2003)
SPA	Valencia	Canals	Crop field	-	51	-	Present work
SPA	Zaragoza	Bujaraloz	Saline lagoon	-	47-49	-	Serra (1978), pers. comm.
SPA	Zaragoza	Perdiguera	Crop field	-	-	-	Present work

Appendix 2: Ibero-Balearic maps with climatic and edaphic indicators.

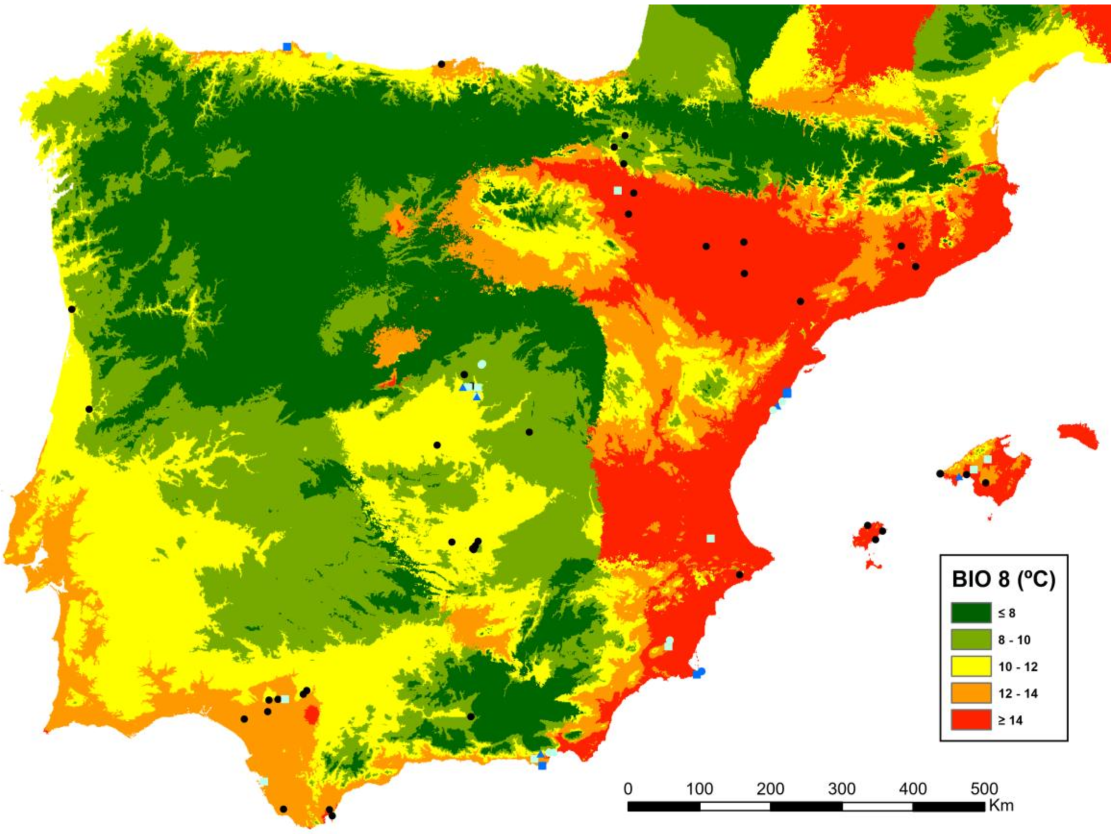
Number of leg-bearing segments: 49 (■), 51 (▲), 53 (●), 55 (■), 57 (▲), 59 (●), unknown leg-bearing segments per specimen or imprecise coordinates (●).



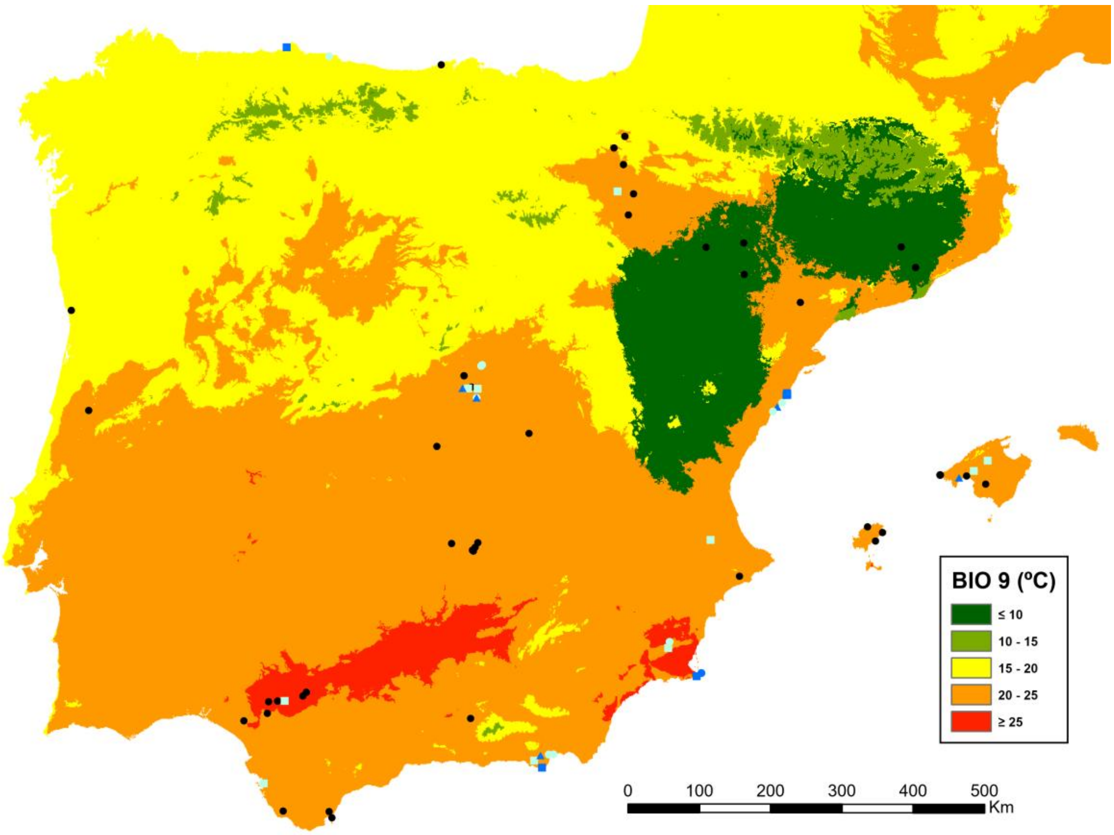


2.1: A) Maximum temperature (º C) of warmest month (BIO5). B) Minimum temperature (º C) of coldest month (BIO6).

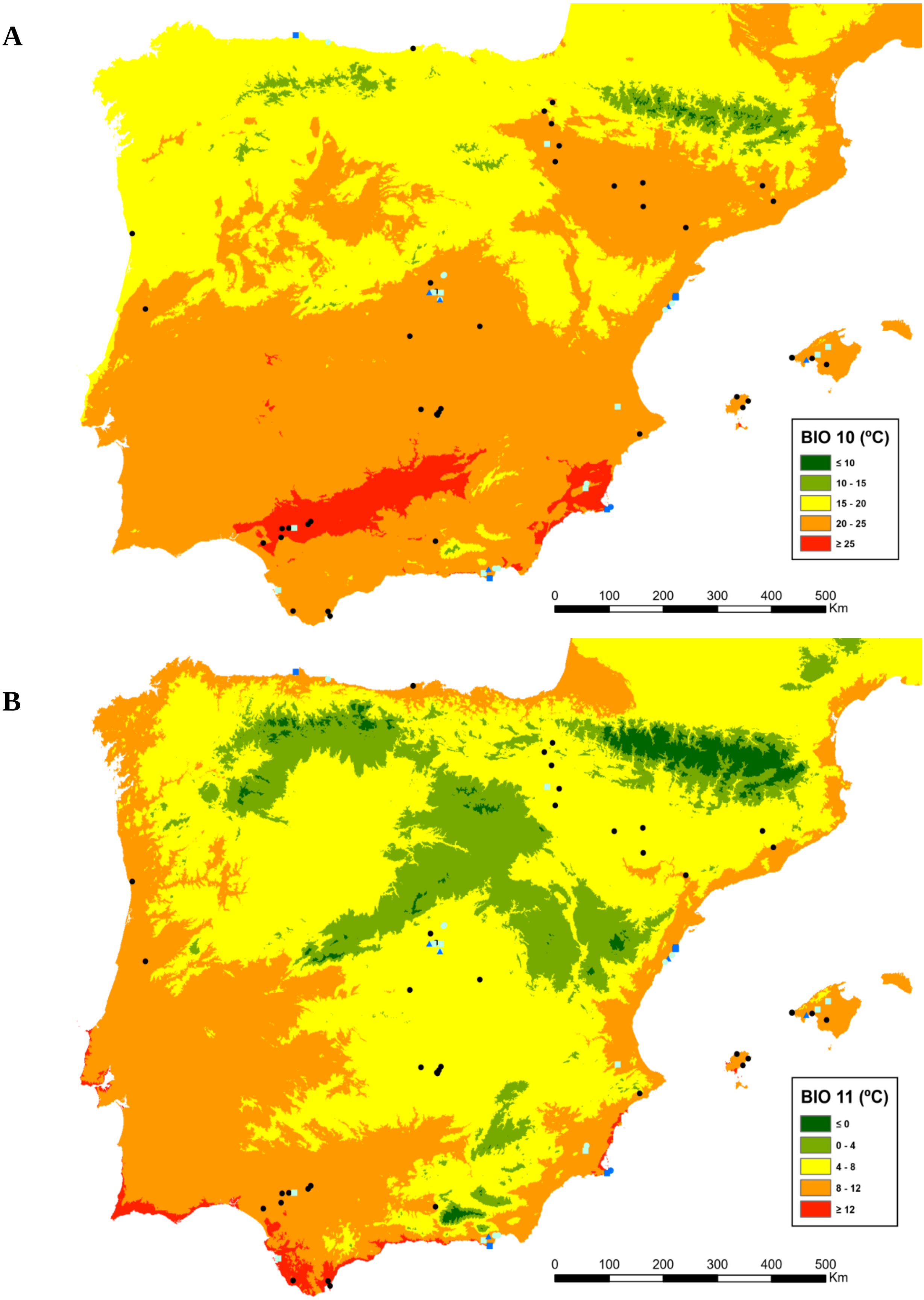
A



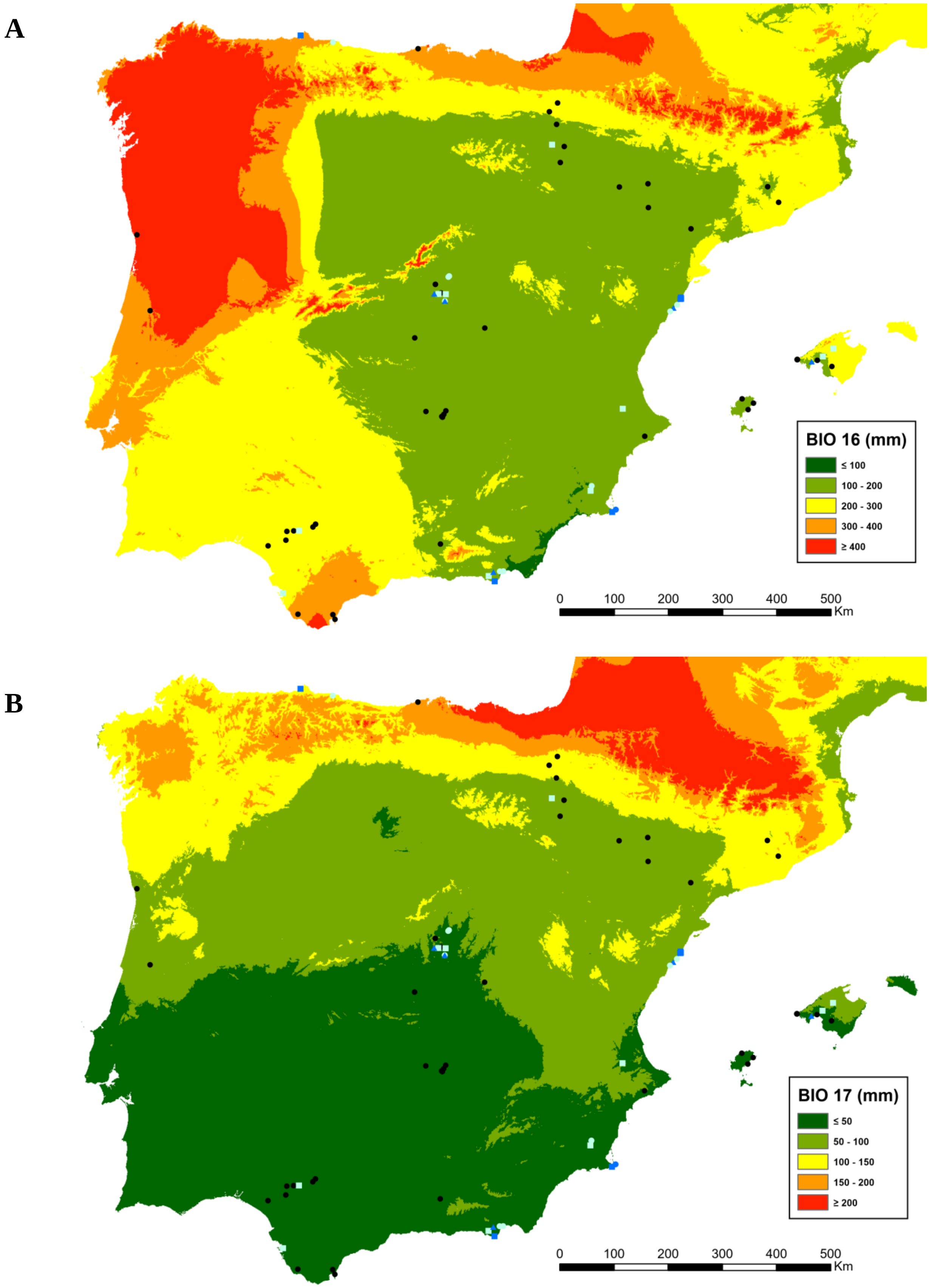
B



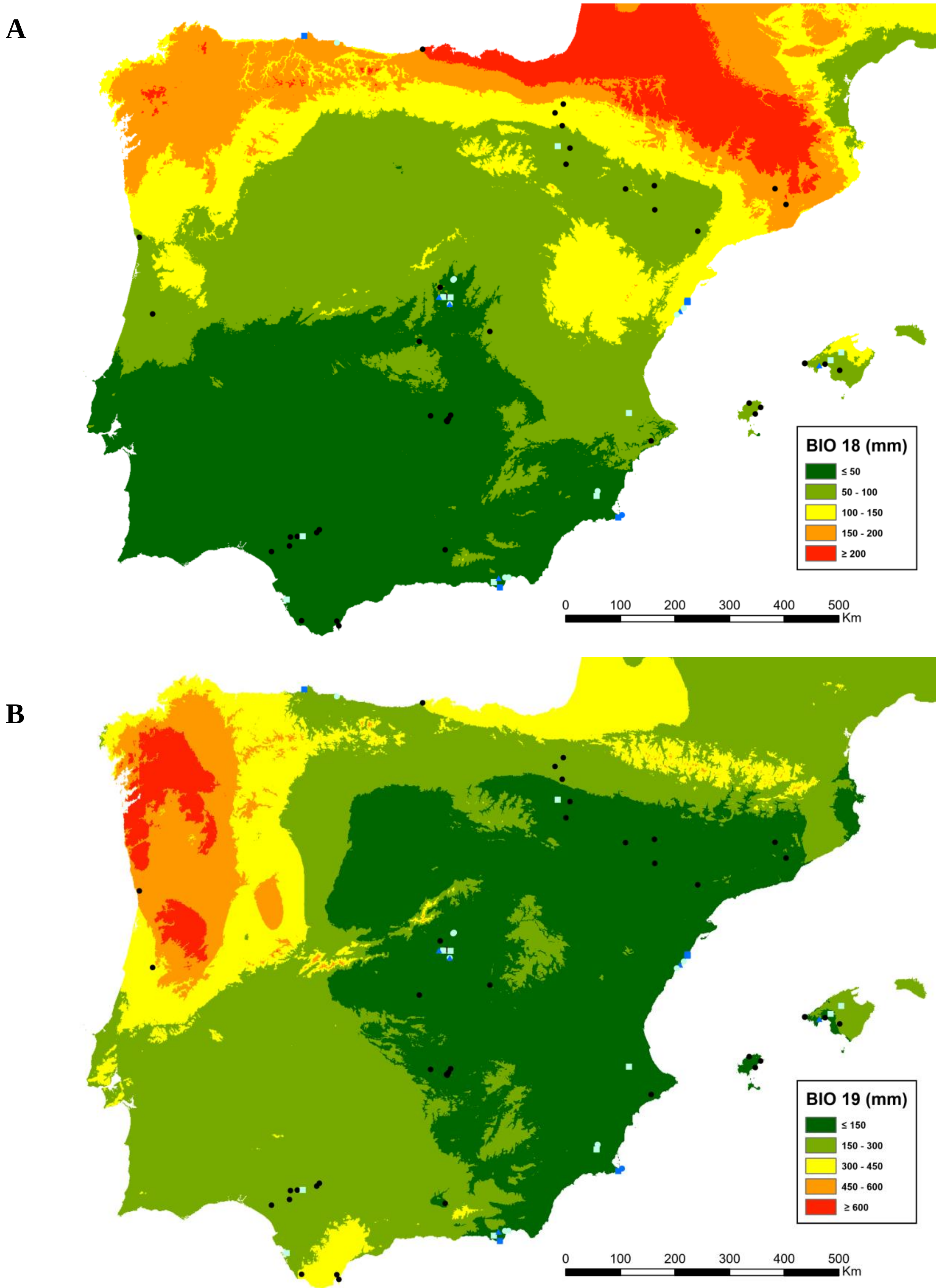
2.2: A) Mean temperature (º C) of wettest quarter (BIO8). B) Mean temperature (º C) of driest quarter (BIO9).



2.3: A) Mean temperature (º C) of warmest quarter (BIO10). B) Mean temperature (º C) of coldest quarter (BIO11).

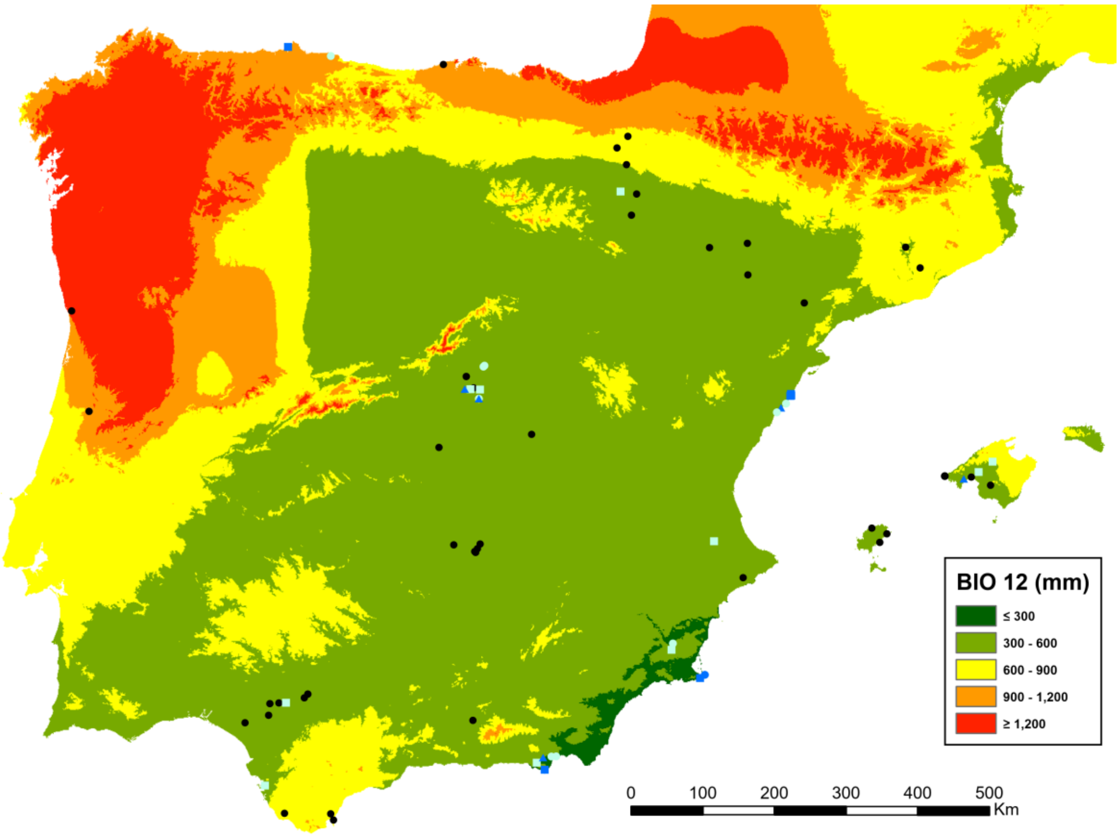


2.4: A) Precipitation (mm) of wettest quarter (BIO16). B) Precipitation (mm) of driest quarter (BIO17).

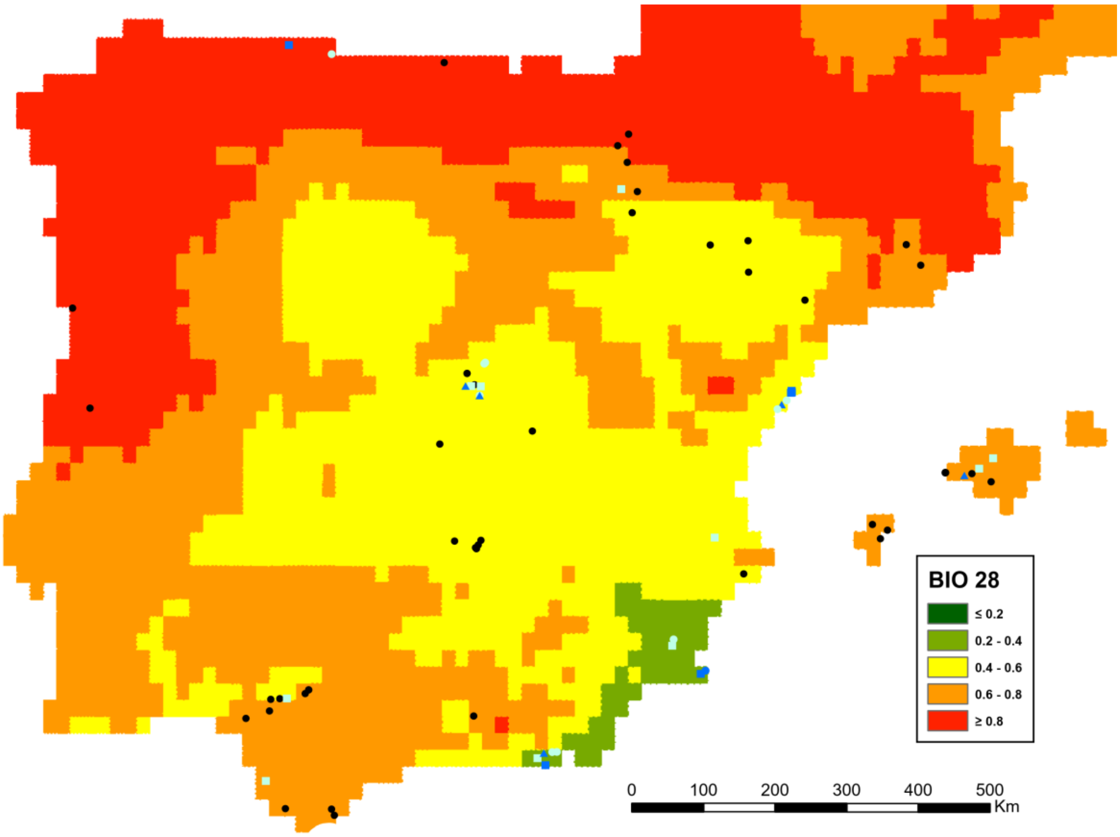


2.5: A) Precipitation (mm) of warmest quarter (BIO18). B) Precipitation (mm) of coldest quarter (BIO19).

A

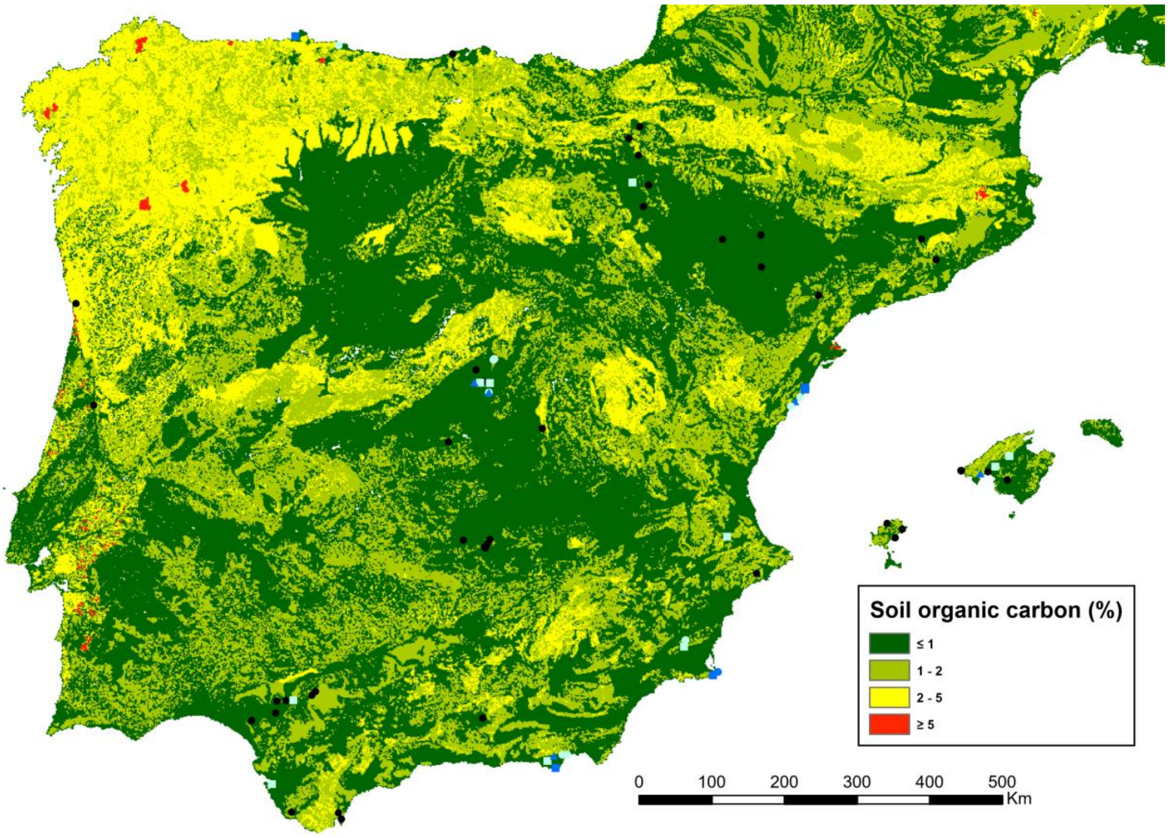


B

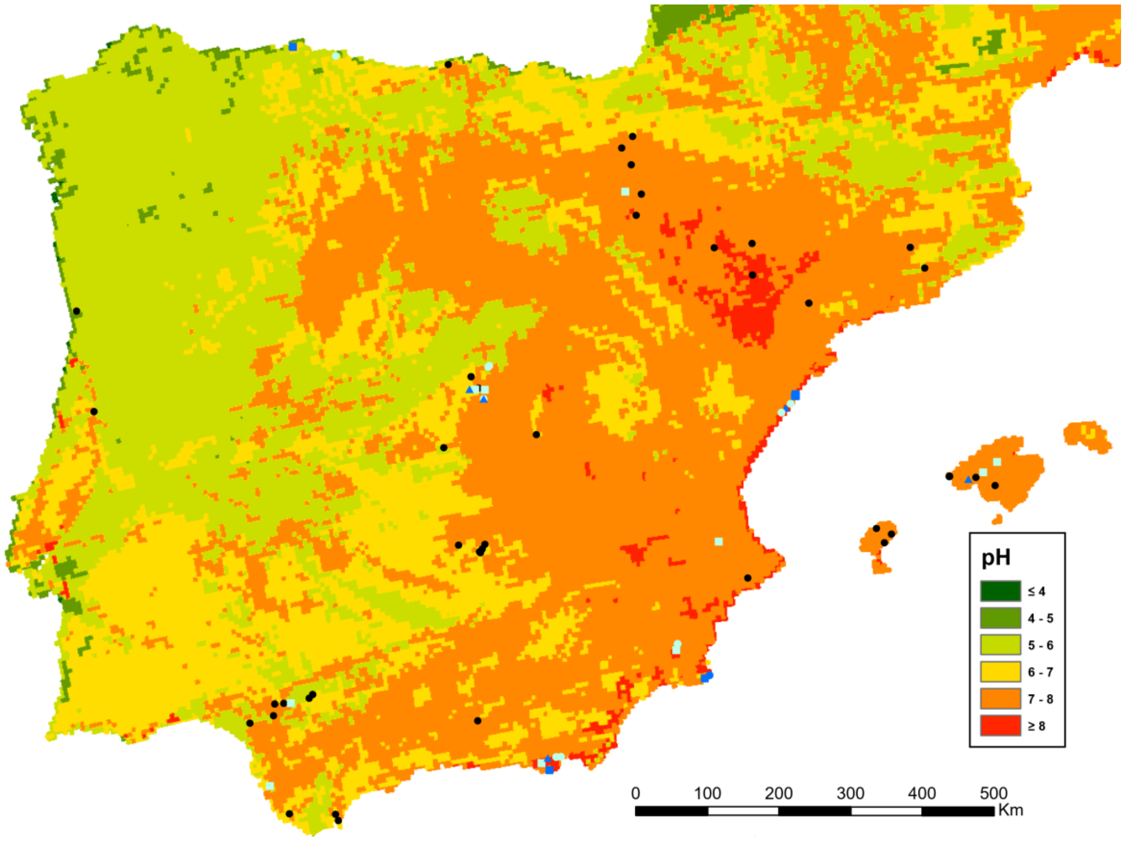


2.6: A) Annual precipitation (mm) (BIO12). B) Annual mean soil moisture index (SMI) (BIO28). Values close to 1 indicate wettest soils while values close to 0 indicate driest soils.

A

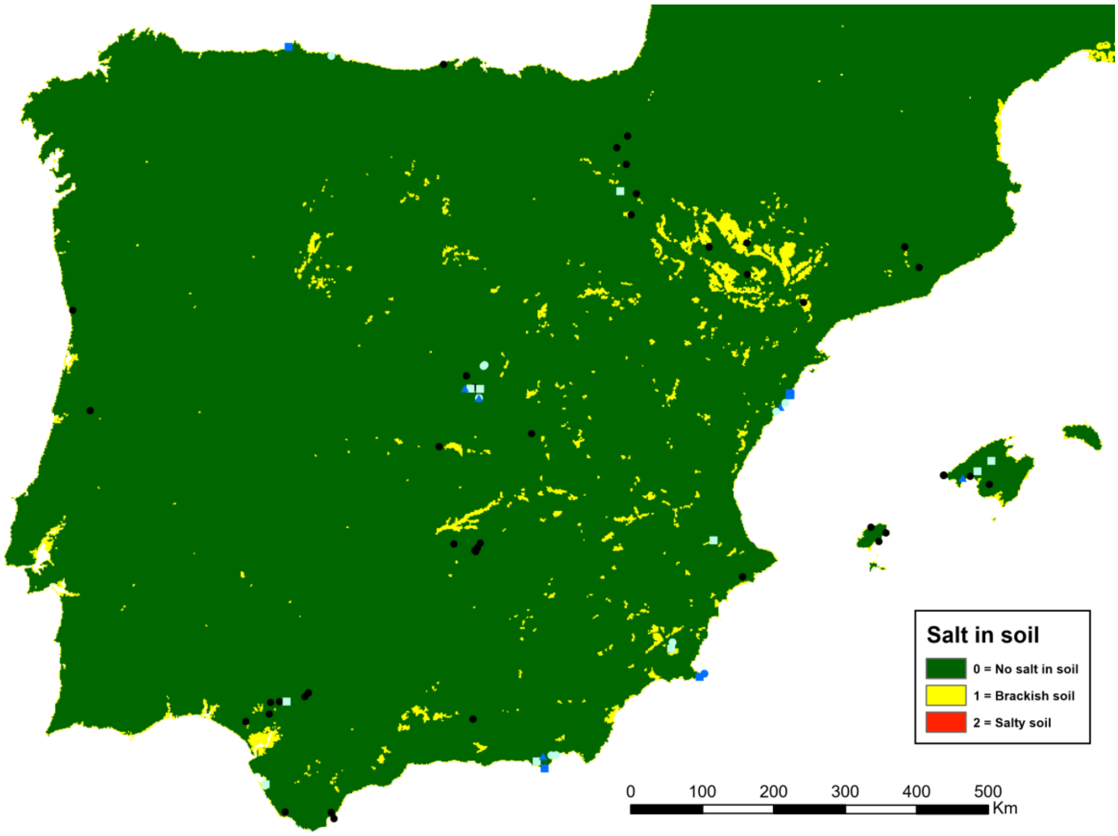


B

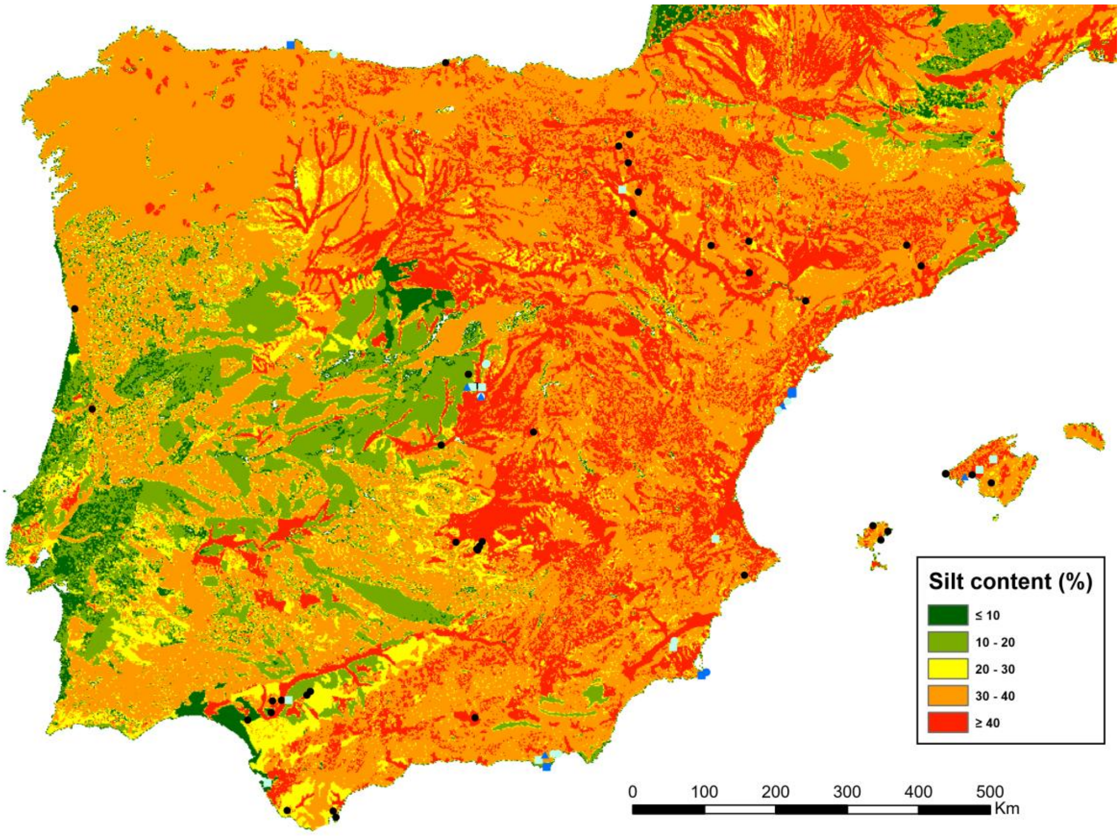


2.7: A) Soil organic carbon (%). B) Soil pH.

A



B



2.8: A) Salt in soil (0 = no salt, 1 = brackish soil, 2 = salty soil). B) Silt content (%).

Armadillidium arcangelii Strouhal, 1929 (Isopoda: Oniscidea): a step towards the conquest of Europe?

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Introduction

In the year 2014, SJG published a description of an unknown *Armadillidium* Brandt, 1831 collected in 2005 and 2010 in the Mediterranean Biome glasshouse of the Eden Project, Cornwall, UK (Gregory, 2014). The species was provisionally attributed to *Armadillidium assimile* Budde-Lund (Gregory, 2010), but differed by its smaller size and in the shape of the 1st pleopod-exopod.

During the period 2014-2015 FN was sent numerous specimens of what appeared to be the same unknown species from several French localities ranging from the Italian border to the Atlantic coast, proving that this species could also live outdoors in North West Europe and was likely to be of European origin.

In the year 2021, following a thorough examination of the available literature by GA, it is possible for us to propose a name for this species and at the same time to re-examine the observations available in order to draw together an overview of its colonisation across Europe.

Here we present the first results obtained and provide criteria for the identification of this species, namely *Armadillidium arcangelii* Strouhal, 1929.

Description

A brief description of the specimens collected from the Eden Project, including drawing of the male characters (intended to differentiate from known UK species), is published by Gregory (2014). A picture of a specimen, collected from the Eden Project, is also present on the BMIG website https://www.bmig.org.uk/species/Armadillidium-arcangelii.

Good (and detailed) illustrations of the habitus of the male of this species are provided by Arp Kruithof (see Fig. 2) and by various observers on the iNaturalist website. For example:

https://www.inaturalist.org/observations/66427092,
https://www.inaturalist.org/observations/42230944 and
https://www.inaturalist.org/observations/67408049.

General appearance

This species is one of the smaller *Armadillidium* in Western Europe, reaching only 8 mm for females (males being smaller). The ground colour varies from dark brown to a mixture of yellow and light brown mottling, females being less uniform and lighter than males. Dark specimens usually show conspicuously pale muscle attachment spots. Epimera are always lighter than the rest of the body. Dorsum with light granulations. The pereionite 1 posterior margin is regularly sinuous. See Figs. 1 & 2.

Figure 1: Detail of head & telson. Image Franck Noël

Figure 2: Habitus and details (head, telson).
Image Arp Kruithof: https://waarneming.nl/observation/4090280/

Cephalon

Fig. 3. The frontal shield (scutellum) is wide, only slightly protruding above the head, with the posterior edge slightly convex and curved over the vertex. Between this and the head, a very small, inconspicuous depression is present. In frontal view, the antenna lobes show a slight angle on their upper part.

Figure 3: Cephalon, details.
Image Thomas Hughes

Telson

Fig. 1 & 2. The telson is about as wide as long, with a narrow, rounded tip.

Male sexual characters

Fig. 4 & 5. The outer edge of the posterior lobe of the 1st pleopod-exopod is shallowly indented, showing a distinct, but shallow, angle centred on the position of the external part the tracheal field (Fig. 4, arrowed).

The 1st pleopod-endopod is straight for much of its length, but slightly curved outwards at the tip.

The 2nd pleopod-exopod is elongated with a slightly curved inwards tip. The 1st pleopod-endopod does not show any useful features for identification.

The 1st pair of pereiopods show no particular modification which can be used for species identification. An enlarged foliaceous spine is present on the carpus of pereiopod 1. The 7th pair is much stouter in males (especially the merus). The inner edge of the ischium is straight. The end of the sternal side shows a crown of 6 to 8 curved spines. The external side is depressed with a setose area extending for nearly 1/3 of the article, which is similar to the description and figures given for *A. apenninorum* in Verhoeff, 1928 (fig.10, p114 – reproduced in Fig. 6).

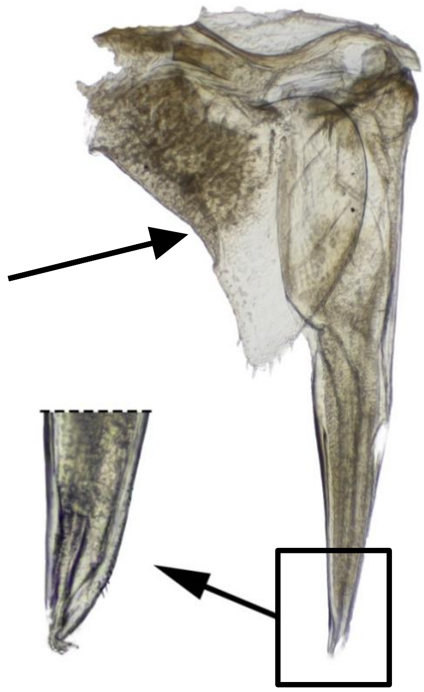

Figure 4: Adult male first pleopod.
Image Thomas Hughes

Attribution to *A. arcangelii*

Armadillidium Brandt is a diverse genus, endemic to Europe, North Africa and West Asia, with more than 180 species described (Boyko *et al*., 2008), many of them occurring in Mediterranean regions (Schmalfuss, 2003).

The original descriptions made by Verhoeff, 1928 (of *A. apenninorum*) and Strouhal, 1929a; 1929b (of *A. marmoratum* and *A. arcangelii*, respectively) allowed us to attribute our observations to *Armadillidium arcangelii* Strouhal, 1929.

Armadillidium arcangelii is quite similar to *A. marmoratum* Strouhal, 1929, an eastern Mediterranean species whose distribution ranges from Greece to Egypt, which shows the same pigmentation pattern, with the epimera lighter than the dorsal part of the tergites, but its average size is much larger.

Armadillidium arcangelii is also very close morphologically to *A. apenninorum* Verhoeff, 1928, another Italian species. Schmölzer (1954) in its key to *Armadillidium* separates *A. apenninorum* from both *A. marmoratum* and *A. arcangelii* by the shape of the outer edge of the posterior lobe of the 1st pleopod-exopod, showing no angle with the tracheal field (Figs. 6 & 7). Also, the 1st pleopod-endopod is said to be straight, up to the tip (*vs* hardly noticeably curved outwards at the tip for *A. marmoratum* and *A. arcangelii*) (Schmölzer, 1954; 1965).

GA was able to collect specimens of *A. marmoratum* from Greece and these were compared, under a microscope, with specimens of presumed *A. arcangelii* from France. The 1st pleopod-exopod are similar in the two species but the tracheal field seems to be more developed in *A. marmoratum*. The 1st pleopod-endopod of *A. marmoratum* is straight for its entire length, not curved at the tip. Another character, which could be used for photo identification is the antenna flagellum, with the 2nd flagellomère being noticeably longer in *A. arcangelii* than in *A. marmoratum* (being of subequal length).

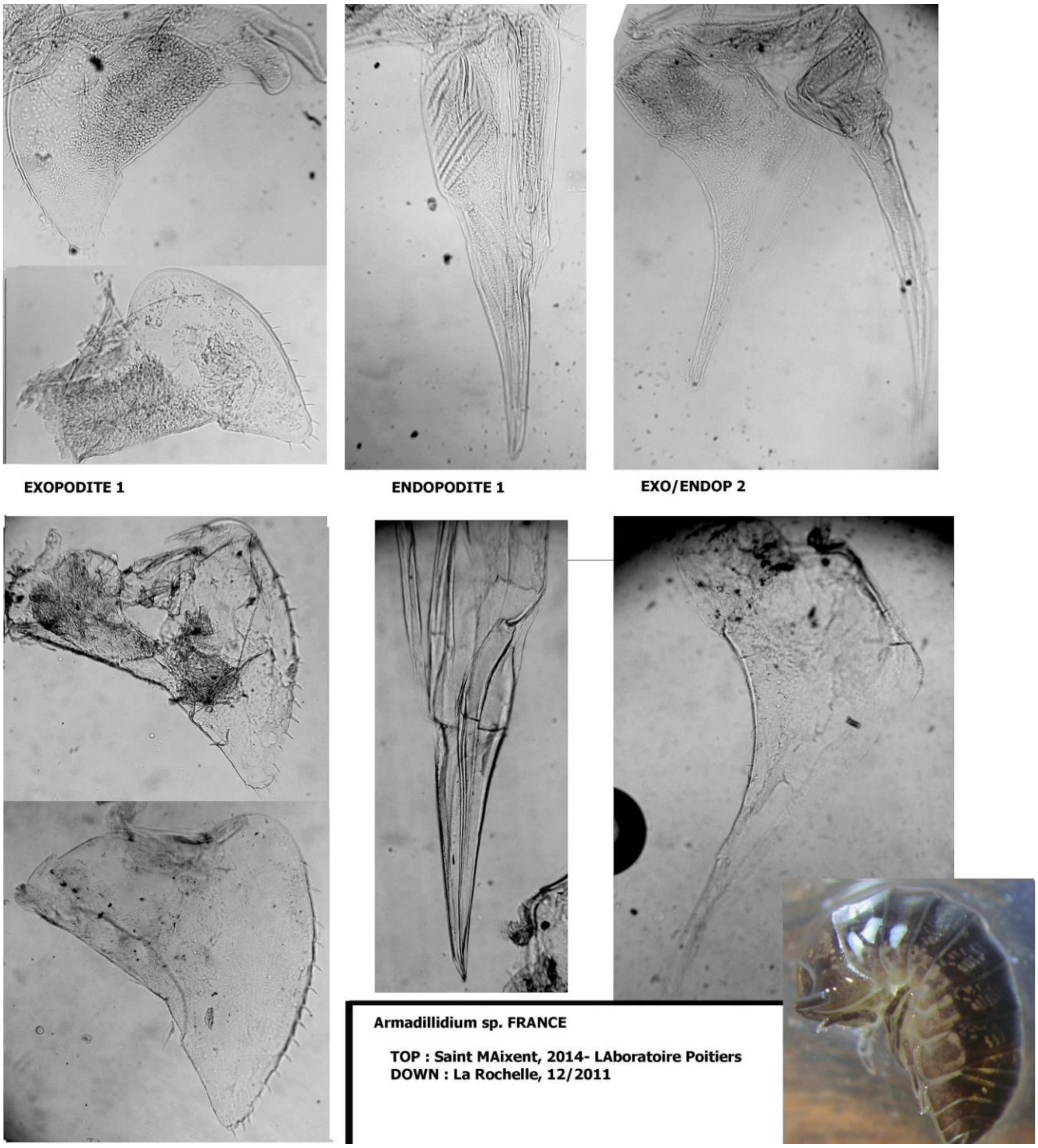

Figure 5: First records of *A.* cf. *arcangelii* in western France
Saint Maixent, Equipe Ecologie Evolution Symbiose, University of Poitiers.
Alexandra Lafitte, Didier Bouchon, Catherine Souty-Grosset leg.

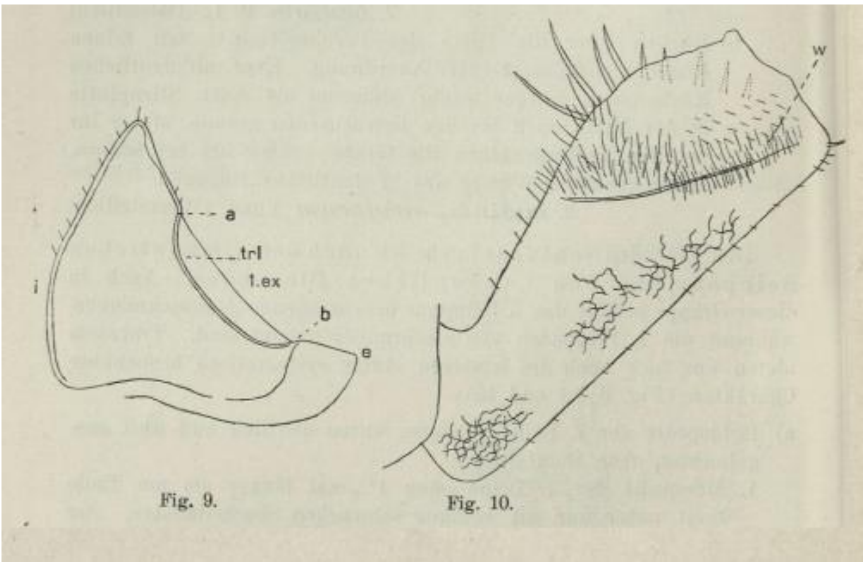

Figure 6: *Armadillidium apenninorum*. Drawing from Verhoeff, 1928.

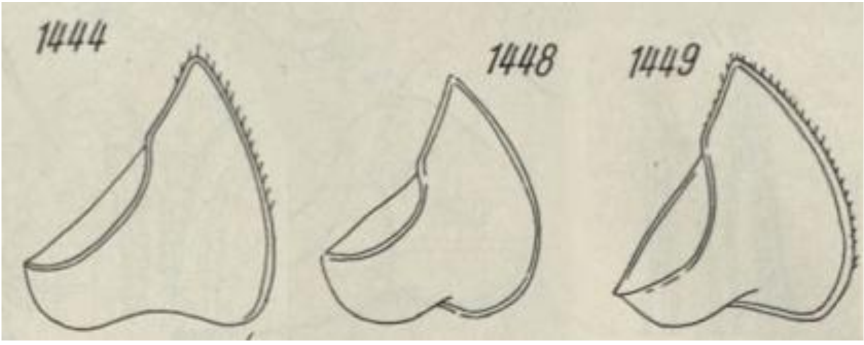

Figure 7: 1st pleopod-exopod from Schmölzer (1965).
1444: *A. apenninorum*, 1448: *A. marmoratum*, 1449: *A. arcangelii*.

The similarity between *A. apenninorum* and *A. arcangelii* has caused some authors to suspect that they may be synonymous (Schmalfuss 2003, 2006a). Verhoeff (1936) seems to find differences in both the 7th male pereiopod: "The 7th pair of legs of males is particularly important with regard to the carpus, since in *apenninorum* this is more than 2½ times as long as wide, whereas in *arcangelii* it is only twice as long as wide" and in the head formation [about *A. arcangelii*] "The frontal plate, which protrudes only slightly, appears flat when viewed from above and behind it there is a transverse gap". The male specimens we were able to examine under a microscope always had a carpus fitting this description for *A. arcangelii*.

Given the small morphological differences and the same distribution pattern, *A. arcangelii* could be a junior synonym of *A. apenninorum* (Stefano Taiti, *pers. comm.*).

We accept that some differences do occur with the original description given in Strouhal, 1929 and subsequently in Verhoeff (1933; 1936) and Schmölzer (1954; 1965). This is particularly the case for the 1st exopodite, which shows an angle (although not pronounced) at the posterior part of the tracheal field. In fact, this important feature is age-related, with young males having a more pronounced angle than adults ones and a less developed lobe. This is illustrated in Garcia & Cabanillas (2021, fig. 4, A & B), and see also individual variations of adult and immature males from France (Fig. 5, 1st column). Until a review of these three taxa is carried out, we consider that the specimens we have observed belong to the species *A. arcangelii*.

Recent data on the expansion of *A. arcangelii* across Europe

Identification work has been carried out on different forums or websites for several years, from photos posted by observers, by both FN and GA. In particular the forum naturamediteraneo (Italy), the forum of the World of Insects "insectes.org" (France) and more recently the site iNaturalist.org were consulted.

Until now, this species has been identified by different names: *Armadillidium* sp., *Armadillidium* sp. A, *Armadillidium* cf. *assimile,* etc. This does not facilitate proper monitoring of its dispersal across Europe. A review will soon be carried out to standardise the determinations, most of which have been collated on the GBIF website (www.gbif.org).

The following section summarises the available observations (outside Italy) that we have been able to collate regarding the expansion of *A. arcangelii* across Western Europe.

United Kingdom: Several specimens were caught in 2005 and 2010 in the Mediterranean Biome glasshouse of the Eden Project in south west England (Gregory, 2014 & 2010). The species has not been found outdoors and is probably not yet acclimatised.

France: The species was first recorded in 2014 and now seems to be dispersing along much of the Atlantic and Mediterranean coasts, probably following a residential and commercial "coastal sprawl". The species was collected from the following Départements: Alpes-Maritimes (J.M. Lemaire rec.), Aude, Charente-Maritime (F. Noël rec. & det.), Deux-Sèvres (Poitiers' University lab), Hérault (Many observations), Var, Gard (J.-M. Ruiz, 12.vii.2021) reaching Paris to the north (Jardín des Serres d'Auteuil, 06.ix.2019, T. Hughes rec.). We also have photographic evidence from Villeurbanne (Rhône) and near Grenoble (Isère), showing that the species is probably spreading north, following the Rhône valley. Most of the records come from gardens and public city parks and the species is more widespread near the coast than inland, maybe due to warmer winter climate.

The question of the abundance of the species in the Crau Steppe (Durance Valley, near Arles, Bouches-du-Rhône), where *A. assimile* has been mentioned for many years has been questioned recently (D. Pavon, *in litt*.). In fact *A. arcangelii* could have been present in these dry habitats for a long time, but confused with *A. assimile* by local naturalists.

Principality of Monaco: Located near the Italian boarder, in some stations *A. arcangelii* is by far the most abundant isopod, reaching remarkable densities (up to 500 individuals in a single pitfall trap implanted on a vegetated roof with *Sedum* spp.) (Lemaire & Raffaldi, 2016).

Spain: Javier A. Canteros took some images of one possible female, 27.iii.2021, north of Barcelona (posted on iNaturalist) and both J.-A. Canteros on 27.iii.2021 and A. Rubio near the same place on 9.vii.2021. Other records posted on iNaturalist include observations from D. Fhuerta near Valence, and from M. Delbas near Girona (Catalunya). Garcia & Cabanillos (2021) have published a record from Ambroz, near Madrid (05.ii.2021) and Garcia & Rojas (2021) an observation from Cádiz, Puerto Real (23.ii.2021). The species seems to be well established and distributed in most Spanish provinces, and it probably has been present in this country for many years.

Portugal: Some observations were posted on the iNaturalist website. The species now seems to be well established in Portugal. A photo from Albufeira (southern Portugal) by Luís Lopes Silva on 23.vii.2020 seems to fit the species. Other specimens were seen and photographed in the Vale do Guardiana NP, Beja District by Joao Tiago Tavares on 08.iv.2019 and by Luis Lopes Silva on the coast between Faro and Portimao, 22.viii.2021. The northernmost record for Portugal is from Viseu, seen by Rui Macário Ribeiro on 19.iv.2020.

Belgium: A possible observation is posted by Alex « Yaminatori » on the iNaturalist forum. The photo is quite distant but the pattern would fit the description of *A. arcangelii*. The specimen was photographed in the center of Ghent, 19.vi.2020. Subsequently, Pallieter De Smedt went to the exact locality but failed to find the species. Similarly, no specimens were found in isopod samples from pitfall traps during a study on green roofs in the city of Antwerp in 2020. The presence of *A. arcangelii* in Belgium is thus doubtful.

Austria: Matthäus Greilhuber collected some specimens of *A. arcangelii* and took photographs of a dissected male under a microscope that he posted on the iNaturalist forum. These came from the Campus Gertrud Frölich-Sandner in Wien, 18.iv.2020.

Croatia: Danijel Ostović posted some picture of one specimen climbing on a wall in "Gajnice", a mixed residential and industrial area of Zagreb 23.viii.2021. They show typical male pattern (mostly dark with light epimera) and triangular telson.

Poland: In 2019, Artur Szpalek posted photographs on forums in order to identify strange Armadillids found in Lavender (*Lavendula* sp.) plants south of Warsaw; these plants originating from The Netherlands. This record gives evidence of the dispersal of *A. arcangelii* via plant material from The Netherlands. A paper, including this record, about interesting observations based of 'citizen science' data will be published soon (Radomir Jaskula, pers. comm.).

Germany: A specimen showing typical pattern is posted on iNaturalist forum by "Recall79", from a house in Langen (Hessen) 18.vi.2021. Unfortunately, only one photo was posted and we were not able to confirm the identification.

The Netherlands: As the Lavender reported in Poland (see above) came from the Netherlands, we contacted Arp Kruithopf. He then remembered an old record from 2008, when he photographed a male coming from the sales area of a garden centre in Deurningen (north of Enschede, near the German border). The photos were posted on the national forum Waarneming.nl ~ https://forum.waarneming.nl/index.php/topic,469101.0.html where it is possible to see all relevant characters, including pleopods, to confirm *A. arcangelii*.

Greece: Specimens attributed to *A. arcangelii* have been found in Greece three times now. The first one concerns individuals observed and collected in the garden of one of us (GA), from April 2019 until June 2021. The origin of this population isn't known for sure, but it is speculated that the individuals were either unintentionally transported there via ornamental plants and/or bags of soil, or that they moved freely between the various interconnected gardens of the neighbourhood, many of which are in a semi-abandoned state. It is also worth noting that the faunal composition of the garden consists almost exclusively of both strongly synanthropic invasive and indigenous species. The first category contains the ant *Nylanderia jaegerskioeldi* (Mayr, 1904), the millipede *Oxidus gracilis* (C. L. Koch, 1847) and the slug *Ambigolimax valentianus* (Férussac, 1822) and the second one the isopods *Agabiformius lentus* (Budde-Lund, 1885), *Armadillo officinalis* Duméril, 1816 and *Porcellionides pruinosus* (Brandt, 1833), the millipede *Pachyiulus flavipes* (C. L. Koch, 1847), the slug *Limacus flavus* (Linnæus, 1758) and the snail *Xerotricha conspurcata* (Draparnaud, 1801). The second record concerns specimens observed and photographed by Savvas Zafeiriou in 26.vi.2019 in the suburb of Glyfada, south of Athens. Around 20 individuals were found walking around inside a potted plant containing succulents in Savvas's garden, which is also in a semi-abandoned state. The specimens were originally misidentified as *Armadillidium atticum* Strouhal, 1929, but after closer examination of the photos by one of the authors (GA), they proved to belong to *A. arcangelii* instead. The third and final record is about a single individual observed and collected alive by one of us (GA) in April 2021. The specimen was found about 1-2 km away from the house of the author, climbing on the exterior wall of a garden, itself built next to the local entrance of the subway. This garden was also in a semi-abandoned and disturbed state.

Turkey: A group of 28 individuals is photographed by Tandoğan Oruz 22.v.2021 near a town park in the town of Tire (Izmir) (Fig. 8). Details observed following microscopic examination were also sent later and match the description of *A. arcangelii*.

Figure 8: ***Armadillidium* cf. *arcangelii* from a group of 28, Tire (Turkey).**
Posted on iNaturalist by Tandoğan Oruz.

Figure 9: Habitus of a female specimen, *Armadillidium* sp.. Marina Gorbunova, near Sebastopol
https://www.inaturalist.org/observations/53949598

Black Sea region: Individuals matching *A. arcangelii* / *marmoratum* in pattern were photographed by iNaturalist user "daniil_polyakov" on 10.viii.2020 in the Russian Adler Microdistrict, some kilometers northwest of the borders with Republic of Abkhazia. The habitat in which they were found (adjacent to the sea) is typical of the Eastern Mediterranean *A. marmoratum*, but as the region is outside of the known distribution of this species and no specimens have been examined yet, we can’t tell for sure if it belongs to *A. arcangelii*, *A. marmoratum* or a superficially similar species. Finally, the recent discovery of some *Armadillidium* populations in the northern Black Sea (north of Sebastopol) by Marina Gorbunova is interesting (Fig. 9). The individuals show a pattern that closely, but not entirely, matches that of *A. arcangelii* / *marmoratum*. However, because no individuals have been closely examined and at least one group of species that can look similar to *A. arcangelii* / *marmoratum* (the "*Armadillidium insulanum*-complex") is known to inhabit the nearby regions of Aegean and southern Black Sea coasts (Schmalfuss, 2006b), we don't feel safe ascribing this record to species level.

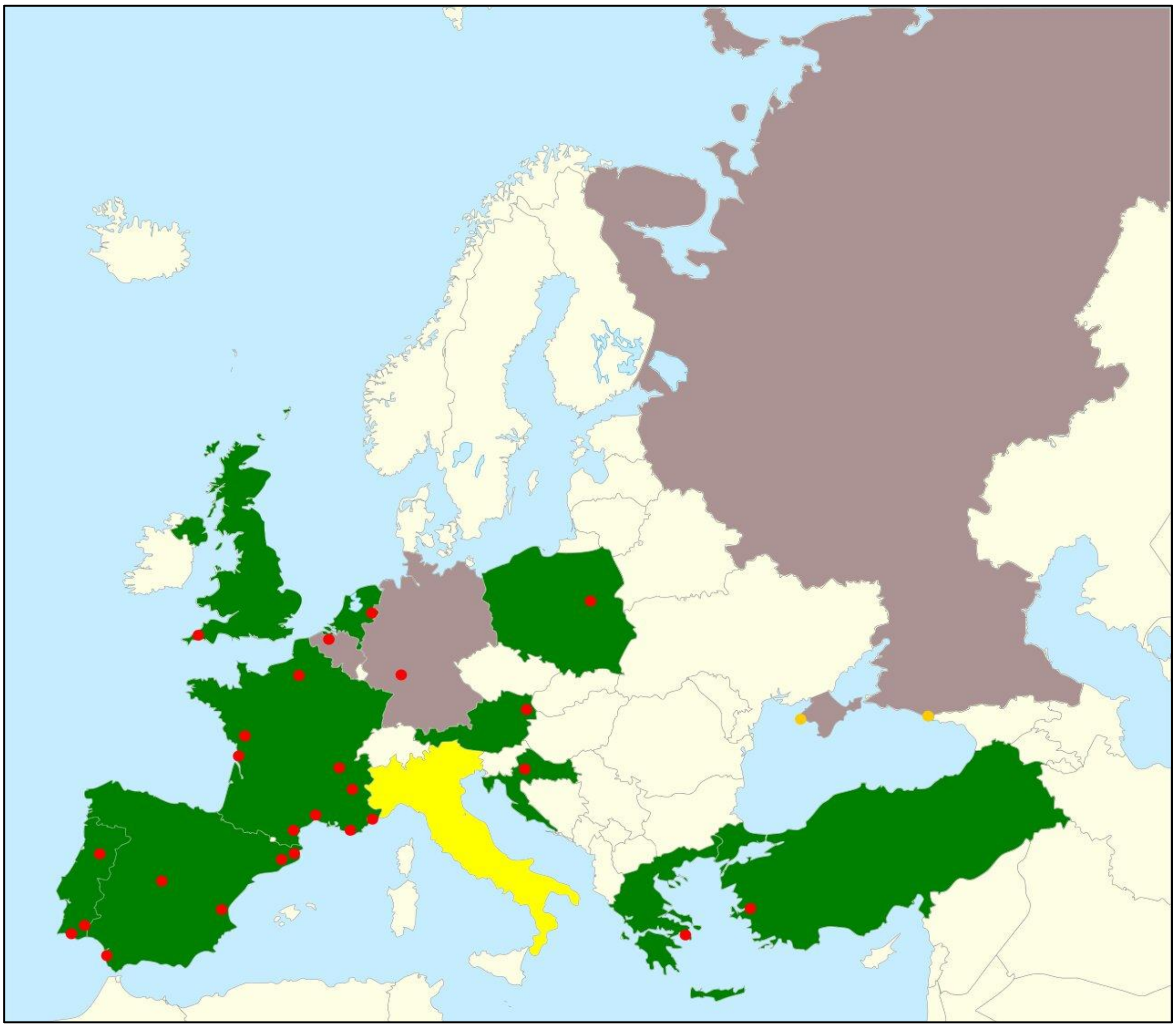

Figure 10: Map of known distribution of *A. arcangelii*

- Country of origin (mainland Italy).
- Countries with verified records (high quality photos and/or examined males).
- Countries with possible, but unverified records (low quality photos and/or only females).
- Specific regions/locations in which specimens were observed/collected.
- Black Sea records with matching phenotypes, that could either belong to *A. arcangelii*, *A. marmoratum* or an indigenous lineage, such as the *A. insulanum*-complex.

Conclusion

The recent expansion of *A. arcangelii* is documented, with records from most of the western European countries (Fig. 10), albeit some still needing to be confirmed by male characters. The species seems to be now quite widespread along the Mediterranean coasts from France to Portugal and is also expanding north along the Atlantic coast and, inland, along the Rhone valley.

Most of the records are made in synanthropic conditions, and anthropochory is documented in Poland, from Lavender plants imported from The Netherlands. Most observations come from gardens or city parks, providing evidence of anthropogenic dispersal via the horticultural trade.

In some localities, particularly on dry habitats, *A. arcangelii* is now the most abundant *Armadillidium* species and even seems to surpass the local *A. vulgare* and *A. nasatum*, suggesting it may be more competitive in some synanthropic habitats. The species is also known from natural, less modified habitats and was recently found in Ré island (Charente-Maritime, France) on sand dunes near *A. album* specimens (F. Noël, pers. obsv.).

Recent discussion also raised the hypothesis of a long unsuspected presence, in the Rhône valley, not far from the Italian border. Here possibly the species went unnoticed, being confused with immature *A. assimile*.

The apparent rapid expansion should lead to an increase in the number of observations across Western Europe and a definitive establishment of the species in some countries. The future development of this species should be monitored and its interactions with other *Armadillidium* species should be studied.

Also, dedicated taxonomic work should be undertaken on the complex *A. arcangelii* / *marmoratum / apenninorum*. We reiterate the problem of age-biased variability of the 1st pleopod-exopod, used in old descriptions and we encourage researchers to perform barcoding on populations of both *A. marmoratum* and *A. apenninorum* in order to compare sequences with those of *A. arcangelii* already obtained.

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Review of the study of woodlice (Crustacea: Isopoda: Oniscidea) in Belarus

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Key words: terrestrial isopods, woodlice, biodiversity, fauna, Belarus.

Abstract

The results of the study of woodlice biodiversity in Belarus are analized in the article. The total number of known species has reached 13, which belong to 7 families. In the future, we should expect the expansion of the species composition of this group of terrestrial invertebrates due to the finds of new species.

Introduction

Woodlice (Oniscidea) – one of the most important groups of terrestrial invertebrates. They act as important elements of food chains, participating in the biological cycle of terrestrial ecosystems and soil-forming processes (Borutzky, 1958). A feature of woodlice is a tendency to inhabit synanthropic sites, which makes them a common bioindicator and one of the most popular zoological objects in the study of urban ecosystems. Also, these invertebrates have the ability to accumulate heavy metals, and therefore are convenient test objects in environmental monitoring of the state of the environment (Bibič *et al.*, 1997; Paoletti & Hassall, 1999).

However, despite the scientific and practical significance of woodlice, no special work on the study of this group of terrestrial invertebrates has been carried out in Belarus before. Fragmentary information (most often woodlice were identified to family at best) can be found in the soil and zoological works carried out in different years on the territory of the Republic, as well as in the generalising article by Maximova (2005), where the presence of 4 species is given. At the same time, Kuznetsova & Gongalsky (2012) in the publication on the cartographic analysis of the woodlice fauna of the former USSR provide information about the habitat in the territory of our republic of 8 species, of which *Porcellio crassicornis* C. Koch, 1841 is currently considered a synonym of *Porcellium conspersum* C. Koch, 1841, that is, 7 species. Finally, the Fauna Europaea database (Boxshall, 2013) contains information about only one species – *Oniscus asellus* Linnaeus, 1758.

Results

As a result of research actively conducted in recent years in various regions of the country (Ostrovsky, 2019a; b; c; d; e; f; 2020; 2021a; b), the fauna of woodlice in Belarus has been enriched with 3 new species: *Armadillidium vulgare* (Latreille, 1804), *Hyloniscus riparius* (S. Koch, 1838) and *Porcellionides pruinosus* (Brandt, 1833). Another species – *A. pulchellum* (Zenker, 1798) – was discovered by the author of this article in August 2018 in the collection of Oleg Aleksandrowicz during a scientific internship at the Institute of Biology and Environmental Protection of the Pomeranian Academy in Slupsk (Poland) (Ostrovsky, 2019b) (Table 1).

Table 1: Systematic list of woodlice species (Oniscidea) of the fauna of Belarus

Species	Maximova (2005)	Kuznetsova & Gongalsky (2012)	Boxshall (2013)	Ostrovsky (2019a; b; c; d; e; f; 2020; 2012a; b)
Family Armadillidiidae Brandt, 1833 1) *Armadillidium pulchellum* (Zenker, 1798)				#
2) *Armadillidium vulgare* (Latreille, 1804)				#
Family Cylisticidae Verhoeff, 1949 3) *Cylisticus convexus* (De Geer, 1778)	#			#
Family Ligiidae Leach, 1814 4) *Ligidium hypnorum* Cuvier, 1792	#	#		
Family Oniscidae Latreille, 1802 5) *Oniscus asellus* Linnaeus, 1758			#	#
Family Porcellionidae Verhoeff, 1918 6) *Porcellio scaber* Latreille, 1804	#	#		#
7) *Porcellio spinicornis* Say, 1818		#		#
8) *Porcellionides pruinosus* (Brandt, 1833)				#
Family Trachelipodidae Strouhal, 1953 9) *Porcellium conspersum* C. Koch, 1841		#		
10) *Protracheoniscus orientalis* (Uljanin, 1875)		#		
11) *Trachelipus difficilis* Radu, 1950		#		
12) *Trachelipus rathkii* (Brandt, 1833)	#	#		#
Family Trichoniscidae Sars, 1899 13) *Hyloniscus riparius* (C. Koch, 1838)				#

Conclusions

Thus, collating the information available to date on the fauna of terrestrial isopods of Belarus, it is possible to guarantee with a certain degree of confidence that 13 species of woodlice from 7 families live on the territory of our country. At the same time, taking into account the registration of about 15 species of woodlice in the adjacent territories of neighbouring countries (Novitsky, 2013), in the future, we should expect an expansion of the species composition of this group of terrestrial invertebrates, for which it is planned to continue their further study.

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Cylindroiulus bouvieri (Brölemann, 1896) a long-overlooked synonym of *C. parisiorum* (Brölemann & Verhoeff, 1896) (Diplopoda: Julida: Julidae).

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Introduction

In a recent study of *Cylindroiulus* from Spain (Read, 2022) HJR came across mention of *Cylindroiulus bouvieri* (Brölemann, 1896) because it was compared by Attems (1952) to two *Cylindroiulus* species he described, *C. franzi* Attems, 1952 and *C. unciger* Attems, 1952.

Cylindroiulus bouvieri (Brölemann, 1896) was described originally as *Julus (Anoploiulus) bouvieri* Brölemann, 1896 in the same paper as *C. parisorum (*Brölemann & Verhoeff, 1896) and *C. parisiorum miraculus* (Verhoeff, 1896)*. The description was based on a single adult male specimen, collected in the warm greenhouses of the Muséum National d'Histoire Naturelle (MNHN), Jardin des Plantes, under a flower pot. Hence the real geographic and/or habitat origin of the specimen is unknown. It was designated by Brölemann as "an interesting form". The gonopods illustrated in the original description appear quite *Cylindroiulus*-like although they are not obviously clearly recognisable as those of any other well-known species.

Following its description *C. bouvieri* seems to have disappeared from the literature. It is not listed on the Fauna Europea website (www.fauna-eu.org) nor mentioned in the recent atlas of European Julids (Kime & Enghoff, 2017) but is cited as an accepted species in the Millibase (www.millibase.org) and Worms (www.marinespecies.org) databases. Recently the type specimen was relocated in the collection of the MNHN by J-JG and studied, with a view to trying to establish the true identify of this species.

Results

Several specimens of *C. bouvieri* were located in jar ED 041, the labelling of which had been changed during a re-organisation (previously the jar would have been labelled EB 041). The jar contained two vials, one containing 2 females, 1 juvenile male and 1 juvenile, all of them broken into several fragments, the other containing the holotype adult male, dissected, consisting of the anterior part with head and anterior segments, posterior part of the body and gonopods preserved and enclosed within a small sheet of paper.

Following examination, the following notes were made:
The specimens are weakly pigmented; however they have been preserved for a number of years in ethanol so the body, tegument and ommatidia are quite depigmented. The adults (male and females) bear 6-7 pairs of setae on the anal valves.

*Note that *C. parisiorum* was described by both Brölemann and Verhoeff despite this being in a paper authored solely by Brölemann (1896).

The two pairs of male gonopods, left and right, while separated, are stuck together and they seem to have been partly crushed and twisted. One gonopod is quite similar to the drawing given by Brölemann in the original description (1896): fig. IX p. 5 (Figure 1). However, when observed from a different orientation, the part indicated as "h" by Brölemann is quite similar to the brachite of *Cylindroiulus parisiorum* drawn by Blower (1985) in fig. 50C (Figure 2). Blower (*loc. cit*) attributed the variation in the detail of the opisthomerite in his drawings to coverslip pressure which altered the appearance of the tip of the brachite (see pages 160-161 for detail).

If the gonopods are turned to another orientation, particularly that not figured by Brölemann (1896), it clearly shows an obvious coxal projection quite similar to the part "a" shown by the drawing by Brölemann and Verhoeff 1896 (fig. VII p. 4). It also appears quite similar to the drawing by Blower (1985) in fig. 50D (Figure 3), those by Lohmander (1925) and also unpublished sketches which are noted as ‘Brade-Birks del. Angleterre’ and were probably by Brade-Birks and sent to Brölemann (the two were certainly in contact, A. Barber pers. com.). These latter sketches are held in the iconographic file in Paris but have probably not been published.

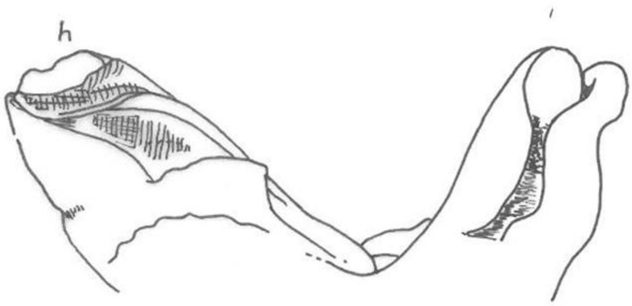

Figure 1:
External view of male gonopods of *C. bouvieri* redrawn from Brölemann (1896) but reversed so same orientation as Figures 2 and 3 (see text for details).

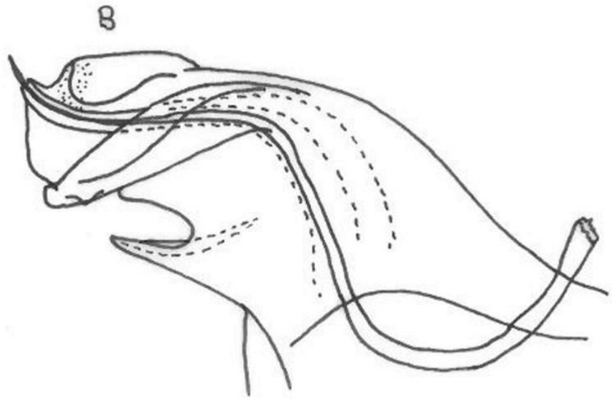

Figure 2:
Internal view of male gonopods of *C. parisiorum* redrawn from Blower (1985, figure 50C). B – brachite.

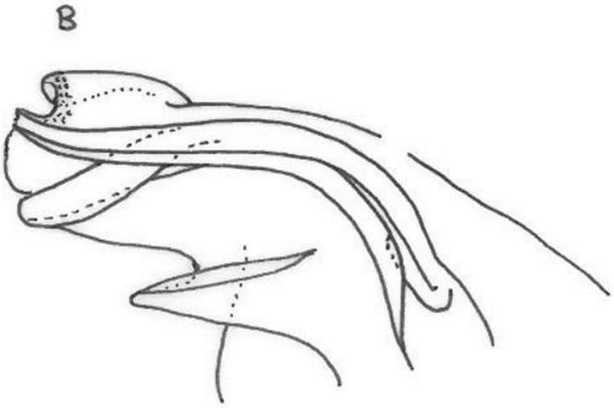

Figure 3:
External view of male gonopods of *C. parisiorum* redrawn from Blower (1985, figure 50D) showing impact of coverslip pressure on brachite (B).

Another species that *C. bouvieri* might potentially be considered as synonymous with is *Cylindroiulus truncorum* (Silvestri, 1896).

However, the gonopods differ in the length of the paracoxal process, which is not as long as that depicted in *C. truncorum* (see Verhoeff's 1926 illustration of *Cylindroiulus luscus salicis* which is now regarded as a synonym of *C. truncorum*; Lohmander 1925). In addition, the brachite of the gonopod does not show any details similar to *C. truncorum* published by Blower 1985 (Fig. 51A, B), Akkari & Enghoff (2008: 14) or Akkari *et al.* (2009: 6).

There are also differences in the somatic characters:

- The number of setae on the anal valves is 6 or 7 (similar to *C. parisiorum*) and not as numerous as *C. truncorum* (which has more than 7 and generally 9-12).
- In the original description the striation of the body rings was described as being denser in *bouvieri* than in *parisiorum*. Well-developed striae are a characteristic of *truncorum* (Korsós & Enghoff 1990) however, when examined in the holotype male as well as the females it was found to be scarcely different to that of *C. parisiorum*.
- In addition, *Cylindroiulus truncorum* is rare in France, known from just a few locations in Nièvre, Val-d'Oise and Brittany (Finistère and Loire-Atlantique), some of which are unconfirmed. In contrast *C. parisiorum* is well known from various locations in Paris and France.

Verhoeff (1896) following his description of different variations in *Iulus parisiorum miraculus*, questioned if they were all the same species. Since 1896, no further specimens of *Cylindroilus bouvieri* have been collected from the Jardin des Plantes, while many other specimens belonging clearly to *Cylindroiulus parisiorum* have been collected from the MNHN greenhouses, the MNHN catacombs and also from other subterranean galleries under Paris (Geoffroy & Ferrand 2020). As the different forms found by Verhoeff (1896) were found in the same location, living together in the same habitat one might think that only one species is represented, showing some variation.

In conclusion, *Cylindroiulus bouvieri* (Brölemann, 1896) should be considered as a junior synonym of *Cylindroiulus parisiorum* (Brölemann & Verhoeff, 1896) and possibly to *Cylindroiulus parisiorum miraculus* (Verhoeff, 1896). However, the latter has currently been considered as a junior synonym of the close species *Cylindroiulus latestriatus* (Curtis, 1845) which is known to live together with *C. parisiorum* in the same soil and subterranean habitats in Paris.

The Julid collection in Paris Museum was relatively recently reorganised by Jean-Paul Mauriès and the relevant collections were moved in the storage as follows:

Anoploiulus parisiorum miraculus Verh. was transferred from Jar EB 213 to Jar ED 146 which is labelled *Cylindroiulus latestriatus* (Curtis).

Julus (Anoploiulus) miraculus Verhoeff was transferred from Jar EB 180 to Jar ED 146 which is labelled *Cylindroiulus latestriatus* (Curtis).

Cylindroiulus latestriatus (Curtis) was transferred from Jar EB 147 to Jar ED 147 which is labelled *Cylindroiulus latestriatus* (Curtis).

These have been checked by J-JG and it is confirmed that the specimens in Jar ED 147, all labelled *Cylindroiulus latestriatus*, are clearly *C. latestriatus*.

Specimens in Jar ED 146 are labelled *Iulus (Anoploiulus) miraculus*, *Julus* or *Cylindroiulus frisius*, *Julus* or *Cylindroiulus luscus* (or *luscus miraculus*). Many of these specimens were collected in France and/or Italy (mainly Lombardia). They seem clearly to belong to *Cylindroiulus latestriatus* (Curtis). The gonopods are similar to those illustrated by Blower 1985 (Fig. 48B p. 157) and the number of setae on the anal valves is 3 (4) vs. 6-7 in *Cylindroiulus parisiorum*. Unfortunately, the number of setae on the anal valves were not clearly documented in Verhoeff's (1896) original description of *Julus (Anoploiulus) parisiorum miraculus*.

The synonymy of *C. parisiorum* is therefore:

***Cylindroiulus parisiorum* (Brölemann & Verhoeff, 1896)**
Iulus (Anoploiulus) Parisiorum Brölemann & Verhoeff, 1896
Iulus (Anoploiulus) Bouvieri Brölemann, 1896, **new synonym**
Cylindroiulus bouvieri (Brölemann, 1896)
Cylindroiulus ignoratus Attems, 1927

The synonymy of *C. latestriatus* remains therefore:

***Cylindroiulus latestriatus* (Curtis, 1845)**
Julus latestriatus Curtis, 1845
Julus hortensis Wood, 1864
Julus frisius Verhoeff, 1891
Cylindroiulus frisius (Verhoeff, 1891)
Iulus parisiorum miraculus Verhoeff, 1896 In: Brölemann & Verhoeff 1896
Iulus owenii Bollman, 1887
Julus luscus Meinert, 1868
Julus hesperus Chamberlin, 1914
Neottiulus striatus Loomis, 1972

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Report on the BMIG field meeting in Lincolnshire in 2013

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Introduction and background

The 2013 BMIG field weekend, held from 11th to 14th April, was based in Scamblesby, Lincolnshire; chosen as a good location for exploring under-worked areas such as the Lincolnshire Wolds, the Limewoods, heaths near Market Rasen and Woodhall Spa and also coastal dune systems, such as those at Saltfleetby. BMIG members were joined for the field excursions by local naturalists Charlie Barnes and Dave Sheppard.

A small amount of recording was undertaken patchily in Lincolnshire by Tony Barber in the late 1960s and a few additional records were added in the 1970s & 1980s. This included at least 12 species of millipede and 12 species of centipede, with *Geophilus impressus* (formerly *G. insculptus*) proving to be quite common and *Lithobius macilentus* recorded. Des Kime also undertook surveys in 1968 recording *Boreoiulus tenuis*, *Nemasoma varicorne*, *Cylindroiulus britannicus*, *Ophiodesmus albonanus* and *Macrosternodesmus palicola.*

The only previous excursion into Lincolnshire by BMIG (then two separate entities, BISG & BMG) was an informal 'pirate' field meeting organised by Jon Daws in October 1993 with just four enthusiastic participants (Jon, Steve Gregory, Dick Jones and Andy Keay). About 25 sites were visited and a brief account of the woodlice is given by Daws (1993) with fourteen species recorded including *Cylisticus convexus* and *Porcellio dilatatus* from a farmyard and seven sites for the elusive *Trichoniscoides albidus* (a species new to both VC 53, south Lincs and 54, north Lincs). Dick Jones (1994) reports that "nothing out of the ordinary" was recorded despite listing six millipedes as new county records (ibid, pg. 3), emphasising the level of under-recording within the county. These are *Allajulus nitidus* (VC 54), *Boreoiulus tenuis* (VC 53), *Cylindroiulus britannicus* (VC 54), *C. caeruleocinctus* (VC 53), *Macrosternodesmus palicola* (VC 53) and *Geoglomeris subterranea* (VC 53 and 54). There seems to be no account of the centipedes recorded (but records were submitted to the National Recording Scheme).

Sites visited

During the field meeting the group visited 25 different sites, though some are split into sub-sites to give 35 discrete localities. All are in North Lincolnshire (VC54); the majority being Lincolnshire Wildlife Trust (LWT) Reserves.

A summary of the sites visited and the sub-locations within these sites is shown in Table 1.

Results

Records from the field meeting have been submitted by Charlie Barnes, Mike Davidson, Steve Gregory, Paul Lee, Angela Lidgett, Keith Lugg, Helen Read, Paul Richards, Dave Sheppard, Duncan Sivell and Imogen Wilde.

Table 1: List of sites visited.

LWT = Lincolnshire Wildlife Trust reserve. Recorders: CB - Charlie Barnes, MD - Mike Davidson, SG Steve Gregory, PL - Paul Lee, AL - Angela Lidgett, KL - Keith Lugg, HR - Helen Read, PR - Paul Richards, DSh – Dave Sheppard, DSi - Duncan Sivell, IW - Imogen Wilde.

Site Code	Locality	Grid Ref	VC	Date	Recorders
1a	Chambers Farm Wood	TF148739	54	12.iv.2013	HR, DSi
1b	Chambers Farm, Butterfly Garden	TF147739			HR, DSi
1c	Chambers Farm (Hatton Wood SSSI)	TF161747			DSi
2	Donna Nook NNR, LWT	TA41-00-	54	12.iv.2013	IW
3	Fir Hill Quarry, Little Cawthorpe, LWT	TF360829	54	12.iv.2013	PL, CB, DSh
4	Furze Hill, LWT	TF346689	54	12.iv.2013 13.iv.2013	PR HR, IW
5	Hagworthingham Churchyard	TF343692	54	12.iv.2013	PR
6a	Gibraltar Point, LWT	TF56-58-	54	12.iv.2013	AL, MD
“		‘’		13.iv.2013	DSi
6b		TF55-57-		13.iv.2013	AL
6c		TF56-57-		12.iv.2013	MD
“		“		13.iv.2013	AL, DSi
6d		TF55-58-		13.iv.2013	MD
7a	Great West Wood	TF11-76-	54	12.iv.2013	AL
7b	Great West Wood	TF10-76			MD
7c	Cocklode Wood	TF10-76			MD
8	Hopton Wood, Willoughby, LWT	TF461716 TF459718	54	12.iv.2013 13.iv.2013	PR HR, IW
9	Legbourne Wood, LWT	TF37-83- TF36-83-	54	12.iv.2013	SG, KL, PL, DSh, IW
10	Little Cawthorpe Churchyard	TF356837	54	12.iv.2013 13.iv.2013	PR IW
11	Mill Hill Quarry, LWT	TF454717 TF452716	54	12.iv.2013 13.iv.2013	PR IW
12	Muckton Wood, Muckton, LWT	TF382810	54	12.iv.2013	PL, DSh
13a	Saltfleetby, East Lindsey Dunes	TF468935	54	12.iv.2013	SG
13b	Saltfleetby, Rimac Dunes NNR, LWT	TF47-92-			SG, IW
13c	Saltfleetby, Theddlethorpe Dunes NNR	TF467917			KL
14	Saltfleetby, All Saints Churchyard	TF455904	54	12.iv.2013	SG, KL
15	Brook House Farm, Scamblesby	TF274785	54	11.vi.2013 13.iv.2013 14.iv.2013	KL, DSi KL, PR SG, KL
16	Red Hill Quarry, LWT	TF264806	54	13.iv.2013	SG, KL, PL
17	Riseholme College, University of Lincoln	SK98-75-	54	12.iv.2013 13.iv.2013	DSi SG, KL, PL
18	Snipe Dales Country Park, LWT	TF33-68-	54	12.iv.2013 13.iv.2013	MD AL, DSi
19	Welton le Wold, LWT	TF283883	54	13.iv.2013	SG, KL, PL

20	Wickenby Wood	TF084828	54	13.iv.2013	PR
21	Woodhall Spa & Tumby	TF20-62-	54	13.iv.2013	PR
22	Derelict Weighbridge Building, Welton	TF281880	54	13.iv.2013	KL
23	Scamblesby Churchyard	TF276784	54	14.iv.2013	SG, KL
24	Lincoln Arboretum	SK986716	54	10.iv.2013	MD
25a 25b	Greetwell Quarry SSSI (stream) Greetwell Quarry SSSI, LWT	SK999723 TF001726	54	10.iv.2013	MD

A total of 57 BMIG species were recorded during the course of the meeting, comprising 24 millipedes, 16 centipedes and 16 woodlice and a waterlouse. The two locations with the highest species diversity were Riseholme College, University of Lincoln (site 17) with 36 species recorded (9 centipedes, 15 millipedes, 12 woodlice) and Brook House Farm, Scamblesby (site 15) with 29 species (10 centipedes, 9 millipedes, 10 woodlice). This is perhaps not surprising given the diversity of synanthropic habitats present at both sites, including a cottage garden, greenhouses and stables at Riseholme College. Of the semi-natural sites Legbourne Wood (site 9), an ancient woodland, was the third most diverse with 24 species (7 centipedes, 9 millipedes, 8 woodlice) including the Nationally Scarce *Brachychaeteuma bradeae* and the elusive *Trichoniscoides albidus*.

Details of the species records for each site are summarised in Tables 2 to 4.

Centipedes

16 species of centipede are recorded, the majority the more or less predictable ones to be expected for Lincolnshire. Synanthropic sites at Scamblesby (Brook House Farm and nearby churchyard) and Riseholme College proved to be the most diverse. At the latter site the Stenotaenia linearis was recorded independently by Duncan Sivell and Keith Lugg. This species, with its distribution centred on the Home Counties, seems to be almost always synanthropic in Britain and thus this observation is perhaps not unexpected.

Lithobius variegatus was recorded from Woodhall Spa & Tumby (site 21) by Paul Richards, an area with much woodland. In Britain the species shows a marked western tendency and appears to be largely or entirely absent from much of eastern England and this record appears to fall into the ‘eastern void’.

Geophilus carpophagus s.str. was recorded from two sites by Duncan Sivell, both in typical habitat. The first from a brick wall in a car park at Chambers Farm Wood (site 1), where it was associated with *Porcellio spinicornis*, and the second from the coast at Gibraltar Point (site 6).

Millipedes

24 species of millipede are recorded. Easily the most diverse site recorded was Riseholme College (15 species) where a variety of synanthropes were found. One of these was the Nationally Scarce *Allajulus nitidus*, a millipede most frequently seen in synanthropic sites in the eastern half of the country. Riseholme College was the only site where both *Polydesmus angustus* and *P. coriaceus* were found during the meeting; the latter species was noted much more frequently than *P. angustus* over the weekend in contrast to their relative frequencies nationally.

The semi-natural sites with the highest diversity were the LWT sites at Legbourne Wood (9 species) and Furze Hill (site 4, 10 species). The most notable millipede species collected during the meeting was the Nationally Scarce *Brachychaeteuma bradeae*. SJG collected a single male specimen attributable to this species in ancient woodland at Legbourne Wood. The gonopods of the specimen were considered typical of *B. bradeae* and it is this taxon rather than *B. bagnalli* that would be expected in East Anglia.

Figure 1: *Boreoiulus tenuis* observed at Riseholme College. Image © Keith Lugg.

Figure 2: *Ophiodesmus albonanus* observed at Riseholme College. Image © Keith Lugg.

Woodlice

During the field meeting 17 species of woodlice were recorded from all 35 locations visited (Table 4). As expected for eastern England, by far the most frequently recorded species were *Oniscus asellus* (29 sites), *Porcellio scaber* (28 sites), *Philoscia muscorum* sensu lato (27 sites) and *Armadillidium vulgare* (22 sites).

Riseholme College, with its greenhouses and stables, proved the most diverse site for woodlice with 12 species recorded, including *Porcellio dilatatus*, *Platyarthrus hoffmannseggii* and both *Haplophthalmus danicus* and *H. mengii* s.str. *Porcellionides pruinosus* was found at three sites, including a typical dung heap habitat at Brook House Farm, under stones, logs and debris at Lincoln Arboretum, and also from a track within ancient woodland at Legbourne Wood. At the latter site the elusive trichoniscid *Trichoniscoides albidus* was also recorded from a track-side ditch (Fig. 3). *Porcellio spinicornis* was recorded from a single site by Duncan Sivell, a brick wall in a car park at Chambers Farm Wood where it was associated with the arboreal centipede *Geophilus carpophagus* s.str.

Figure 3: *Trichoniscoides albidus* observed at Legbourne Wood. Image © Keith Lugg.

For the purposes of this report *Philoscia muscorum* is being treated as a species complex, since it is possible that some records may refer to *Philoscia affinis* Verhoeff. Although first recorded in Britain in 2017, this woodlouse is of similar appearance to *P .muscorum* and appears to have been long overlooked (Gregory, 2020). On current evidence, *P. affinis* is mainly restricted to western Britain and it seems likely that the majority, if not all, records of *P. muscorum* sensu lato reported herein will refer to *P. muscorum* (Scopoli) sensu stricto.

Acknowledgements

The field meeting was organised by Imogen Wilde, including arranging access to Lincolnshire Wildlife Trust sites and Riseholme College.

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Table 2: Centipedes recorded during Scamblesby field meeting. For details of sites see Table 1.

Site:	**1**			**2**	**3**	**4**	**5**	**6**				**7**			**8**	**9**	**10**	**11**	**12**
Centipedes	**a**	**b**	**c**					**a**	**b**	**c**	**d**	**a**	**b**	**c**					
Cryptops hortensis	#	#				#										#			
Geophilus carpophagus s.str.	#							#											
Geophilus easoni			#													#			
Geophilus electricus																			
Geophilus flavus	#	#											#			#	#		#
Geophilus insculptus																			
Geophilus truncorum			#			#		#				#		#	#	#			#
Lithobius crassipes										#				#		#			
Lithobius forficatus	#	#	#					#		#		#	#	#	#	#		#	#
Lithobius melanops																			
Lithobius microps		#				#									#		#	#	
Lithobius variegatus																			
Schendyla nemorensis								#		#						#			
Stenotaenia linearis																			
Haplophilus subterranea																	#		
Strigamia acuminata																			#
Total 16 centipede species	4	4	3	-	-	3	-	4	-	3	-	2	2	3	3	7	3	2	4

Table 2: continued

Site:	**13**			**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**		**Total**
Centipedes (cont.)	**a**	**b**	**c**												**a**	**b**	
Cryptops hortensis					#		#	#						#			8
Geophilus carpophagus s.str.																	2
Geophilus easoni								#									3
Geophilus electricus				#													1
Geophilus flavus			#		#	#	#						#	#			12
Geophilus insculptus				#	#		#						#				4
Geophilus truncorum		#				#		#									11
Lithobius crassipes					#			#									5
Lithobius forficatus				#	#	#	#	#				#	#	#			20
Lithobius melanops				#	#	#	#						#				5
Lithobius microps				#	#	#	#		#	#			#	#		#	14
Lithobius variegatus											#						1
Schendyla nemorensis					#		#						#				6
Stenotaenia linearis							#										1
Haplophilus subterranea					#		#		#				#	#			6
Strigamia acuminata					#			#									3
Total 16 centipede species	-	1	1	5	10	5	9	6	2	1	1	1	7	5	-	1	

Table 3: Millipedes recorded during Scamblesby field meeting. For details of sites see Table 1.

Site:	**1**			**2**	**3**	**4**	**5**	**6**				**7**			**8**	**9**	**10**	**11**	**12**
Millipedes	**a**	**b**	**c**					**a**	**b**	**c**	**d**	**a**	**b**	**c**					
Allajulus nitidus																			
Archiboreoiulus pallidus																#			
Blaniulus guttulatus						#													
Boreoiulus tenuis																		#	
Brachychaeteuma bradeae																#			
Brachydesmus superus						#										#		#	
Brachyiulus pusillus		#																	
Cylindroiulus britannicus	#					#													
Cylindroiulus caeruleocinctus																			
Cylindroiulus latestriatus								#		#									
Cylindroiulus punctatus	#	#	#			#	#	#		#		#		#	#	#			#
Geoglomeris subterranea																		#	
Glomeris marginata	#		#		#	#							#	#		#		#	#
Julus scandinavius								#											
Macrosternodesmus palicola																	#	#	
Nanogona polydesmoides																			
Ommatoiulus sabulosus										#									
Ophiodesmus albonanus																#			
Ophyiulus pilosus	#					#		#		#				#					
Polydesmus angustus						#		#		#									
Polydesmus coriaceus	#					#						#		#	#	#	#	#	#
Polyxenus lagurus																			
Proteroiulus fuscus			#			#										#			
Tachypodoiulus niger	#	#	#			#	#	#		#		#	#	#	#	#	#	#	#
Total 24 millipede species	6	3	4	-	1	10	2	6	-	6	-	3	2	5	3	9	3	7	4

Table 3: continued

Site:	**13**			**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**		**Total**
Millipedes	**a**	**b**	**c**												**a**	**b**	
Allajulus nitidus							#										1
Archiboreoiulus pallidus				#													2
Blaniulus guttulatus	#			#		#	#		#				#	#			8
Boreoiulus tenuis				#		#	#							#			5
Brachychaeteuma bradeae																	1
Brachydesmus superus					#		#										5
Brachyiulus pusillus							#										2
Cylindroiulus britannicus					#		#	#									5
Cylindroiulus caeruleocinctus					#						#						1
Cylindroiulus latestriatus					#									#			4
Cylindroiulus punctatus				#	#	#	#	#	#	#			#	#			21
Geoglomeris subterranea						#											2
Glomeris marginata						#		#									11
Julus scandinavius								#									2
Macrosternodesmus palicola				#		#	#										5
Nanogona polydesmoides							#										1
Ommatoiulus sabulosus					#						#						3
Ophiodesmus albonanus							#										2
Ophyiulus pilosus				#	#		#		#							#	10
Polydesmus angustus							#	#									5
Polydesmus coriaceus				#	#	#	#		#				#			#	16
Polyxenus lagurus				#													1
Proteroiulus fuscus				#			#	#									6
Tachypodoiulus niger	#			#	#	#	#	#	#	#		#	#			#	26
Total 24 millipede species	2			10	9	8	15	7	5	2	2	1	4	4	-	3	

Table 4: Woodlice and Waterlice recorded during Scamblesby field meeting. For details of sites see Table 1.

Site code:	**1**			**2**	**3**	**4**	**5**	**6**				**7**			**8**	**9**	**10**	**11**	**12**
Woodlice	**a**	**b**	**c**					**a**	**b**	**c**	**d**	**a**	**b**	**c**					
Androniscus dentiger																#		#	
Armadillidium vulgare		#		#	#	#	#	#	#	#	#					#		#	
Asellus aquaticus																			
Haplophthalmus danicus		#				#													
Haplophthalmus mengii s.str.																			
Ligia oceanica				#															
Oniscus asellus	#	#	#	#	#	#	#	#		#		#	#	#	#	#	#	#	#
Philoscia muscorum sensu lato	#	#	#		#	#		#		#	#			#	#	#	#	#	#
Platyarthrus hoffmannseggii																			
Porcellio dilatatus																			
Porcellio scaber	#	#	#	#		#	#	#		#	#		#		#	#	#	#	#
Porcellio spinicornis	#																		
Porcellionides pruinosus																#			
Trichoniscoides albidus																#			
Trichoniscus pusillus agg.		#	#			#	#							#	#	#			#
Trichoniscus provisorius																			
Trichoniscus pygmaeus		#					#											#	#
Total 17 isopod species	4	7	4	4	3	6	5	4	1	4	3	1	2	3	4	8	3	6	5

Table 4: continued

Site code:	**13**			**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**		**Total**
Woodlice	**a**	**b**	**c**												**a**	**b**	
Androniscus dentiger				#			#		#								5
Armadillidium vulgare	#	#	#	#	#	#	#		#		#		#			#	22
Asellus aquaticus					#		#								#		3
Haplophthalmus danicus					#		#							#			5
Haplophthalmus mengii s.str.					#	#	#										3
Ligia oceanica																	1
Oniscus asellus			#	#	#	#	#	#	#	#	#	#	#	#			29
Philoscia muscorum sensu lato	#	#	#	#	#	#	#	#	#		#		#	#		#	27
Platyarthrus hoffmannseggii							#										1
Porcellio dilatatus							#										1
Porcellio scaber	#	#		#	#	#	#	#	#		#	#	#	#		#	28
Porcellio spinicornis																	1
Porcellionides pruinosus					#									#			3
Trichoniscoides albidus																	1
Trichoniscus pusillus agg.				#	#	#	#	#	#	#			#			#	17
Trichoniscus provisorius														#			1
Trichoniscus pygmaeus				#	#	#	#										8
Total 17 isopod species	3	3	3	7	10	7	12	4	6	2	4	2	5	6	1	4	

Obituary: Ulf Scheller 1925-2021

Ulf Scheller (Image Zoltan Korsos)

Ulf Scheller – an outstanding world specialist of Pauropoda and Symphyla – died June 25 2021 at an age of 95 years. After many years of contribution to myriapodology he became an Honorary member of CIM in 2002.

Ulf studied zoology and botany at the University of Lund. After graduating with a master´s degree he became a teacher, first in Karlskrona and from 1956 at the private boarding-school Lundsberg in Värmland. Here he stayed until he retired in 1990. Besides this full time work as a teacher he succeeded to do a lot of scientific work which resulted in more than a hundred published papers dealing with Pauropods and Symphyls. He also got a doctors degree in 1970 based on his work The Pauropoda of Ceylon.

On holidays and when he could take leave of absence from the school, he travelled a lot and visited several European countries, Africa and America to collect "his animals".

He also visited many museums to study their collections. Especially he cooperated with the Natural History Museum in Genève which he visited several times.

After retirement he moved to a house at the countryside in Western Sweden not far from the town Lidköping. Then he had more time for scientific work but also a house and a garden to take care of.

From the beginning he studied both Symphyls and Pauropods, but soon he found that there was more than enough to do with the Pauropods and concentrated his work on this group. For many years he was the only world specialist of Pauropoda and got material from all over the world to study. This resulted in a lot of publications and descriptions of several hundred new species.

A great deal of the material he studied was sent back to a museum in the country where the animals were collected. A lot of material is also kept at the museum in Genève. All material he had in his own collection at home is now housed at the Gothenburg Natural History Museum. This material includes a lot of types, both holotypes and paratypes.

It is a remarkable life work done by a private researcher in a small room in his own house, without the facilities of a museum or a scientific institution for help. No laboratory assistant, no secretary, no help with copying, illustration or other technical service. Having no laboratory resources it was not surprising that he never took the step into the molecular biology for the study of his animals. Nor did he have resources to work with SEM pictures. He had instead developed a very effective method to study the specimens and make exact measurements and very precise drawings of the systematic characters needed for describing species. The animals were not mounted but placed in alcohol on a glass slide under a moveable cover glass so it could be turned around and studied from all sides. This time-consuming work resulted in publications with very good descriptions and redescriptions of species.

The myriapod community has lost a valuable member. Very few of the about 175 registered CIM members work with Pauropoda or Symphyla. It will be difficult to fill the empty space after Ulf Scheller.

Göran Andersson

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Ulf Scheller and pauropods recorded in Britain

A. D. Barber

Although the first description of a pauropod was from London by Sir John Lubbock in 1866, apart from Richard Bagnall who published a series of papers on them in the earlier part of the following century and the listing in S.G. Brade-Birks' 1939 sources for description paper, few workers worked on this group of myriapods in Britain up to the 1970s when Ulf Scheller started to look at our fauna. Paul Remy had published two short papers in 1956 and 1961 and F.A. Turk reported on cave records in 1967. An article reprinted from the Museums Journal of 1919 by "W.R.B" described methods of collecting pauropods and symphylans which the author had collected freely at Hastings. Aside from such descriptions and lists of species, S.M. Manton had included the group in her series of papers on arthropod locomotory mechanisms.

Ulf Scheller read a paper on pauropods from arable soil in Great Britain identified by him from samples sent to him from by H.J. Gough and C.A. Edwards at the 1972 Myriapod Congress in Manchester (Scheller, 1974). He recorded four species new to British arable soils, three of which were new to Britain. The paper is also of some interest in the discussion that followed it which included reference as to how to find these animals. 1982 saw the publication of F.R. Moore's account of the Pauropoda of a coal shale heap in Lancashire where *Allopauropus danicus* and *Pauropus lanceolatus* were recorded. That same year P.G.Oliver and A.F.Amsden published an article about pauropods in *Nature in Wales* and reported on the finding of *Allopauropus gracilis*. In both cases, the pauropods were identified or confirmed by Dr Scheller.

In 1986 Gordon Blower reported what was named at the time as *Gravieripus cordatus*, subsequently described as *Trachypauropus britannicus*, a new species from the Windermere area, identification and description by Dr Scheller (1990). The following year (1991) Gordon published a report on the myriapoda of Lancashire and Cheshire with a list of pauropods and names of the authors of the records. The 1990 Scheller paper sorted out a number of dubious names and reported four species new to Britain making a total of twenty-three altogether.

To try to stimulate interest in the group, the BMG Bulletin published in 1992 an article by Barber, Blower and Scheller, the latter contributing by far the greatest input both directly or indirectly (*Bull.Br.Myriapod Group* **8**: 13-23). Entitled *Pauropoda, the smallest myriapods*, it included, as well as descriptive material, notes on collection and examination, a checklist of species and provisional keys down to the level of genera.

References

Most of these are listed in the 1992 BMG Bulletin report (*Bull.Brit.Myriapod Group* **8**: 13-3).

Other references are:

Blower, J.G. (1986) A pauropod new to Britain and North-West Europe. *Newsletter Brit.Myriapod Group*, **5**: 2 (unpublished).

Brade-Birks, S.G. (1939) Notes on Myriapoda XXXVI Sources for description and illustration of the British Fauna. J. *SE Agric.Coll.Wye,* **44**:156-179.

"W.R.B" (1919) Notes on collecting Pauropoda and Symphyla. *Museums J.,* **18**: 130-132.

Bjarne Meidell

As this Bulletin was "in press" we learnt the sad news of the death of Bjarne Meidell of Bergen on 17th May. Bjarne published a number of papers relating to Norwegian myriapods and had attended the 1972 Manchester Myriapod Congress. He was regularly present at the international congresses and organised the 13th one in Bergen in 2005. He was also one of the authors of *Mångfotingar Myriapoda* (Andersson *et al*., 2005). In 1967 he recorded *Polydesmus angustus* for the first time from Norway, distinguishing it from *P. complanatus* and in 1969 recorded *Geophilus insculptus* (now known as *G. impressus*) from that country, distinguishing it from the widespread *G. proximus*.

It is hoped than the next volume of the Bulletin will contain a more extended tribute.

Editors