

THE MILLIPEDE GENUS *CYLINDROIULUS* VERHOEFF, 1894 (DIPLOPODA: JULIDA; JULIDAE) IN SPAIN: RECENT RECORDS AND DESCRIPTION OF THREE NEW SPECIES FROM THE BASQUE COUNTRY, NAVARRA, ANDALUCÍA AND CATALUÑA

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ABSTRACT

Two large collections of *Cylindroiulus* were examined (one from the Basque country and Navarra and one from Andalucía) supplemented by other, smaller collections from other areas of Spain; in total 10 species were represented. Three new species are described: *C. caramelos* sp. nov., *C. elosegiorum* sp. nov. and *C. karinhansorum* sp. nov. The remaining seven species are: *C. londinensis* (Leach, 1814), *C. franzi* Attems, 1952, *C. punctatus* (Leach, 1815), *C. pyrenaicus* Brölemann, 1897, *C. sagittarius* Brölemann, 1897, *C. sanctimichaelis* Attems, 1927 and *C. unciger* Attems, 1952. Information has been presented on these species where this has added to that previously available. Comments have been made on the challenging *londinensis*-group which seems particularly speciose in the Iberian Peninsula. Suggestions are made for further work on this group include genetic studies.

Keywords: Diplopoda, Julidae, *Cylindroiulus caramelos*, *Cylindroiulus elosegiorum*, *Cylindroiulus karinhansorum*.

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RESUMEN

El género de milpiés *Cylindroiulus* Verhoeff, 1894 (Diplopoda: Julida; Julidae) en España: citas recientes y descripción de tres nuevas especies del País Vasco, Navarra, Andalucía y Cataluña

Se han examinado dos cuantiosas colecciones de *Cylindroiulus* (una del País Vasco y Navarra y otra de Andalucía), y se han suplementado con otras, más pequeñas, de otras áreas de España; en total se han encontrado 10 especies. Se han descrito tres nuevas especies: *C. caramelos* sp. nov., *C. elosegiorum* sp. nov. y *C. karinhansorum* sp. nov. Las otras siete especies fueron: *C. londinensis* (Leach, 1814), *C. franzi* Attems, 1952, *C. punctatus* (Leach, 1815), *C. pyrenaicus* Brölemann, 1897, *C. sagittarius* Brölemann, 1897, *C. sanctimichaelis* Attems, 1927 y *C. unciger* Attems, 1952. Se presenta información sobre esas especies, añadiéndola a la ya disponible. Se hacen comentarios sobre el difícil grupo *londinensis*, que parece ser especialmente rico en especies en la península ibérica. Se sugieren futuras líneas de investigación para este grupo, incluyendo estudios genéticos.

Palabras clave: Diplopoda, Julidae, *Cylindroiulus caramelos*, *Cylindroiulus elosegiorum*, *Cylindroiulus karinhansorum*.

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Introduction

The diplopod fauna of the Iberian Peninsula is relatively under studied in comparison with much of Europe. Following work by Attems and Verhoeff in the early part of the 20th century there was a relatively long gap until work in the 1970s and 1980s on cave fauna (Mauriès & Vicente, 1977a), species from north-west Spain and the Pyrenees (Mauriès, 1975; Mauriès & Vicente, 1977b) and some ecological studies by Vicente & Ascaso (1990) and Serra *et al.* (1997) in Cataluña and Mauriès & Barraqueta (1985) in Biscay. Vicente (1981) published a list of species from Cataluña including details to help with identification.

In recent years there has been a resurgence in interest of Iberian millipedes with a variety of collections made and papers published. These include descriptions of new species in the Polydesmida (Gilgado *et al.* 2015b; Djursvoll, 2019), Platydesmida and Polyzoniida (Mauriès, 2015, 2018), Chordeumatida (Gilgado *et al.*, 2015a, 2017; Mauriès, 2014; Serra & Mauriès, 2018), Callipodida (Gilgado *et al.*, 2020) and the Julid genera *Ommatoiulus* Latzel, 1884 (Akkari & Enghoff, 2012; Akkari *et al.* 2018) and *Cylindroiulus* (Read, 1989, 2007; Reboleira & Enghoff, 2018).

The French fauna is comparatively well studied and some *Cylindroiulus* species relatively abundant further north have a range that extends down to and/or over to the south side of the Pyrenees, such as *Cylindroiulus londinensis* (Leach, 1814), *Cylindroiulus parisorum* (Brölemann & Verhoeff, 1896) and *Cylindroiulus punctatus* (Leach, 1815) (Kime & Enghoff, 2017).

SYSTEMATICS OF THE GENUS *CYLINDROIULUS*

The genus *Cylindroiulus* is large, with over 100 species described. Read (1990) clarified a previously confusing situation between *Cylindroiulus* and *Allajulus* C.L. Koch, 1847 which are now considered separate genera, distinguished by the presence of setae on the apodous body rings in *Allajulus* and details of the gonopods. Both genera are found on the Iberian Peninsula, although *Allajulus* is currently represented only by *A. spinosus* (Ribaut, 1904). A few species groups can be identified within the genus, with those relevant to Iberia being: the *perforatus*-group (*Cylindroiulus perforatus*, (Verhoeff, 1905) *Cylindroiulus fenestratus*, Read, 1989, *Cylindroiulus ventanaea* Read, 2007 and *Cylindroiulus villumi* Reboleira & Enghoff, 2018), distinguished by usually having a perforate mesomerite, a feature which has so far not been seen on any species outside the Iberian peninsular, and denticles on the anterior flagellum-conducting lamella (Read, 1989; Reboleira & Enghoff, 2018), a feature which has so far not been seen on any species outside the Iberian Peninsula; some of the *truncorum/luscus*-group (*arborum* Verhoeff, 1928, *bellus* (Lignau, 1903), *britannicus* (Verhoeff, 1892), *latestriatus* (Curtis, 1845), *parisorum*, and

truncorum (Silvestri, 1896) and a group of large bodied species with similar gonopods consisting of *caeruleocinctus* (Wood, 1864), *chalandei* (Ribaut, 1904), *finitimus*, (Ribaut, 1905), *ibericus*, Brölemann, 1913, *londinensis* (Leach, 1814) and *sanctimichaelis* Attems, 1927, (*londinensis*-group).

THE GENUS *CYLINDROIULUS* ON THE IBERIAN PENINSULA

Vicente (1981) listed 14 species of *Cylindroiulus* from the Iberian Peninsula: *C. britannicus*, *C. chalandei*, *C. finitimus*, *C. franzi* Attems 1952, *C. ibericus*, *C. latestriatus*, *C. londinensis*, *C. perforatus*, *C. pyrenaicus* Brölemann, 1897, *C. sagittarius*, Brölemann 1897, *C. sanctimichaelis*, *C. silvarum* (now *C. punctatus* Leach, 1815), *C. spinosus* and *C. teutonicus* (Pocock, 1900) (now *C. caeruleocinctus*). Of these, *spinosus* is now considered to be in the genus *Allajulus* (Read, 1990), but the list omitted *Cylindroiulus dahli* Demange, 1970, *C. iluronensis* Brölemann, 1912 and *C. unciger* Attems, 1952 as well as *C. propinquus* (Porat, 1870) and *C. truncorum* Silvestri, 1896 both from Portugal. In recent years this list has been added to by *Cylindroiulus angliclectus* Read, 2007, *C. boreoibericus* Read, 2007, *C. gregoryi* Read, 2007, *C. fenestratus* and *C. ventanaea*. All of the species listed above were listed for Spain in the European Atlas of Julids (Kime & Enghoff, 2017). Subsequently an additional species has been described, *Cylindroiulus villumi*. Spelda (2015) also provides a complete list of *Cylindroiulus* species from Spain including Macaronesia which includes an additional two species from the Iberian Peninsula, *C. hispanicus* Ceuca, 1974 and *C. simplex* Ceuca, 1974 but these have previously been synonymised with *C. sagittarius* and *S. chalandei* respectively.

Material and methods

Most of the material studied here was collected during a week-long visit by an international group of Myriapodologists who visited the Basque Country and Navarra, in 2009 and were assisted by various local biologists and foresters. The Sierra de Grazalema was visited by a German expedition, primarily collecting myriapods, in 2008 (see Voigtländer & Reip, 2013 for more details). Additional material studied was from smaller collections and includes some unidentified *Cylindroiulus* in the collection of the NHMD and specimens collected by S. Pagola-Carte and I. Zabalegui, Basque entomologists.

Species in the genus *Cylindroiulus* tend to be very uniform in shape, are often of similar size, and are generally pigmented with a fairly standard pattern. Descriptions of colour or patterning are generally only given when they differ from the *Cylindroiulus* basic pattern. There are relatively few external

characters that are generally useful for distinguishing species, making descriptions and identification of the species within the genus difficult. In the following descriptions the overall body shape is described using the terms anterior constriction, which is the reduction in body width behind the head in dorsal view. Posterior attenuation refers to the degree of reduction in body height at the posterior end of the body when looking from the side. The term body rings is used instead of segments as the rings in a millipede do not equate to true segments. Setae on the anal valves are generally evenly spaced and located just in from the margin, unless otherwise specified.

Locations given on labels were converted to a standard format (decimal degree) using coordinates-converter.com. For the small number where details of location from labels were vague, a map was used to find the decimal degree of the nearest place mentioned on the label. To produce the distribution maps Henrik Enghoff hand plotted them on the relevant species map from the European Atlas (Kime & Enghoff 2017) using <https://mappingsupport.com/p2/gissurfer.php> to help locate the positions.

Specimens were examined using a Nikon SMZ 2B binocular microscope and a Brunel Microscopes SP-1100 compound microscope. Photographs were taken using a Cannon EOS 100D using photoadapters from Brunel Microscopes and the stacking software Helicon Focus 7 was used. Photoshop was used for further picture editing.

ACRONYMS

The locations of type specimens are stated using the following acronyms.

GEE – Gipuzkoa Entomologia Elkartea, Oiartzun, Spain

MNCN – Museo Nacional de Ciencias Naturales, Madrid, Spain

NHMD – Natural history Museum of Denmark (formerly ZMUC), Copenhagen, Denmark

NHMW – Naturhistorisches Museum, Wien, Austria

NHM – The Natural History Museum, London, UK

SGMT – Sheffield Galleries and Museum, Sheffield, UK

SMNG – Senckenberg Museum of Natural History Görlitz, Germany

ZMBN – University Museum of Bergen, Norway

Unless otherwise stated non type material is held as follows:

Specimens collected by S. Pagola and I. Zabalegui are in GEE

Specimens collected by Per Dursvoll are in ZMBN

Specimens collected by Steve Gregory and J. Paul Richards are in their private collections

Specimens collected by Karin Voigtländer are in SMNG

Specimens collected by Hans Reip and Norman Lindner are in the collection of Hans Reip

Specimens collected by Desmond Kime and Helen Read are in the private collection of Helen Read

Numbers in brackets before detailed descriptions of localities are the numbers given to locations during the collecting trips in 2009 and 2008.

Results

The collections studied yielded 10 species of *Cylindroiulus*. Some of these are well known with good descriptions published elsewhere but three new species were found which are described here. In addition, some species were felt worthy of fuller descriptions with the addition of more specimens, and the *caeruleocinctus/sanctimichaelis/londinensis* group has been discussed in more detail as they are challenging to distinguish. The abundance of some species has enabled comments to be made about life histories which have previously been unknown.

Specimens collected by Hans Reip and Norman Lindner from the Basque Country and Navarra were identified by Hans Reip.

DESCRIPTION OF SPECIES

Cylindroiulus caramelos sp. nov.

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Figs. 1-18

HOLOTYPE: ♂, Spain: Cataluña: Tarragona, Alfara de Carles, El Toscar. 40.86, 0.334. 3.04.2015. J.D. Gilgado leg. (NHMD).

PARATYPES: 4 ♀♀, details as above (NHMD).

TOTAL MATERIAL STUDIED: male (1), females (4).

DIAGNOSIS

Very similar to *Cylindroiulus sanctimichaelis* and *Cylindroiulus caeruleocinctus*, with large body size and lacking a telson projection. Differing by having a relatively long body with many body rings. Dark in colour, preserved specimens are banded in colour, with pale legs. Gonopods are similar to *C. caeruleocinctus/C. sanctimichaelis*, the anterior gonopods are relatively large in relation to the posterior gonopods which have a large brachite.

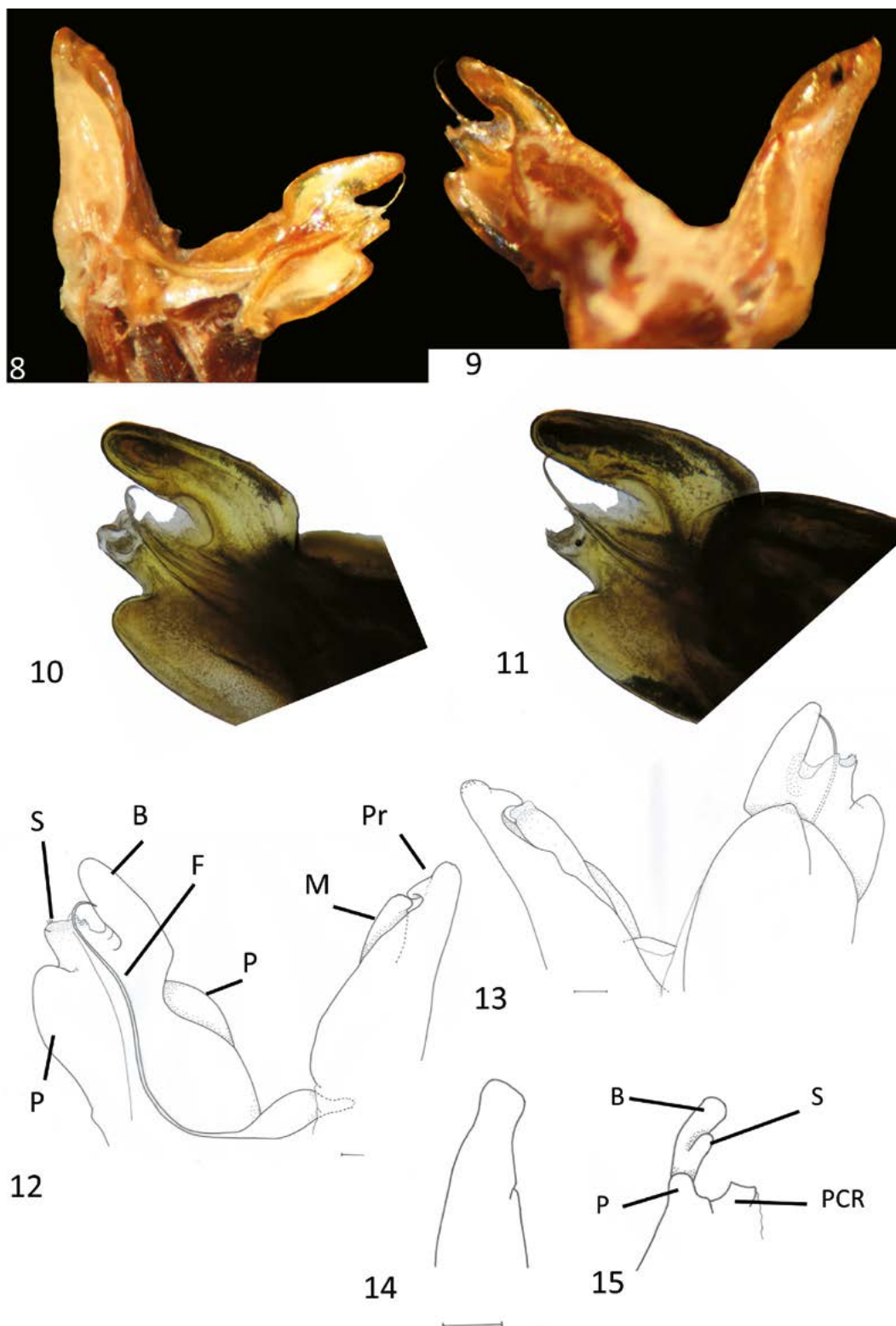
DESCRIPTION

Length: ♂ 38 mm; ♀ up to 51 mm. Body height: ♂ 2.1 mm; ♀ up to 3.06 mm. Rings: ♂ 57; ♀ up to 62. Body colour: General appearance, black with white legs (Figs. 1-5). Head dark brown, prozonites pale grey, metazonites black, with paler posterior edge.



Figs. 1-7.— *Cyldroiulus caramelos* sp. nov. 1. Head and anterior body rings, female paratype. 2. Telson, female paratype. 3. Mid body rings showing colouration, male holotype. 4. Ventral view of seventh body ring showing location of gonopods, male holotype. 5. Head and anterior body rings, male holotype. 6. Mid body walking leg. 7. El Toscar, the type locality for *C. caramelos* sp. nov. with the collector J.D. Gilgado. Photograph V. Martínez-Pillado.

Figs. 1-7.— *Cyldroiulus caramelos* sp. nov. 1. Cabeza y anillos corporales anteriores, paratipo hembra. 2. Telson, paratipo hembra. 3. Anillos corporales centrales mostrando la coloración, holotipo macho. 4. Vista ventral del séptimo segmento corporal mostrando la localización de los gonópodos, holotipo macho. 5. Cabeza y anillos corporales anteriores, holotipo macho. 6. Pata de la zona central del cuerpo. 7. El Toscar, localidad tipo de *C. caramelos* sp. nov. con el colector J.D. Gilgado. Fotografía V. Martínez-Pillado.



Figs. 8-15.— *Cylindroiulus caramelos* sp. nov. gonopods, male holotype. 8. Gonopods in mesal view. 9. Gonopods in lateral view. 10. Detail of opisthomerite in mesal view. 11. Detail of opisthomerite in lateral view. 12. Illustration of gonopods in mesal view. 13. Illustration of gonopods in lateral view. 14. Gonopods in anterior view. 15. Gonopods in posterior view. Abbreviations: B - brachite; F - Flagellum; M - Mesomerite; S - solenomerite; P - phylacum; PCR - paracoxal rim; Pr - Promerite; S - solenomerite). Scale bars: 12-13 = 0.1 mm; 14-15 = 0.21 mm.

Figs. 8-15.— *Cylindroiulus caramelos* sp. nov. gonópodos, holotipo macho. 8. Gonópodos en vista mesial. 9. Gonópodos en vista lateral. 10. Detalle del opisthomerito en vista mesial. 11. Detalle del opisthomerito en vista lateral. 12. Ilustración del gonópodo en vista mesial. 13. Ilustración del gonópodo en vista lateral. 14. Gonópodo en vista anterior. 15. Gonópodo en vista posterior. Abreviaturas: B - braquito; F - flagelo; M - mesomerite; P - filacum; PCR - margen paracoxal; Pr - promerite; S - solenomerite). Escalas: 12-13 = 0.1 mm; 14-15 = 0.21 mm.

Thin black mid dorsal line. Appearing striped around the body (but only preserved specimens seen). Anal valves very dark brown, preanal ring dark brown/black with white posterior margin. Overall body shape: Anterior constriction, present, just behind the head, posterior attenuation present but not strong, largely just the apodous rings. Head: Antennae, dark brown, eye rows: clear and readable. Stadia: ♂ 9 rows of ommatidia = X; ♀ up to 12 rows = XIII. Body rings: Metazonite vaulting present and clearly noticeable, limbus not crenulate. Legs: Pale in colour. Despite the preservation of the holotype being of good quality, almost all the legs had broken accessory claws. Of the few that appeared unbroken, the accessory claws seemed to be slightly shorter than the claw (Fig. 6). Females also had a large number of broken accessory claws, with those intact appearing to be slightly shorter than the claw. Telson: Preanal ring with no projection, perhaps bearing setae but probably worn off in the male. Subanal scale not projecting, with one pair of setae. Anal valves with three pairs of setae.

Mature male secondary sexual characters: Mandibular stipites of mature males strongly expanded and projecting anteriorly, First pair of legs in mature male tight hooks with prominent ‘knees’ on the angle of the hook.

Gonopods (Figs. 8-15): Promerite narrow and slender in anterior view, relatively bulky in mesal view, with hooked apex. Mesomerite narrow and slender and almost completely enclosed by promerite apart from the distal part. Flat topped and with different textured apex. Opisthomerite broad and bulky in mesal view. Brachite large, projecting beyond the solenomerite, with angular ventral margin and clear cleft between it and the solenomerite with membranes across it. Phylacum large, curvaceous. Solenomerite with three small teeth at the apex and membranous area at tip. Paracoxal rim very high, paracoxal process lacking.

ETYMOLOGY

Named for its superficial resemblance to a mint humbug (a stripy child’s sweet); “caramelos” are sweets in Spanish.

RELATIONSHIPS WITH OTHER SPECIES

This species clearly falls into the problematic *londinensis* group, for full discussion see under *C. sanctimichaelis*. It can be distinguished by details of the gonopods and has more body rings in total and more body rings for the body height than other similar species (Figs. 16-17). The short accessory claw might also be diagnostic but most appeared to be broken so the reliability of this character is uncertain. It is also not well enough studied in all the similar species to be confident of its value.

HABITAT

The type locality is situated in a limestone mountainous region range close to Tarragona with a Mediterranean

climate and occasional snow. The site is situated in a humid area (Fig. 7) which is the source of many small water courses in the shadow of the mountain. The mountains are considered a transition zone between the Sistema Ibérico Mountains and the Catalan pre coastal mountain range but are separated from the Pyrenees.

LIFE HISTORY

Adults were found in April. There are not enough specimens to analyse for life history.

DISTRIBUTION

Only known from the type locality (Fig. 18). When the manuscript was in the proof stage, communication with Hans Reip revealed that this species may be quite common west and south of the Ebro delta, a little south of the type location.

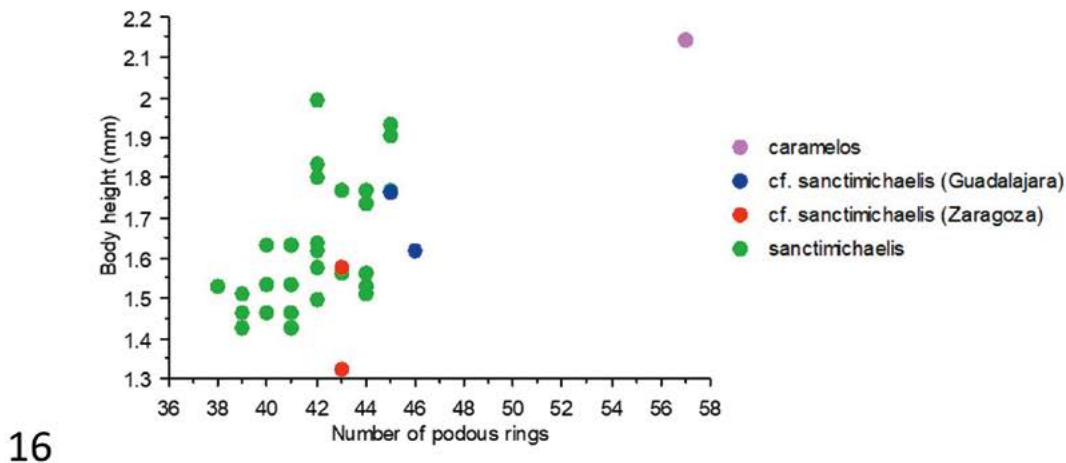
Cylindroiulus elosegiorum sp. nov.

urn:lsid:zoobank.org:act:AAED2DE2-B26D-45DB-B883-D43FB4A2EC39
Figs. 19-39

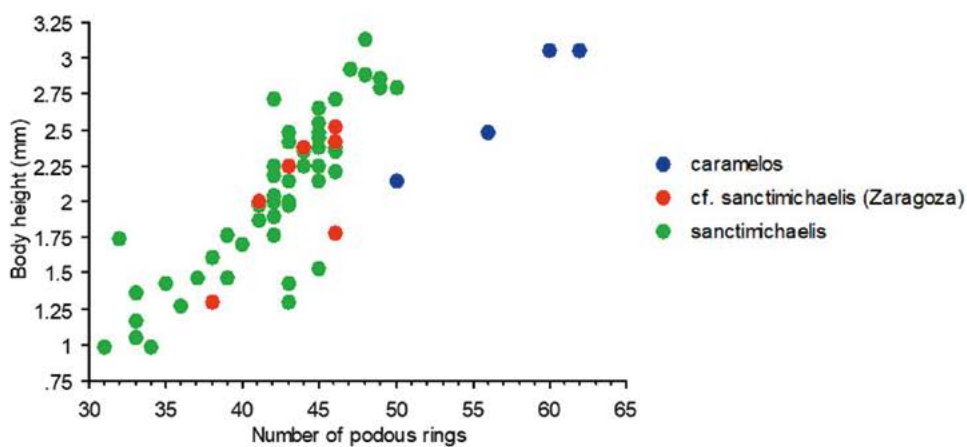
HOLOTYPE: ♂, Spain, Navarra: Leitza, Ariz Mendiak, at area “Kornieta”, 43.0698, -1.8823, 910 m, 4.02.2010, *Fagus* L. woodland, poor understorey, rocky, siliceous soils, mosses, *Helleborus* L. under bark & in leaf litter. Helen Read & Mark Frater leg. (MNCN 20.07/2072).

PARATYPES:

- 5♂♂, 1j♂, 14♀♀/j, details as above. (MNCN 20.07/2073-2092).
(7 & 8) Navarra: Leitza, Ariz Mendiak, at area “Kornieta”, 43.0698, -1.8823, 910 m, 20.04.2009, *Fagus* woodland, poor understorey, rocky, siliceous soils, mosses, under bark & in leaf litter. 3♂♂, 16♀♀. Desmond Kime (NHMD) & Steve Gregory (NHM) leg.
(9) Navarra: Leitza, town area, 43.0788, -1.9161, 470 m, 20.04.2009, house & garden around casa rural Aztieta under stones and logs. 2♂♂. Steve Gregory leg. (GEE).
(12b) Navarra: Sierra de Aralar, south of Errazkin, north of area “Axkarateko Malkorra”, 42.9972, -1.9703, 630 m, 21.04.2009, *Fagus* woodland. 7♂♂, 12♀♀, Karin Voigtländer leg. (SMNG VNR 014759-8).
(22) Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, at area “Izáin”, 42.9714, -1.9384, 790 m, 22.04.2009, Karst area with deep grykes and bare limestone rocks, *Fagus* woodland & some *Crataegus* Tourn. Ex L. bushes in leaf litter, partly sieved out. 1♂, 4♀♀. Helen Read leg. (NHMD)
(23) Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, at area “Izáin”, 42.9724, -1.9361, 730 m, 22.04.2009, Karst area with deep grykes and bare limestone rocks, *Fagus* woodland & some *Crataegus* bushes ground of deep and collapsed gryke, sieved from *Fagus* leaf litter. 2♂♂, 18♀♀, Karin Voigtländer leg. (SMNG VNR 014771-13).
(24B) Navarra: Sierra de Aralar, Sierra de San Miguel, mountain point Artxueta at radio mast, 42.9525, -1.9668, 1300 m, 22.04.2009, Karst area with bare limestone rocks, grove of low growing *Fagus* in litter and under bark. 1♂, 1j♂, 2♀♀, Helen Read leg. (GEE)
(17-1) Guipuzkoa: Sierra de Aralar, Beasain, road from Lazkao to Etxarri-Aranaz, westerly Pass, 42.9572, -2.1122, 550 m, 21.04.2009, forest of *Fagus* in leaf litter. 5♂♂, 1j♂, 11♀♀, Karin Voigtländer leg. (SMNG VNR 014831-2).



16



17

18



Figs. 16-18.— 16-17. Scatter plots of body height against podous body rings for *C. sanctimichaelis* and *C. caramelos* sp. nov. See text under *C. sanctimichaelis* for further details. 16. Males. 17. Females (note there were no females from Guadalajara). 18. Distribution map showing location of the type location of *C. caramelos* sp. nov.

Figs. 16-18.— 16-17. Gráficos de dispersión de la altura corporal frente a los anillos corporales con patas para *C. sanctimichaelis* y *C. caramelos* sp. nov. Ver el texto del apartado de *C. sanctimichaelis* para más detalles. 16. Machos. 17. Hembras (téngase en cuenta que no había hembras de Guadalajara). 18. Mapa de distribución que muestra la ubicación del tipo de *C. caramelos* sp. nov.

- (29) Navarra: Between Sierra de Urbasa and Sierra de Andía, road (NA-120) 2,5 km SSW of Puerto de Lizarraga, “Fagadierer” (300 m E of Bentaberri), 42.8372, -2.0233, 860 m, 22.04.2009, Mediterranean *Buxus* L.-*Fagus*-Forest within leaf litter of *Fagus*. 1♂, 1j♂, 3♀♀. Steve Gregory leg. (ZMBN).
- (34) Navarra: Sierra de Urbasa, on top, near road NA-7182, 42.8375, -2.1815, 930 m, 23.04.2009, grazed *Fagus* woodland, in parts with bushes of *Crataegus*, otherwise few bushes, partly covered with herbs: *Corydalis* DC., *Urtica* L., *Rubus* L. etc., very little dead wood on the ground, in leaf litter, mainly *Crataegus*. 1♂, 2♀♀, Karin Voigtländer leg. (SMNG VNR 014820-4).
- (35) Navarra: Sierra de Urbasa, on top at southern cliff border, east of road NA-7182, 42.7989, -2.1417, 930 m, 23.04.2009, pasture on stony ground, some thorny bushes, occasional trees or groups of *Fagus*. 1♀, Karin Voigtländer leg. (SMNG VNR 014826-6).
- (35) As above, in leaf litter. 1♂, 3♀♀/J, Helen Read leg. (NHMW).
- (36) Navarra: Sierra de Urbasa, at southeastern cliff border, eastern zigzag of road NA-7182, under cliffs, 42.7953, -2.1397, 810 m, 23.04.2009, steep slope with forest of *Fagus*, thick leaf layer, thick humus layer (no more raw humus) – in the herb layer: *Hepatica nobilis* Schreb., *Scilla* L. sp., at the cliff: *Saxifraga* Tourn. Ex L. sp., *Asplenium* cf. *adulterinum* Milde, in thick leaf litter. 3j♂, 11♀♀, Karin Voigtländer leg. (SMNG VNR 014781-25).
- (38) Navarra: Sierra de Urbasa, on top, near road NA-7182, 42.8411, -2.18, 920 m, 23.04.2009, *Fagus* woodland on limestone karst under stones and in leaf litter. J. Paul Richards (3♂♂, 6♀♀/J, SGM: accession number SHEFM:2021.2) & Helen Read (1♀, 1j♂, NHMW) leg.
- (45) Guipuzkoa: Montes de Alzania, Sierra de Urquilla, south of mountain chain Aikorriko Mendikatea, southwest of Mountain Aitzgorri – north of end of road from Salvatierra to Ordonana, Zalduondo, Zumarraundi – north slope of Aldasbarreneta valley, 42.9411, -2.3339, 1170 m, 24.04.2009, forest of *Fagus*, very mossy, almost no herbs, isolated fern and *Daphne* L. in leaf litter. 2♂♂, 2j♂, 10♀♀, K. Voigtländer leg. (SMNG VNR 014787-13). (SMNG).
- (36) Navarra: Sierra de Urbasa, at southeastern cliff border, eastern zigzag of road NA-7182, under cliffs, 42.7953, -2.1397, 810 m, 23.04.2009, steep slope with forest of *Fagus*, thick leaf layer, thick humus layer (no more raw humus) – in the herb layer: *Hepatica nobilis* Schreb., *Scilla* L. sp., at the cliff: *Saxifraga* Tourn. Ex L. sp., *Asplenium* cf. *adulterinum* Milde, in thick leaf litter. 1♂, 1♀, Norman Lindner leg. & 3♂♂, 5♀♀, 3j, Hans Reip leg. Hans Reip det.
- (41) Navarra: Sierra de Urbasa, on top, 1km east of road junction to road NA-7182 at site “Bentakaita”, 42.854, -2.1595, 890 m, 23.04.2009, *Fagus* forest, *Prunus*, *Corydalis*, *Mercurialis* L., *Anemone* L., *Erythronium* L. in leaf litter. 1♀. Desmond Kime leg.
- (45) Guipuzkoa: Montes de Alzania, Sierra de Urquilla, south of mountain chain Aikorriko Mendikatea, southwest of Mountain Aitzgorri – north of end of road from Salvatierra to Ordonana, Zalduondo, Zumarraundi – north slope of Aldasbarreneta valley, 42.9411, -2.3339, 1170 m, 24.04.2009, forest of *Fagus*, very mossy, almost no herbs, isolated fern and *Daphne* in leaf litter. 1j Hans Reip leg. & det.
- (52) Alava: Sierra de Peña Gorbea [Gorbeia], Valley of the River “Bayas Ibaia”, north of Sarria, at (bridge) Arkarai, at area “Eczaray”, 43.017, -2.83, 720 m, 24.04.2009, slope with coniferous forest, mainly without herb layer, barely rotten wood, some dead wood pieces, on the lower edge some medium sized stones on the ground under bark of (freshly) dead wood or stumps. 2♂, 1j♂, 1♀. Desmond Kime & Steve Gregory leg.

MATERIAL IDENTIFIED BY HANS REIP, NO MATURE MALES BUT HIGHLY LIKELY TO BE THIS SPECIES:

- (48) Guipuzkoa: Montes de Alzania, Sierra de Urquilla, south of mountain chain Aikorriko Mendikatea, southwest of Mountain Aitzgorri – north of end of road from Salvatierra to Ordonana, Zalduondo, Zumarraundi – Portua Zarra, west of Eskaratza, 42.9334, -2.3283, 1200 m, 24.04.2009, small sharp summit of limestone rock/cliff, *Fagus* forest with small accumulations of leaves in leaves between rocks. 1J, Hans Reip leg.
- (49) Alava: Montes de Alzania, Sierra de Urquilla, south of mountain chain Aikorriko Mendikatea, southwest of Mountain Aitzgorri – north of end of road from Salvatierra to Ordonana, Zalduondo, Zumarraundi – north of Zumarraundi, deep gryke with stream discharge, in the lower third, 42.9241, -2.3224, 980 m, 24.04.2009, forest of *Fagus*, thick leaf layer in leaf litter. 1♀, Hans Reip leg.

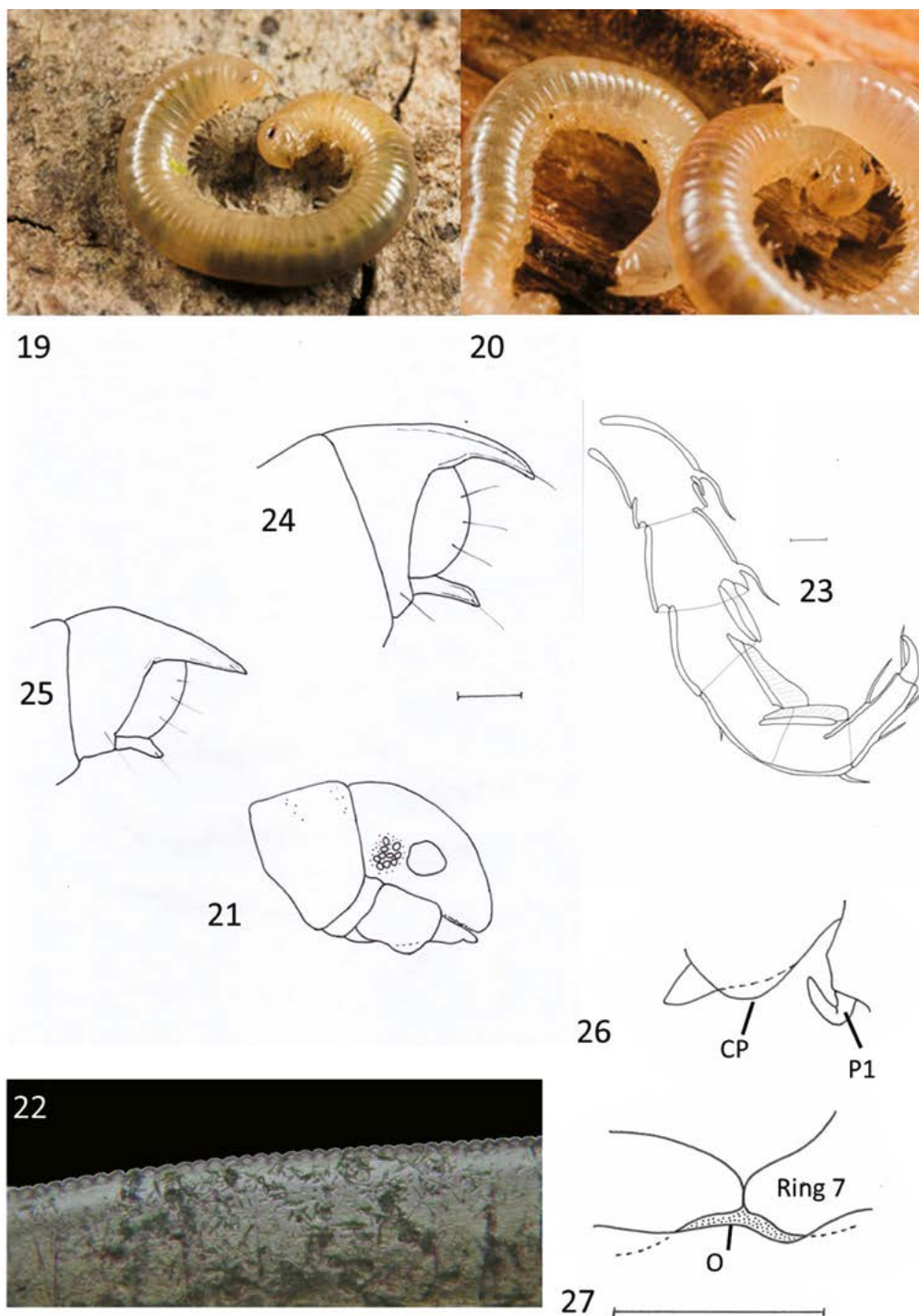
TOTAL MATERIAL STUDIED: males: 39; juvenile males: 11; females: 120

DIAGNOSIS

A small pale *Cylindroiulus* with exceptionally strongly down pointed telson projection and large upward pointing subanal scale. Reduced number of ommatidia, in jumbled rows, often variable in size. Gonopods relatively simple and conforming to the normal *Cylindroiulus* plan.

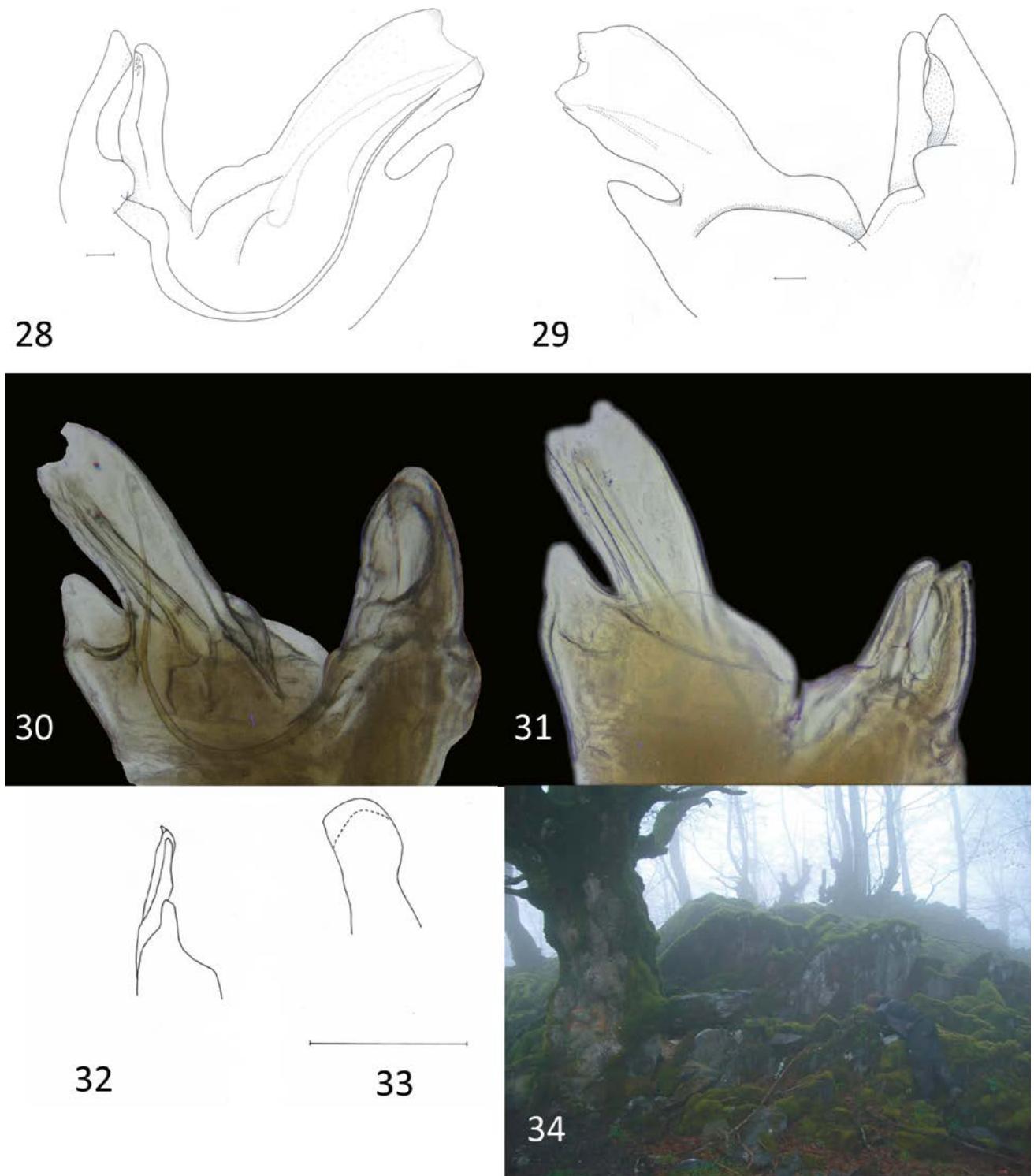
DESCRIPTION

Length: ♂ 8.9-16.6 mm; ♀ up to 19.2 mm. Body height: ♂ 0.7-0.9 mm; ♀ up to 1.4 mm. Rings: ♂ with 27-43 podous rings. ♀ up to 50. Body colour: Generally pale straw coloured with little pigmentation (Figs. 19-20). Some specimens darker posteriorly, probably the result of gut contents showing through the paler integument. Repugnatorial glands, when



Figs. 19–27.— *Cylindroiulus elosegiyorum* sp. nov. 17–18. Specimen from location 30 Sierra Andia, Los Ristros. 19–28. Specimen from Leitza, Kornieta in 2010 (Type locality). 28–29. Specimen from Puerto de Lizarraga. 19. Habitus showing colour; photograph J. Paul Richards. 20. Showing 'two-tailed' appearance due to projections of telson and subanal scale; photograph J. Paul Richards. 21. Head of male showing expansion of cheek plate. 22. Limbus of metazonite from internal view. 23. Walking leg of mature male showing claw and accessory claw. 24. Posterior end of mature male showing projecting telson and subanal scale. 25. Posterior end of juvenile. 26. First pair of legs of mature male (P1), anterior to left; also showing slightly expanded cheek plate (CP). 27. Opening (O) next to ring 7 in mature male, anterior uppermost. Scale bars: 21, 24–27 = 0.21 mm; 23 = 0.025 mm; 25 = 0.2 mm.

Figs. 19–27.— *Cylindroiulus elosegiyorum* sp. nov. 17–18. Ejemplar de la localidad 30 Sierra Andia, Los Ristros, 19–28. Ejemplar de Leitza, Kornieta en 2010 (localidad tipo). 28–29. Ejemplar del Puerto de Lizarraga. 19. Habitus, mostrando el color, fotografía de J. Paul Richards. 20. Apariencia de "dos colas" como consecuencia de las proyecciones del telson y de la escama ventral, fotografía de J. Paul Richards. 21. Cabeza del macho mostrando expansión del estípites. 22. Limbus del metazonito en vista interna. 23. Pata de macho maduro mostrando la uña y la uña accesoria. 24. Extremo posterior de un macho maduro mostrando el telson y la escama ventral proyectados. 25. Extremo posterior de un juvenil. 26. Primer par de patas de macho maduro (P1), anterior a izquierda; muestra también estípites ligeramente expandida (CP). 27. Abertura (O) junto al anillo 7 en un macho aduro, anterior superior. Escalas: 21, 24–27 = 0.21 mm; 23 = 0.025 mm; 25 = 0.2 mm.



Figs. 28-34.— *Cylindroiulus elosegiorum* sp. nov. Gonopods of mature male. 28. Mesal view. 29. Lateral view. 30. Photograph of male gonopods in mesal view. 31. Photograph of male gonopods in lateral view. 32. Posterior view of posterior gonopods. 33. Anterior view of anterior gonopod. 34. Type location in Leitza, Navarra, showing rocky substrate under ancient *Fagus sylvatica* trees. Scale bars: 28-29 = 0.025 mm; 32-33 = 0.21 mm.

Figs. 28-34.— *Cylindroiulus elosegiorum* sp. nov. Gonópodos de un macho maduro. 28. Vista mesal. 29. Vista lateral. 30. Fotografía de gonópodos de un macho en vista mesal. 31. Fotografía de gonópodos de un macho en vista lateral. 32. Vista posterior de un gonópodo posterior. 33. Vista anterior de un gonópodo anterior. 34. Localidad tipo en Leitza, Navarra, mostrando sustrato rocoso bajo viejos árboles de *Fagus sylvatica*. Escalas: 28-29 = 0.025 mm; 32-33 = 0.21 mm.

visible, pale brown/orange. Overall body shape: Anterior constriction not obvious, posterior part of trunk wider than anterior. Head: Antennae: slender and pale in colour. Eye rows: Eyes not in clear rows except in younger juveniles, difficult to 'read'. Ommatidia reduced in number, often jumbled and sometimes varying in size in the same ocular field (Fig. 21). Ommatidia black and contrasting in comparison with pale body colour. ♂ with 8-14 ommatidia; F up to 15-16 ommatidia. Body rings: Striae on metazonites fairly strong and close together, limbus crenulate (Fig. 22). Legs: Generally pale, similar to body colour. With strong and crooked setae on more basal leg segments. Claw of normal shape; accessory claw slightly longer than claw, with distinct change of direction after surpassing the claw tip (Fig. 23). Telson: Preanal ring with strong projection, curved ventrally. With 1 pair of setae at end and another pair ventrally. Less strongly projecting in juvenile individuals and tending to be straighter/less down turned. Subanal scale projecting well past the anal valves (Figs. 20, 24). More-or-less parallel with ventral margin of trunk but sometimes appearing dorsally directed giving the impression of a pincer shape at the posterior end of the animal. With one pair of setae. Smaller relative to body size in juveniles (Fig. 25). Anal valves: With three pairs of setae (Fig. 24).

Mature male secondary sexual characters: Mandibular stipites of mature males barely expanded (Fig. 21). First pair of legs in mature males forming tight hooks with prominent 'knee' (Fig. 26). Keel of body ring 7 in mature males open, but not very wide, no obvious keel (Fig. 27)

Gonopods (Figs. 28-33): Promerite: Short and squat with no 'window'. Flagellum of normal length. Mesomerite: Short and squat, similar in length to promerite. Opisthomerite: Simple in shape with membranous tip. Long thin phylacum and small brachite. Large paracoxal process which seems a slightly strange shape from some angles and in posterior view.

ETYMOLOGY

Named after the Elozegi family from Leitza, in particular José Miguel, Migel Mari and Arturo, all of whom have helped me explore the Basque area and given freely of their time and knowledge. Note that members of the family spell their name in two different ways, Elózegui and Elozegi. The latter is the 'original' Basque spelling and the former the Spanish version. The family have expressed their preference for the Basque spelling.

RELATIONSHIPS WITH OTHER SPECIES

This species is one of a small group that have strongly down pointed dorsal projections on the preanal ring and strongly pointed subanal scale (although it is perhaps the most extreme in this species), others

being *C. apeninnorum* (Brölemann, 1897) (Italy, also presumably introduced to the Netherlands and UK), *C. gestri* (Silvestri, 1898) (Sardinia), *C. propinquus* (Portugal) and *C. pyrenaeicus* (Spain). The gonopods however do not appear similar to any of these species. It is unknown what the function of a strongly pointed telson is, and this is also true of the subanal scale. Pointed telsons occur in a variety of *Cylindroiulus* species and it seems likely that this does not relate to any particular evolutionary relationships.

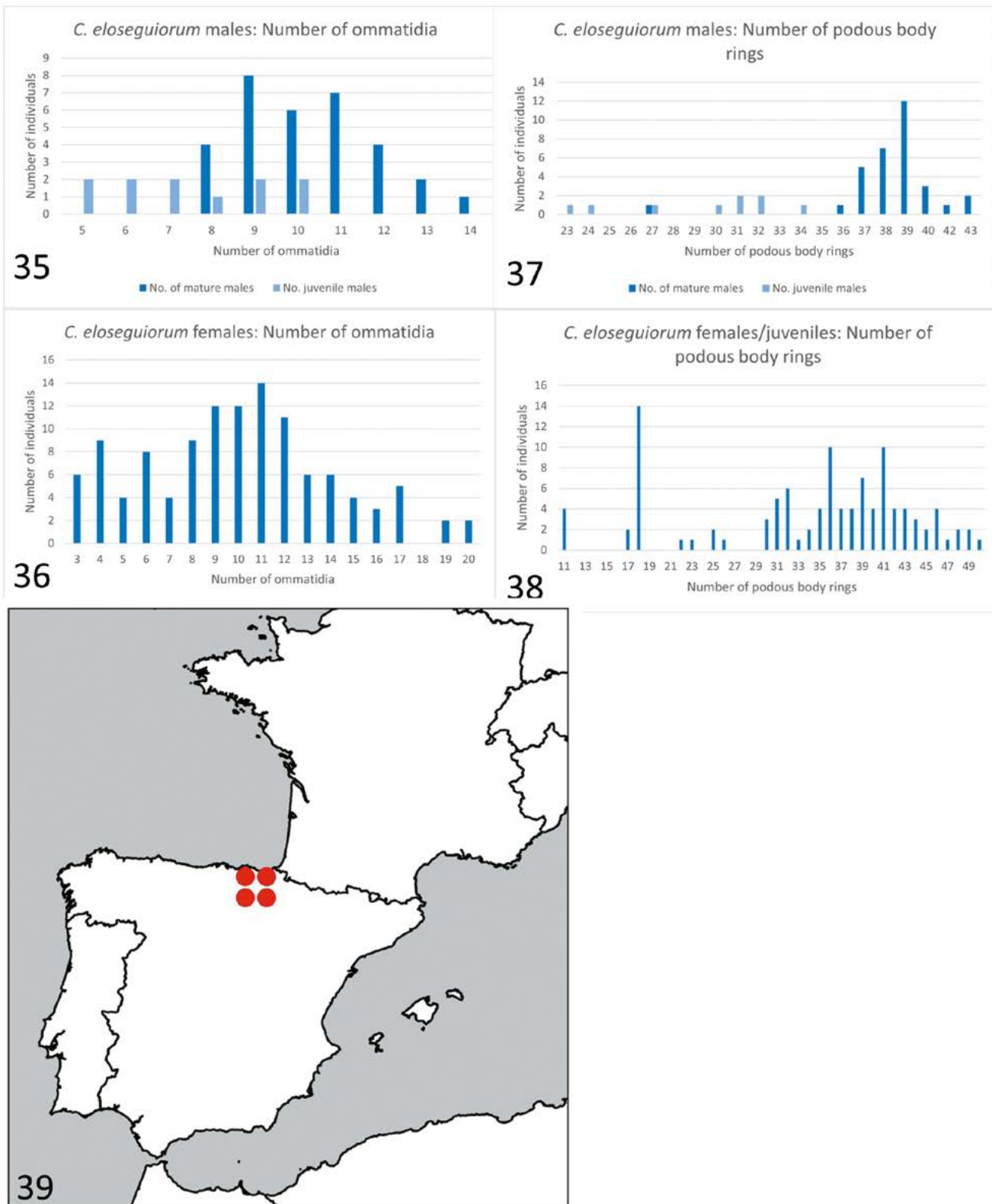
LIFE HISTORY

Cylindroiulus species add the apodous body rings to the number of podous body rings at each moult, and, if they have ommatidia they also add eye rows each time so it is possible to infer details of their life history by looking at the distribution of these characteristics across the collected specimens (Read, 1988). The eye rows for this species are very jumbled and are also reduced in terms of numbers of ommatidia (in comparison to the total, assuming that an extra row of ommatidia is added at each moult). As part of the characterisation of this species the numbers of ommatidia were counted and a plot showing the number of individuals for each ommatidia number, broken down by sex is shown in Figs. 35-36. Sometimes the number of ommatidia was not easy to determine and for a few specimens both sides of the head were examined. When the number of ommatidia varied on each side the head the lowest number was used in the graphs. Similar graphs illustrate the variation in the number of podous rings broken down by sex (Figs. 37-38). These figures show that the mature males have a relatively tight cluster of possible podous ring numbers. Allowing for the relatively high number of apodous rings in this species, between 3 and 5 for individuals with 39 or 40 podous rings, this probably reflects just one or two stadia. Aside from one very small mature male (perhaps misdesignated?) the distribution seems to show a normal pattern of juvenile males developing into matures for both number of ommatidia and podous ring number.

The graphs for the females show a more extended 'tail', i.e. more individuals with larger numbers of ommatidia and podous rings than the males. There is therefore a suggestion that the females undergo further moults once maturity has been reached. This situation is not uncommon in the genus *Cylindroiulus*. It therefore appears that the males are probably semelparous, but the females may be iteroparous. Having eight apodous rings was not unusual amongst juveniles of this species, hence the gaps in the graphs reflects this development pattern.

DISTRIBUTION

This species was found quite widely and frequently over the area sampled in 2009, in the provinces of Navarra and Guipuzkoa and just into Alava. A species of the hills, it was found in several mountain ranges



Figs 35-39.– 35-38. Graphs showing stadiol spectra for *C. elosegiyorum* sp. nov. 35. Numbers of individuals against numbers of ommatidia for males. 36. Numbers of individuals against numbers of ommatidia for females. 37. Numbers of individuals against numbers of podous rings for males. 38. Numbers of individuals against numbers of podous rings for females. 39. Distribution map showing the locations from which *C. elosegiyorum* sp. nov. was found.

Figs 35-39.– 35-38. Gráficos mostrando los espectros de estados para *C. elosegiyorum* sp. nov. 35. Número de individuos frente a número de omatidios en machos. 36. Número de individuos frente a número de omatidios en hembras. 37. Número de individuos frente a número de anillos con patas en machos. 38. Número de individuos frente a número de anillos con patas en hembras. 39. Mapa de distribución que muestra las localidades de colecta de *C. elosegiyorum* sp. nov.

from Leitza in the east, across Sierra de Aralar to Gorbeia in the west, and south to Sierra de Urbasa and Sierra de Andia (Fig. 39). While many locations were deciduous woodland, frequently with *Fagus sylvatica* L. (Fig. 34), it was also found in stony wood pasture with scattered trees and in the garden of a house in the centre of the town of Leitza.

***Cylindroiulus franzi* Attems, 1952**

Figs. 40-46

MATERIAL STUDIED:

(9) West side of the Sierra de Grazalema; banks of the river Río del Bosque, hiking trail between El Bosque and Benamahoma; around 36.772, 5.481; 370 m; narrow and deeply incised valley, gallery forest; at humid sites in leaf litter. Sieving. 05.02.2008. 4♂♂, 24 ♀♀/J, Hans Reip & K. Vöigtlander leg. (SMNG).

TOTAL MATERIAL COLLECTED: male (4), females (24)

DIAGNOSIS

A small and pale species with no telson projection but a characteristic tented shape to the top of the telson. Simple shaped gonopods with a prominent paracoxal process which is jagged on the posterior side.

DESCRIPTION

Length: ♂ 17 mm; ♀ up to 20 mm. Body height: ♂ 1 mm; ♀ up to 1.3 mm. Rings: ♂ 48-51, ♀♀ up to 54. Body colour: Overall pale in colour, telson a little darker, some individuals with small amount of darker mottling. Antennae and legs pale in colour. Overall body shape: Anterior constriction behind head; posterior attenuation only of apodous rings. Legs with accessory claw slightly longer than claw. Head: Eye rows rather jumbled with what look to be extra ommatidia (Fig. 40). First two rows often seemingly a single ocellus. Stadia: ♂ VII to VIII, ♀ up to IX. Body rings: Striae on metazonites regular. Limbus not crenulate. Telson: Preanal ring without clear dorsal projection but with a roof-like shape which gives the appearance of a prominent point dorsally (Fig. 41). Bearing 1 or 2 pairs of setae ventrally and one pair dorsally on the projection. Subanal scale not projecting, bearing 1 pair of setae. Anal valves generally with 3 pairs of setae.

Mature male secondary sexual characters: Mandibular stipites of mature males expanded to medium extent, with a vertical anterior margin (Fig. 40). First pair of legs in mature male: tight hooks. Keel of body ring 7 in mature male very small, barely projecting but body appearing slightly wider at this point.

Gonopods (Figs. 42-45): Promerite and mesomerite relatively low and squat. Promerite slightly longer and much broader than mesomerite which appears narrowly projecting up almost through the promerite. Flagellum of normal length. Paracoxal rim barely

present. Opisthomerite simple in shape, with hyaline region apically. Paracoxal process large and with jagged posterior margin, although rather less stout than illustrated by Mauriès (1978). Despite the size of the paracoxal process it can be difficult to see *in situ* being situated on the mesal side of the gonopods.

RELATIONSHIPS WITH OTHER SPECIES

Attems considered that this species was in the subgenus *Plagionicus*, together with *C. parisorum* and *C. bouvieri* (Brölemann, 1896) (now = *C. parisorum* Geoffroy *et al.* in press), but the simple gonopods look more similar to the Caucasian species *C. placidus* (Lignau, 1903) and *C. besucheti* Strasser, 1975 both considered in the *C. placidus*-group (Read, 1992). The original illustrations are rather poor, but a more complete description has been made by Mauriès (1978) including a drawing of the type. The current specimens accord well with that of Mauriès *loc cit.*

ECOLOGY & LIFE HISTORY

With so few samples further analyses are not possible.

DISTRIBUTION

Previously known from Sierra de las Nieves close to Ronda and Mt Arastepa in the Sierra de Ronda. The current larger collection is from the same area. If the collection from Granada can be confirmed as the same species (see below) this would be a considerable expansion to the range, although still within Andalucía. (Fig. 46).

Cylindroiulus cf. franzi

No mature males were in these collections. The telson and overall appearance looks similar but location of one is somewhat distant from those recorded so far.

MATERIAL STUDIED

Andalucía: P.N. Sierra de las Nieves, road to Quejigales. 23.3.2008. 1♀, H. Read & M. Frater leg.

Andalucía: Granada, Sierra Nevada, Güéjar Sierra, Barranco de las Ánimas, 1400 m, 14.8.2014. 1♀, 1j♂, J.D. Gilgado & A. Tinaut leg (NHMD).

***Cylindroiulus karinhansorum* sp. nov.**

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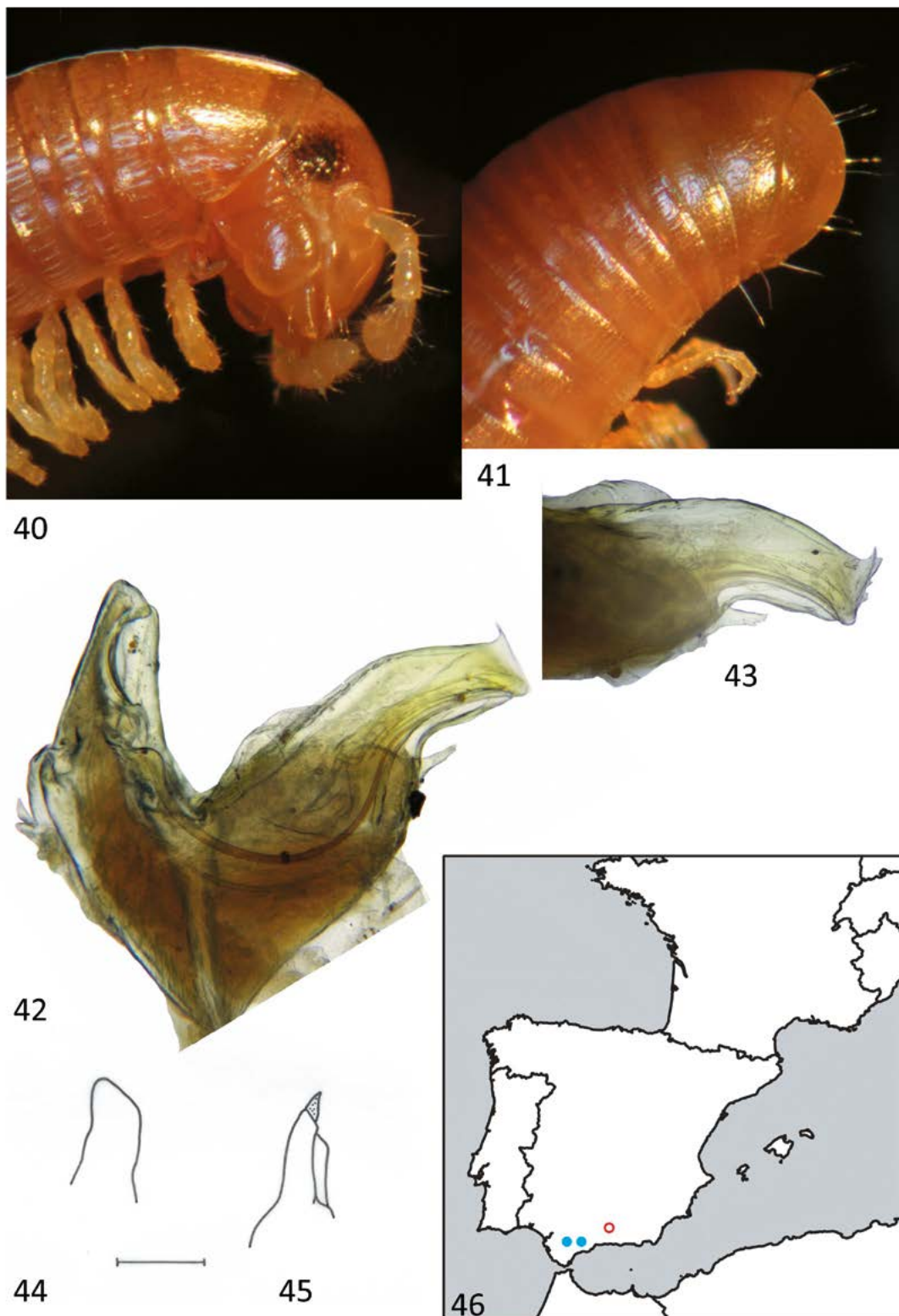
Figs. 47-59

HOLOTYPE: ♂, Spain, (21) Andalucía: Northern part of Los Alcornocales; south of the road from Cortes de la Frontera to Alcalá de los Gazules, forest track south of the mountain Peñón del Berrueco. 36.593, -5.423, altitude ca. 680 m, 8.02.2008. Hans Reip & K. Vöigtlander leg. (SMNG).

PARATYPES: 1♂, 6j♂♂, 26♀♀/J, details as above. (SMNG).

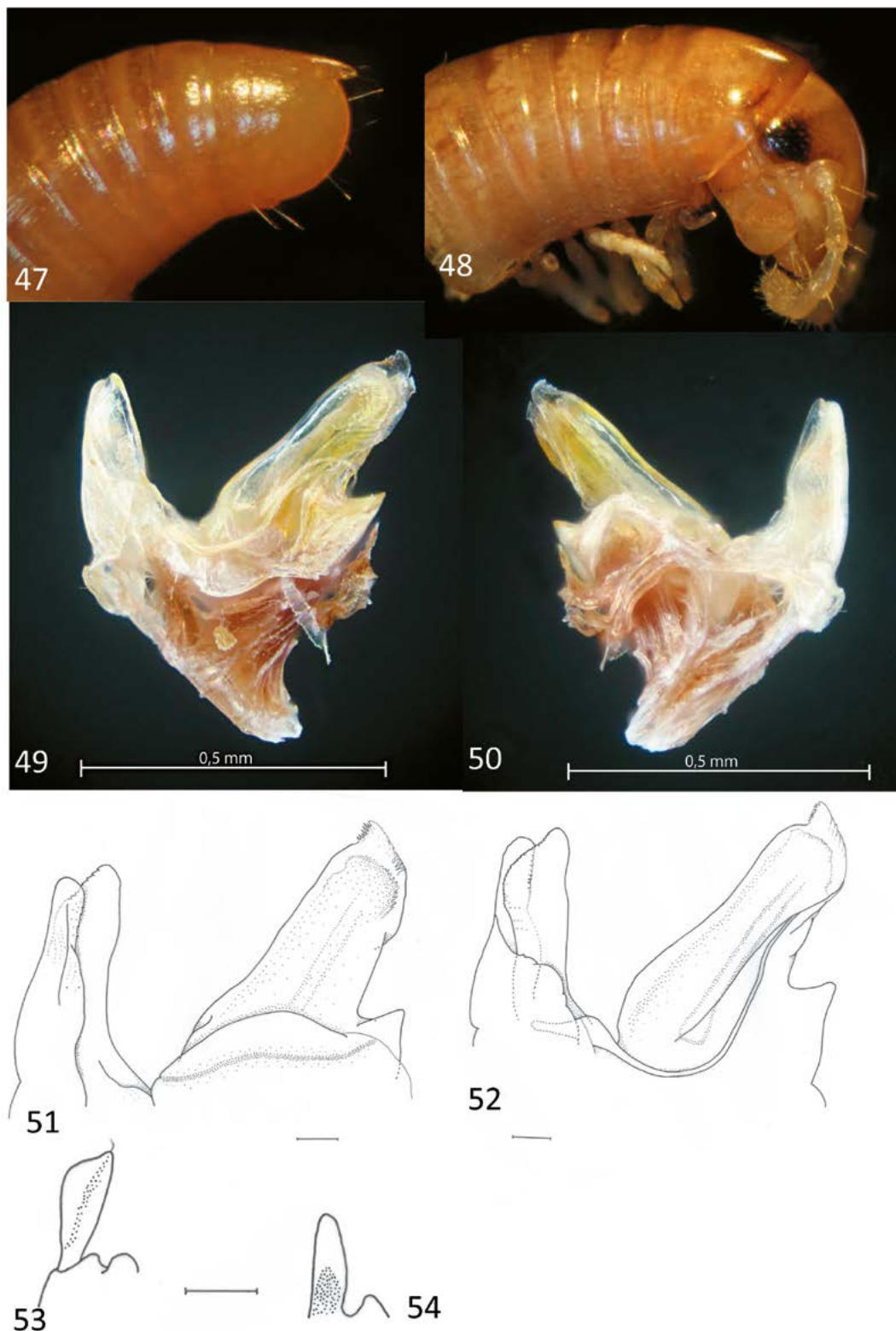
1♂, 2♀♀, details as above (NHMD).

(11) Northern part of Los Alcornocales; south of the road from Cortes de la Frontera to Alcalá de los Gazules, east of the turn-off to Ubrique, south of the mountain Peñón del Berrueco, Casa de los Llanos, wayside; 36.614, -5.421, 5.02.2008. 740 m;



Figs. 40-46.— *Cylindroiulus franzi* Attems, 1952. 40. Head and anterior body rings of mature male showing expanded cheek plate. 41. Telson and posterior body rings. 42. Gonopods in mesal view. 43. Enlargement of posterior gonopods in lateral view. 44. Anterior gonopods in anterior view. 45. Posterior gonopods in posterior view. 46. Distribution map. Blue spots are previous records, as published in Kime & Enghoff (2017). Open red spot shows the location of *C. cf. franzi* from Grenada. Scale bars: 44-45 = 0.21 mm.

Figs. 40-46.— *Cylindroiulus franzi* Attems, 1952. 40. Cabeza y anillos corporales anteriores de macho maduro mostrando el estipe expandido. 41. Telson y anillos corporales posteriores. 42. Gonópodos en vista mesial. 43. Ensanchamiento de gonópodos posteriores en vista lateral. 44. Gonópodos anteriores en vista anterior. 45. Gonópodos posteriores en vista posterior. 46. Mapa de distribución. Los puntos azules son registros anteriores, según Kime & Enghoff (2017); el círculo rojo muestra la localidad de *C. cf. franzi* de Granada. Escalas: 44-45 = 0.21 mm.



Figs. 47-54.— *Cylindroiulus karinhansorum* sp. nov. 47. Telson and posterior body rings. 48. Head showing expanded cheek plate in male. 49. Gonopod of male from location 19 in mesal view, photograph Hans Reip. 50. Gonopods of male from location 19 in lateral view, photograph Hans Reip. 51. Illustration of gonopods of holotype male in lateral view. 52. Illustration of gonopods of holotype male in mesal view. 53. Posterior gonopods in posterior view. 54. Anterior gonopods in anterior view. Scale bars: 51-52 = 0.05 mm; 53-54 = 0.21 mm.

Figs. 47-54. *Cylindroiulus karinhansorum* sp. nov. 47. Telson y anillos corporales posteriores. 48. Cabeza mostrando el estipe expandido en un macho. 49. Gonópodo de un macho de la localidad 19 en vista mesial, fotografía de Hans Reip. 50. Gonópodo de un macho de la localidad 19 en vista lateral, fotografía Hans Reip. 51. Ilustración de gonópodos del holotipo macho en vista lateral. 52. Ilustración de gonópodos del holotipo macho en vista mesial. 53. Gonópodos posteriores en vista posterior. 54. Gonópodos anteriores en vista anterior. Escalas: 51-52 = 0.05 mm; 53-54 = 0.21 mm.

Quercus suber L. forest, loose soil, slightly humid; under dead wood and stones, hand sampling. 1♂, 1j♂, 5♀. Hans Reip & K. Voigtlander leg. (SMNG).

- (13) Zahara de la Sierra and Grazalema, near the mountain área Los Cambreros/Los Pilones, above Garganta Verde. 36.814, -5.403, 6.02.2008, 560 m, *Nerium* L., *Ceratonia siliqua* L., *Quercus*. Cool and humid, in leaf litter. Sieving. 1♀. Hans Reip & K. Voigtlander leg. (SMNG)
- (19) Sierra de Grazalema, hiking trail between Ubrique and Benaocaz (Calzada Romana), 36.689, -5.439, 8.02.2008, 470 m, meadow with diverse shrubs, under stones. Hand sampling. 2♂♂, 1♀, Hans Reip & K. Voigtlander leg. (SMNG).
- (20) Northern part of Alcornocales, south of the road from Cortes de la Frontera to Alcalá de los Gazules, forest way south of the mountain Peñón del Berrueco. Between 36.606, -5.419 and 36.605, -5.423, 8.02.2008, 780 m, open oak woodland (cork and other oaks), under bark, hand sampling. 1j♂, 6♀♀, Hans Reip & K. Voigtlander leg. (SMNG).

TOTAL MATERIAL COLLECTED: males (6), juvenile males (8), females (41).

DIAGNOSIS

A medium sized species, generally pale in colour. With slightly, but definitely, projecting telson and relatively simple gonopods.

DESCRIPTION:

Length: ♂ 13 mm; ♀ up to 24 mm. Body height: ♂ 0.8-1.0 mm; ♀ up to 1.5 mm. Rings: ♂ 37-44+3-4 apodous (one male apparently has 49 rings but is broken into three pieces so it is not entirely clear if they all belong to the same individual); ♀ to 59. Body colour: Generally pale in colour but variable with some individuals darker brown in colour, adults with typical *Cylindroiulus* colouring though rather faint. Some darker dorsally. Juveniles with almost pink sheen. Overall body shape: Anterior constriction present but not strong. Head: Antennae pale in colour. Eye rows rather mixed up and difficult to read the lines, some individuals easier than others and some showing substantial variation between the two sides of the same individual. Several appear to have extra ommatidia. Stadia: ♂ VII–VIII; ♀ to IX. Body rings: Metazonites with strong and even striae, vaulting almost absent, posterior attenuation only slight, of apodous rings. Limbus not crenulate. Legs: Pale in colour, with accessory claw substantially longer than claw (Fig. 55). Telson: Preanal ring clearly projecting but not long and not extending beyond the anal valves (distinct from that of *franzi* which is very short), chestnut brown in some specimens (Fig. 47). With 2-3 pairs of setae, 1-2 ventrally and one on the telson projection but not at the tip and set back a short distance. Subanal scale not projecting, with 1 pair of setae. Anal valves with 1-3 pair of setae.

Mature male sexual characters: Mandibular stipites of mature males expanded but not greatly, anterior margin more or less vertical (Fig. 48). First pair of legs in mature males tight hooks. Keel of body ring 7 in mature males slightly projecting around a large gap in the body wall.

Gonopods (Figs. 49-54): Promerite slightly shorter than mesomerite, flagellum of normal length. Opisthomerite simple in shape, parallel sided and lacking brachite but with possible slight phylacum. Apex with hyaline structure. Paracoxal process sharp, clearly defined but not extensive. Paracoxal rim not particularly large.

ETYMOLOGY

Named in honour of Karin Voigtländer and Hans Reip who collected the type material, contributed many other specimens to this study and who have both contributed greatly to our knowledge of millipedes.

RELATIONSHIPS WITH OTHER SPECIES

Cylindroiulus karinhansorum sp. nov. does not easily fit into a *Cylindroiulus* species group. The relatively simple gonopods, similar to the *Cylindroiulus* ground plan make it difficult to comment on its taxonomic position; they are not dissimilar to *C. franzi* in overall appearance.

ECOLOGY & LIFE HISTORY

Six females from the type locality had fungi on their first two pairs of legs (Fig. 56) which was identified as *Rickia laboulbenioides* De Kesel by Henrik Enghoff. The species seems to have been found in wooded areas in the mountains, often with *Quercus suber*.

The stadial spectra of this species is given in Figs. 57-58. The eye rows were not clear enough to consider reliable, so the graphs have been drawn using the number of podous rings. Generally mature males had up to four apodous rings, the graph thus suggests that the mature males probably represent two different stadia, suggesting that they are semelparous. As expected, the females had a wider range of numbers of podous rings, with one having 59, substantially more than the others. There are hints that some females, at least might be iteroparous.

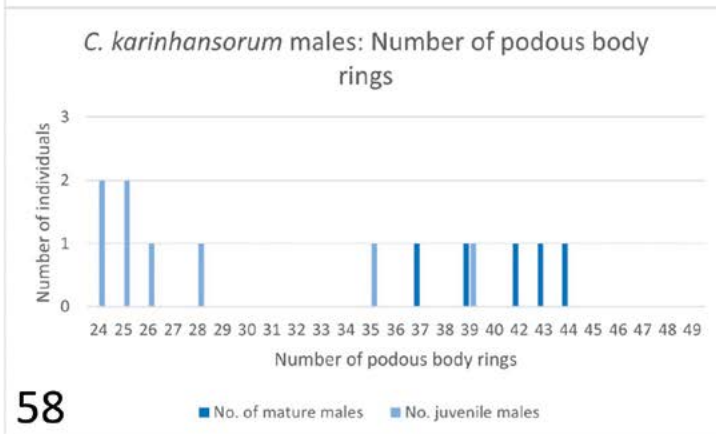
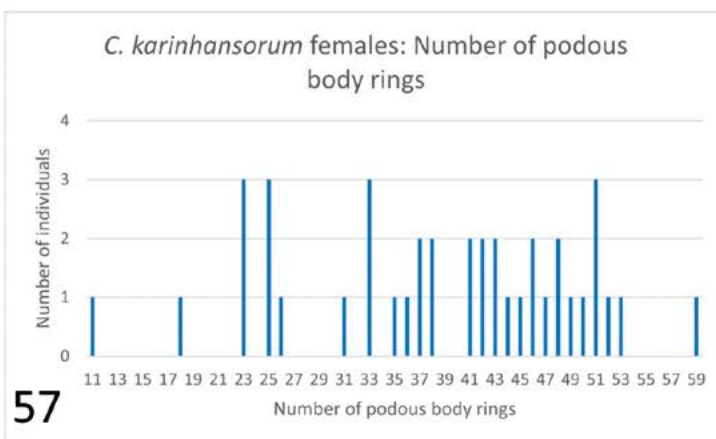
DISTRIBUTION

Discovered from several locations in the Grazalema mountains and nearby in P.N. de los Alcornocales (Fig. 59).

Cylindroiulus londinensis (Leach, 1814)

MATERIAL STUDIED

- (3A) Navarra: Leitza, Ariz Mendiak, between area “Ustarleku” and “Karobieta”, above side stream to Gorritaran, 43.0778, -1.8775, 615 m, 20.04.2009, grove of *Castanea* Mill., pollard trees on the slope – *Ranunculus ficaria* L., *Daphne*, *Helleborus*, *Salvia*, *Rubus*, *Lathrea* L. - soil loamy and calcareous. 2♂♂, 3♀♀, K. Voigtländer (2♂♂, 1♀ SMNG VNR 014744-13 & SMNG VNR 014746-12), J. Paul Richards, Helen Read (2♀♀, MNCN 20.07/2096) & Hans Reip (1♂, 2j) Reip-E517-F2449 leg.
- (7 & 8) Navarra: Leitza, Ariz Mendiak, at area “Kornieta”, 43.0698, -1.8823, 910 m, 20.04.2009, *Fagus* woodland, poor understorey, rocky, siliceous soils, mosses, *Helleborus*, under



Figs. 55-59.— *Cylindroiulus karinhansorum* sp. nov. 55. Mid body walking leg showing accessory claw. 56. Female from Los Alcornocales showing fungi on anterior legs. 57. Numbers of individuals against numbers of podous rings for females. 58. Numbers of individuals against numbers of podous rings for males. 59. Map showing the location of the type locality for *C. karinhansorum* sp. nov.

Figs. 55-59.— *Cylindroiulus karinhansorum* sp. nov. 55. Patas andadoras centrales mostrando uña accesoria. 56. Hembra de Los Alcornocales mostrando hongos en las patas anteriores. 57. Número de individuos frente a número de anillos con patas en hembras. 58. Número de individuos frente a número de anillos con patas en machos. 59. Mapa con la ubicación de la localidad tipo de *C. karinhansorum* sp. nov.

- bark & in leaf litter. 2♂♂, 2♀♀, Steve Gregory, Desmond Kime (1♂, MNCN 20.07/2095) & Helen Read (1♂) leg.
- (11 & 12) Navarra: Sierra de Aralar, south of Errazkin, north of area “Axkarateko Malkorra”, 42.9972, -1.9703, 630 m, 21.04.2009, wood of *Fagus* trunk, dead wood. 2♂♂, 3♀♀, Helen Read (1♀, GEE), Per Djursvoll & Karin Voigtländer leg. (1♂, SMNG VNR 014758-13).
- (15) Guipuzkoa: Sierra de Aralar, Tolosa, 500 m south of Bedaio/Goikoa, 43.0494, -2.04, 420 m, 21.04.2009, farm buildings & stone wall, logs, wood, stones and rubble under stones and logs. 3♂♂, 10♀♀J. Helen Read leg.
- (17) Guipuzkoa: Sierra de Aralar, Beasain, road from Lazkao to Etxarri-Aranaz, western Pass, 42.9572, -2.1122, 550 m, 21.04.2009, forest of *Fagus*. 1♂, 1♀ (Reip-E534-F2506). Hans Reip leg.
- (18) Guipuzkoa: Sierra de Aralar, Beasain, road from Lazkao to Etxarri-Aranaz, Pass Puerto de Lizarrusti, 42.9614, -2.0983, 690 m, 21.04.2009, forest of *Fagus*, on slope under stones & in leaf litter. 3♂♂, 5♀♀J. Karin Voigtländer (1♂, SMNG VNR 014764-11), Hans Reip (1♂, Reip-E535-F2513-AS183) & Norman Lindner leg.
- (21) Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, at area “Urkia”, 42.9762, -1.9318, 710 m, 22.04.2009, wet wood pasture, *Corylus* L. with some *Quercus*, *Ilex*, *Ranunculus ficaria*, *Daphne*, *Oxalis* L., *Helleborus*, *Euphorbia* L., *Geranium* L., *Lathrea* in leaf litter. 1♂, 11♀♀. Helen Read (GEE) & Hans Reip (1♂, 2j, Reip-E540-F2524 & Reip-E542-F2528) leg.
- (22) Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, at area “Izáin”, 42.9714, -1.9384, 790 m, 22.04.2009, Karst area with deep grykes and bare limestone rocks, *Fagus* woodland & some *Crataegus* bushes in leaf litter, partly sieved out. 1♀ (Reip-E543-F2533), Hans Reip leg.
- (24) Navarra: Sierra de Aralar, Sierra de San Miguel, mountain point Artxueta at radio mast, 42.9525, -1.9668, 1300 m, 22.04.2009, Karst area with bare limestone rocks, pasture, under stones and dung. 3♀♀, Per Djursvoll leg.
- (26) Navarra: Sierra de Aralar, Sierra de San Miguel, southern lower slope at Iraneta, 42.9258, -1.9597, 500 m, 22.04.2009, dry *Quercus* wood in leaf litter. 1♂ (Reip-E546-F2553), Hans Reip leg.
- (36) Navarra: Sierra de Urbasa, at southeastern cliff border, eastern zigzag of road NA-7182, under cliffs, 42.7953, -2.1397, 810 m, 23.04.2009, steep slope with forest of *Fagus*, thick leaf layer, thick humus layer (no more raw humus) – in the herb layer: *Hepatica nobilis*, *Scilla* sp., at the cliff: *Saxifraga* sp., *Asplenium* cf. *adulterinum*, in thick leaf litter. 2♂♂, 2♀♀ (Reip-E557-F2586-AS181/2), Hans Reip leg.
- (48) Guipuzkoa: Montes de Alzania, Sierra de Urquilla, south of mountain chain Aikorriko Mendikatea, southwest of Mountain Aitzgorri – north of end of road from Salvatierra road to Ordonana, Zalduondo, Zumarraundi – Portua Zarra, west of Eskaratz, 42.9334, -2.3283, 1200 m, 24.04.2009, small sharp summit of limestone rock/cliff, *Fagus* forest with small accumulations of leaves in leaves between rocks. 5♀♀, Karin Voigtländer (4♀♀, SMNG VNR 014791-9) & Hans Reip (1♀, Reip-E563-F2610) leg.
- (52) Alava: Sierra de Peña Gorbea [Gorbeia], Valley of the River “Bayas Ibaia”, north of Sarria, at (bridge) Arkarai, 43.017, -2.830, 720 m, 24.04.2009, semi-open stream valley with old *Fagus* trees and bushes, with pasture beside river, *Erica* L., *Ulex* L., *Ilex* L., *Prunus* L. in leaf litter/humus. 1♂, 2♀♀, Steve Gregory leg.
- (55) Alava: south Salvatierra, Campezo, near village Oteo, 42.726, -2.3628, 710 m, 25.04.2009, *Quercus faginea* Lam. Wood; *Q. ilex*, *Arbutus unedo* L., *Viburnum lantana* L., *Juniperus* L. under stones and leaf litter. 3♂♂, 5♀♀J, Steve Gregory, Desmond Kime, J. Paul Richards & Helen Read (1J GEE).
- Navarra: San Miguel de Aralar, Huarte-Araquil, 42.89, -2.02, 1250 m, 28.06.2007. 1♂, I. Zabalegui leg.
- Gipuzkoa: Hernani, Aiako Harria P.N., Ugaldetxo, 43.22, -1.93, 50 m, 29.06.2007. 1♂, 1♀, 1J, I. Zabalegui leg.
- From elsewhere in Spain: Zaragoza: Longás. 1♂, 1♀. 14.05.2015. J.D. Gilgado leg. (NHMD)

TOTAL MATERIAL STUDIED: males: 23; females/juveniles: 54

DISTRIBUTION

The additional records do not add greatly to the known distribution for *C. londinensis* (Fig. 60) which appears to be on the edge of its range on the Iberian Peninsula.

NOTES

In a few locations only females were found but the shape of the telson coupled with the size of the specimens allowed placement within this species with reasonable certainty.

One *Cylindroiulus londinensis* had an expanded cheek plate and hook shaped first leg pair but one pair of normal walking legs on body ring 7. The combination of these characteristics is not suggestive of an intercalary male (these usually have a very short first pair of legs that are not hook shaped and a cheek plate intermediary between a mature male and a juvenile). Presumably this individual is just an aberrant example or a gynandromorph. It was not examined for vulvae as is now in the collection of S. Gregory.

Cylindroiulus cf. *londinensis*

MATERIAL STUDIED

Navarra: Selva de Irati, 22.06.2013, *Fagus sylvatica* forest, 1♀, V. Martínez-Pillardo leg. (NHMD).

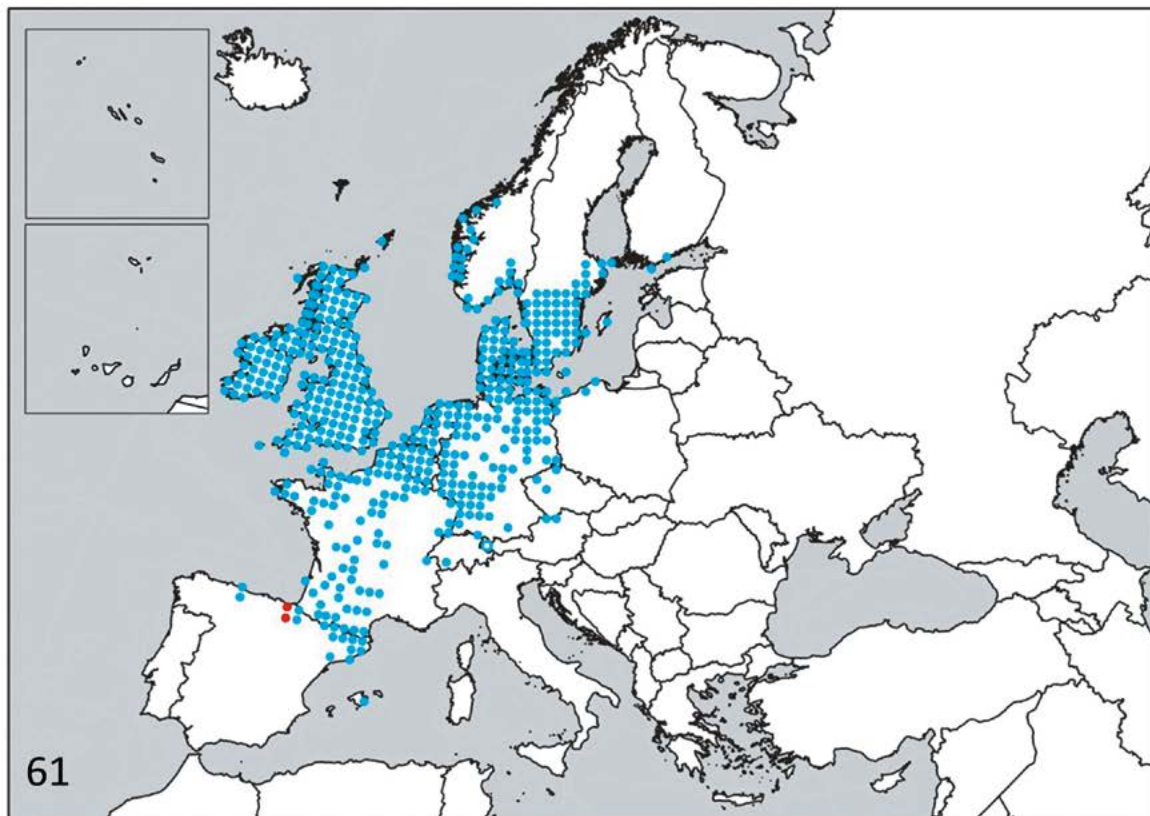
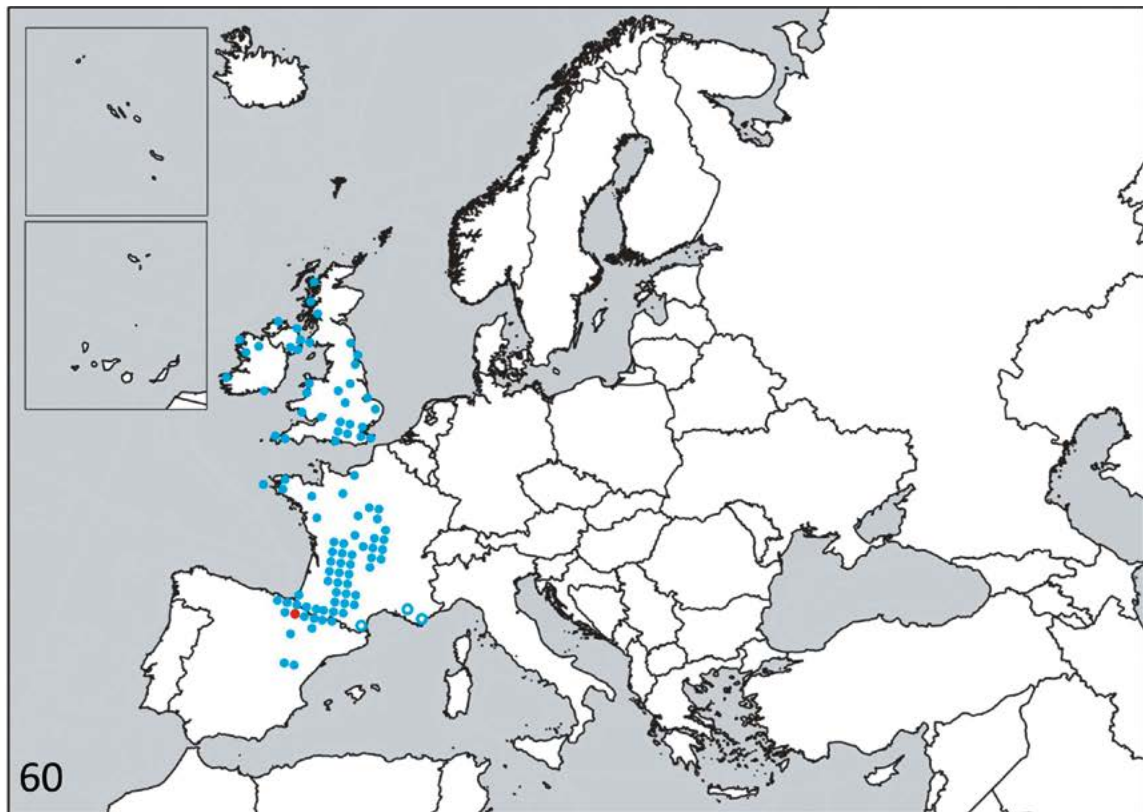
This female was exceptionally large in size with a body height of 5 mm. Probably 12 rows of ommatidia (= stadia XIII) and 45+1 body rings. The preanal process was distinct but not especially long. Another exceptionally large female was found at location (7) Leitza, area Kornieta. At this locality mature males of *C. londinensis* were also found, adding to the likelihood of these specimens being this species but just exceptionally large sized individuals.

For further discussion of this species see under *Cylindroiulus sanctimichaelis* below.

Cylindroiulus punctatus (Leach, 1815)

MATERIAL STUDIED

- (2) Navarra: Pamplona, south of Airport, near Salinas de Pamplona, at Río Elortz, 42.7539, -1.6431, 440 m, 19.04.2009, edge of deep stream valley, meadow slope. 1♂, 2♀♀, Hans Reip leg.
- (3) Navarra: Leitza, Ariz Mendiak, between area “Ustarleku” and “Karobieta”, above side stream to Gorritaran, 43.0778,



Figs. 60-61.— 60. Distribution map of *C. londinensis*. Blue spots are previous records, as published in Kime & Enghoff (2017), the red spot is a new location from the current collection. 61. Distribution map of *C. punctatus*. Blue spots are previous records, as published in Kime & Enghoff (2017), red spots show new locations from the current collection.

Figs. 60-61.— 60. Mapa de distribución de *C. londinensis*. Los puntos azules son registros anteriores, según Kime & Enghoff (2017); el rojo, una nueva localidad del material actual. 61. Mapa de distribución de *C. punctatus*. Los puntos azules son registros anteriores, según Kime & Enghoff (2017); los rojos, nuevas localidades del material actual.

- 1.8775, 615 m, 20.04.2009, grove of *Castanea*, pollard trees on the slope – *Ranunculus ficaria*, *Daphne*, *Helleborus*, *Salvia*, *Rubus*, *Lathraea* – soil loamy and calcareous. 2♀♀/J, J. Paul Richards & Steve Gregory leg.
- (9) Navarra: Leitza, town area, 43.0788, -1.9161, 470 m, 20.04.2009, house & garden around casa rural Aztieta under stones and logs. 1♀, Steve Gregory leg.
- (31) Navarra: Sierra de Andía, Valle de Goñi, 500 m NE Goñi at area “Mustillogorri”, 42.855, -1.8992, 930 m, 22.04.2009, grazed deciduous *Quercus* woodland, within agricultural areas (pastures) under stones. 1♂, 3♀♀, Steve Gregory & J. Paul Richards leg.

Although only females were found in Leitza the shape of the telson projection of this species is characteristic and it seems highly likely that the specimens found were this species.

DISTRIBUTION

This widespread north-western European species just extends into the Iberian Peninsula south of the Pyrenees. The current collection confirms its presence in this area and adds slightly to previous records (Fig. 61), but it does not appear to be common.

Cylindroiulus pyrenaicus Brölemann, 1897 Figs. 62-74

MATERIAL STUDIED:

- (52) Alava: Sierra de Peña Gorbea [Gorbeia], Valley of the River “Bayas Ibaia”, north of Saria, at (bridge) Arkarai, 43.017, -2.830, 720 m, 24.04.2009, semi-open stream valley with old *Fagus* trees and bushes, with pasture beside river, *Erica*, *Ulex*, *Ilex*, *Prunus* in leaf litter/humus. 8♂♂, 14♀♀/J, Steve Gregory leg.
- (42) Alava: Sierra de Urbasa, west side, at road A-2128 to Salvatierra/Agurain, south of Puerto de Opacua, south of next road junction at spring of Arroyo/Larrondo, east of Alto de los Tiles, at site “Orguchi”, 42.7957, -2.3194, 940 m, 23.04.2009, *Fagus* wood in gorge, fairly open with *Calluna* Salisb., *Anemone*, *Juniperus*, *Erythronium*, *Lathraea*, *Narcissus bulbocodium* L., *Helianthemum* Mill., *Pteridium* Gled. Ex Scop. & grasses in leaf litter. 1♂, 14♀♀/J, Desmond Kime leg.
- (21b) Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, at area “Urkia”, 42.9762, -1.9318, 710 m, 22.04.2009, wet wood pasture of *Fagus*, *Anemone nemorosa*, *Arum*, *Geranium*, *Helleborus*, *Euphorbia*, *Mercurialis*, *Ranunculus ficaria* under stones and logs. 1♂, 3♀♀, Helen Read leg.
- (5b) Navarra: Leitza, Ariz Mendiak, between area “Ustarleku” and “Karobieta”, Gorritaran/Ibaia-stream valley, 43.0789, -1.8839, 550 m, 20.04.2009, slope to road verge, *Corylus et al.* 1♀, Karin Voigtländer leg. (SMNG VNR 014753-9).
- (12) Navarra: Sierra de Aralar, south of Errazkin, north of area “Axkarateko Malkorra”, 42.9972, -1.9703, 630 m, 21.04.2009, *Fagus* woodland. 1♂, 10♀♀/J, 1♂♂, Per Djursvoll & J. Paul Richards leg.
- (50B) Alava: Montes de Altzania, Sierra de Urquilla, south of mountain chain Aikorriko Mendikatea, southwest of Mountain Aitzgorri – north of end of road from Salvatierra to Ordonana, Zalduondo, Zumarraundi – 1 km south of “Zumarraundi”, “Urbieta”, 42.9175, -2.3305, 830 m, 24.04.2009, eastern slope of open *Quercus* forest with some *Fagus* trees in leaf litter. 1♀. Per Djursvoll leg.

- (27a) Navarra: Between Sierra de Urbasa and Sierra de Andía, road (NA-120) from Lizaraga to Puerto de Lizaraga, north of cliff, 42.8631, -2.0114, 930-960 m, 22.04.2009, steep slope below cliff, stony meadow. 1♀, 1J♂, J. Paul Richards leg.

TOTAL MATERIAL STUDIED: males: 11; juvenile males: 2; females/juveniles: 49.

There are three samples where no males were found but the pale head, along with the overall size and telson/subanal scale shape indicated this was the correct species.

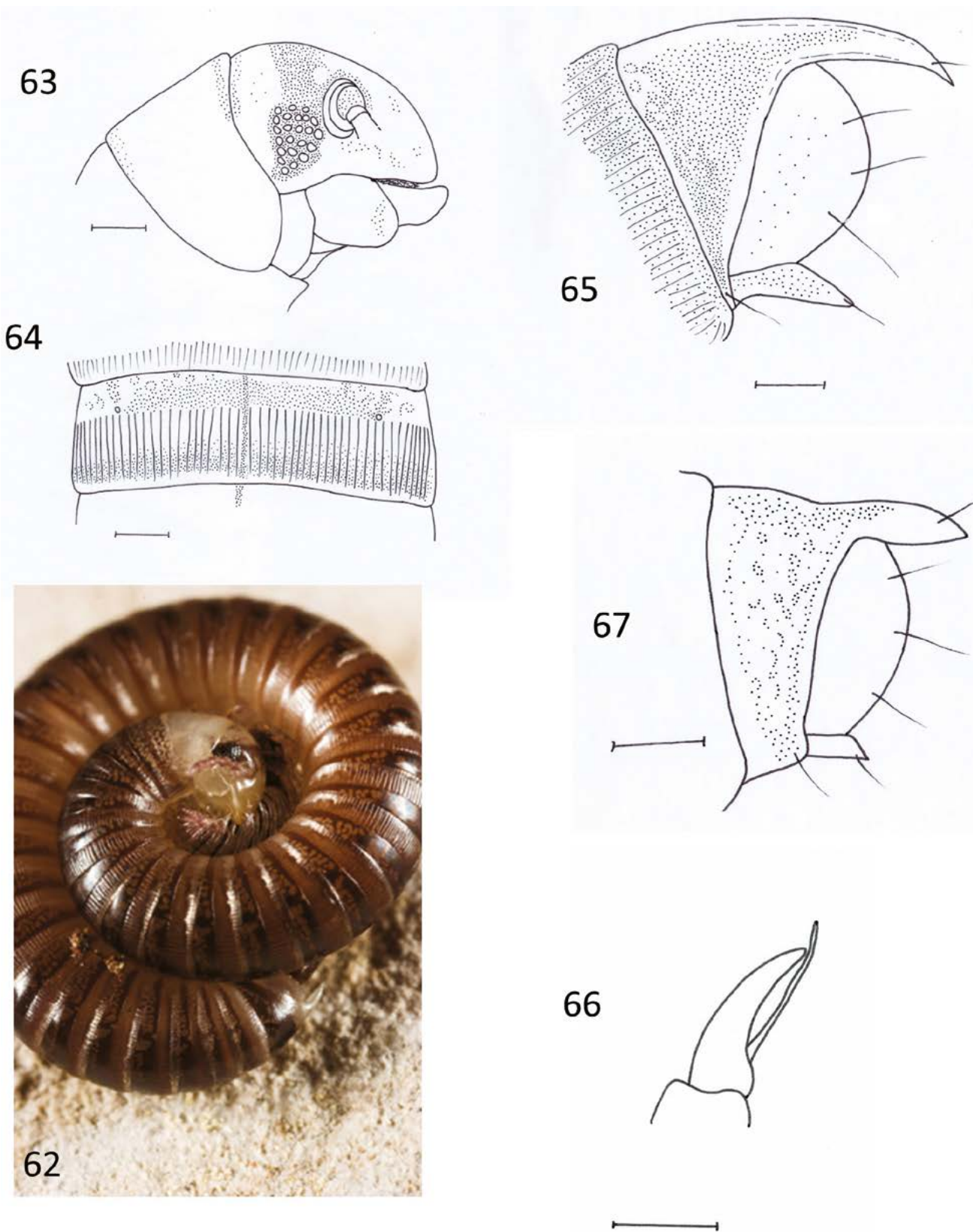
DIAGNOSIS

Small to medium sized species, with strong and down pointing telson projection and projecting anal valve, although not as pincer-like as in *C. elosegiorum* sp. nov. Generally well pigmented but with obvious pale head, first few rings and anal valves.

DESCRIPTION

Length: ♂ 16-18 mm; ♀ up to 24 mm. Body height: ♂ 1.2-1.5 mm; ♀ up to 2 mm. Body rings: ♂ 36-40 podous rings; ♀ up to 42. Body colour: Generally glaucous and dull, dorsal generally darker than ventral. Head and first 1, 2 or 3 rings usually noticeably paler (Fig. 62), becoming yellow in preserved specimens. Despite the overall pale colour there is often a darker band covering and linking the eyes (Fig. 63). Telson, mostly dark, with pale posterior margin and dorsal projection gradually fading in colour to straw/yellow (Figs. 62, 65). Colour in the juveniles sometimes appearing less contrasting. Overall body shape: Anterior constriction behind head but no posterior attenuation. Head: Antennae appearing relatively long and slender. Eye rows generally clear but final row often with reduced number of ommatidia and rather jumbled (Fig. 63). Stadia: ♂ 5RO = VI to 8RO = IX; ♀ up to 9RO = X. Body rings: Metazonites rugged and almost fluted, with close and strong striae sometimes giving a banded appearance, at least anteriorly (Figs. 64). Limbus not crenulate under light microscope. Legs: Legs with accessory claw surpassing claw (Fig. 66). Telson: Preanal ring with long and strong projection, strongly bent ventrally towards the tip. One pair of setae on the tip of the projection, another pair ventrally (Fig. 65). In smaller juveniles of stadium VI the telson projection appears relatively shorter and the down turn less pronounced (Fig. 67). Subanal scale projecting beyond the anal valves a relatively long distance but slightly ventrally, so less ‘pincer-like’ in appearance than *C. elosegiorum* sp. nov., with 1 pair of setae towards the tip. In smaller juveniles the projection is still present but relatively less well developed. Anal valves with 3-4 pairs of setae (Fig. 65).

Mature male secondary sexual characters: Mandibular stipites of mature males distinctly expanded and roughly square shaped. First pair of legs



Figs. 62-67.– *Cylindroiulus pyrenaicus* Brölemann, 1897, all collected in Gorbeia except Fig. 62. 62. Habitus of female from Opakua, photograph by J. Paul Richards. 63. Male head showing expanded cheek plate. 64. Dorsal view of tergites. 65. Posterior end showing projecting telson and subanal scale. 66. Claw and accessory claw. 67. Telson area in juvenile. Scale bars = 0.21 mm.

Figs. 62-67. *Cylindroiulus pyrenaicus* Brölemann, 1897, ejemplares recogidos en Gorbeia excepto Fig. 62. 62. Habitus de hembra de Opakua, fotografía, J. Paul Richards. 63. Cabeza de macho mostrando el estipe expandido. 64. Vista dorsal de un tergito. 65. Extremo posterior mostrando el telson y la placa ventral proyectados posteriormente. 66. Uña y uña accesoria. 67. Área del telson en un juvenil. Escalas = 0.21 mm.

in mature male: small tight hooks. Keel of body ring 7 in mature male only very slightly enlarged.

Gonopods (Figs. 68-72): Promerite very rounded with rather weak attachment to the gonopod block. Flagellum of normal length. Mesomerite short and squat, slightly shorter than *C. sagittarius*, rounded in posterior view. Opisthomerite chunky but posterior margin very membranous and therefore hard to see when glanced at quickly, so the opisthomerite appears at first sight more slender and simple in outline, thickened distally. (Compare Fig. 70 where the membranous area appears faint with Figs. 68-69 where it is drawn in). Membranous area on posterior margin of opisthomerite runs adjacent to the paracoxal process so they appear part of the same structure. Paracoxal process more obvious in posterior view and triangular in shape. Female first leg pair thickened and second also perhaps slightly enlarged.

RELATIONSHIPS WITH OTHER SPECIES

One of a relatively small number of *Cylindroiulus* species with strongly projecting sub anal scale as well as a strongly down curved and pointed telson. Others with this feature are *C. apenninorum*, *C. elosegiorum* sp. nov. (see above), *C. gestri* and *C. propinquus* all of which have different shaped gonopods and, as mentioned above under *C. elosegiorum* sp. nov., this does not appear to have any evolutionary implications.

ECOLOGY

The species was found in the leaf litter but, while all locations had trees present, many were described as being more open and/or a wood pasture and almost all were associated with a stream or, in one case, wet wood pasture.

LIFE HISTORY

The stadial spectrum (Fig. 73) indicates that males are semelparous, being mature just in two stadia (VIII and IX). The pattern for the females indicates a similar life cycle (Fig. 74).

DISTRIBUTION

Kime & Enghoff (2017) shows the range for this species along the whole of the Pyrenees and extending a little away from the mountains in southeast France and west in Spain along the coast. The current collection falls within the known range and added nothing new to the atlas maps. Recent experience suggests that it is fairly widespread, from Pau area in France, across the Basque country at least as far as Gorbeia in Alava although it does not appear to be particularly common. *C. pyrenaicus* has recently been found in the UK where it is likely to have been introduced, and also in several sites in northwest France (Gregory *et al.*, 2018).

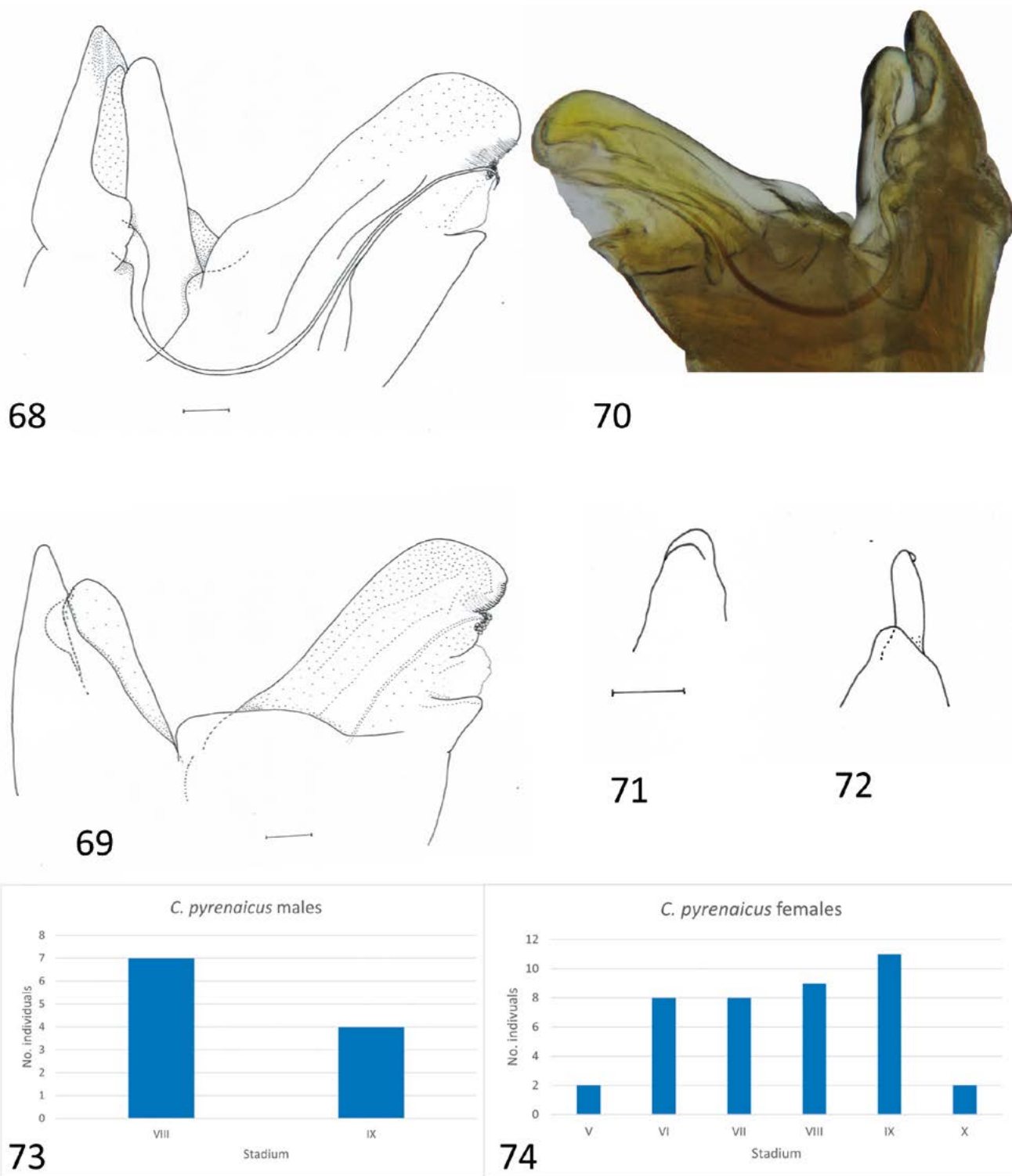
The current collection of *C. pyrenaicus* was compared carefully with the original description made by Brölemann (1897) and the specimens from

the current collection accord well with the original description. The size, general appearance and shape of the telson and subanal scale look very similar. It was noticeable that live specimens have an obvious pale/yellow head which is not mentioned by Brölemann *loc. cit.* This perhaps becomes less obvious in alcohol but the combination of head colour contrasting with the body and the telson/anal valve shape makes this species quite characteristic. The gonopods at first sight seem a little different to those illustrated by Brölemann (1897) but when drawn they are similar. The difference seems to be due to the very membranous appearance of most of the opisthomerite which when drawn give the impression of very chunky posterior gonopods.

Cylindroiulus sagittarius Brölemann, 1897 Figs. 75–83

MATERIAL STUDIED

- (3) Navarra: Leitzza, Ariz Mendiak, between area “Ustarleku” and “Karobieta”, above side stream to Gorritzaran, 43.0778, -1.8775, 615 m, 20.04.2009, grove of *Castanea*, pollard trees on the slope, *Ranunculus ficaria*, *Daphne*, *Helleborus*, *Salvia*, *Rubus*, *Lathrea* – soil loamy and calcareous. 19♂♂, 3j♂, 25♀♀, Karin Voigtländer (8♂♂, 3♀♀, 5J SMNG VNR 014824-1 & SMNG VNR 014744-12), Steve Gregory, Helen Read (Hans Reip (7♂♂, 2♀♀, 7j, Reip-E516-F2446-AS175) leg.
 - (5) Navarra: Leitzza, Ariz Mendiak, between area “Ustarleku” and “Karobieta”, Gorritzaran/Ibaia-stream valley, 43.0789, -1.8839, 550 m, 20.04.2009, *Alnus* wood along stream in the inundation area, in the topsoil layer or under leaves. 2♂♂, 14♂♂/J (Reip-E522-F2460, Reip-E523-F2466 & Reip-E523-F2461), Hans Reip leg.
 - (8) Navarra: Leitzza, Ariz Mendiak, road to area “Kornieta”, between area “Ustarleku” and “Karobieta”, above spring Gorritzaran/Ibaia-stream, 43.0794, -1.8699, 750 m, 20.04.2009, *Fagus* pollards, calcareous soils under logs and & leaf litter. 1♂, 1j♂, 4♀♀, Steve Gregory leg.
 - (12) Navarra: Sierra de Aralar, south of Errazkin, north of area “Axkarateko Malkorra”, 42.9972, -1.9703, 630 m, 21.04.2009, young *Fagus* and old big *Quercus*, *Ilex*, *Ruscus* L., *Hedera helix* L., *Astragalus* L.? *Euphorbia* L.?, ferns in leaf litter. 3♂♂, 4+♀♀/J, Karin Voigtländer (2♂♂, 4♀♀ SMNG VNR 014758-14), Per Djursvoll & J. Paul Richards leg.
 - (20) Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, 42.9851, -1.9203, 670 m, 22.04.2009, open pasture with some *Fraxinus* and *Quercus*, stony, calcareous under stones, in *Corylus* litter. 1♂, 1♀, Per Djursvoll leg.
 - (22) Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, at area “Izáin”, 42.9714, -1.9384, 790 m, 22.04.2009, Karst area with deep grykes and bare limestone rocks, *Fagus* woodland & some *Crataegus* bushes in leaf litter, partly sieved out. 1♀, Helen Read leg.
- Guipuzkoa: Aiako Harria P.N., Oiartzun, Oieleku, 43.248, -1.83, 600 m, 09.2005, pollarded *Fagus* trees, under & in *Fagus* logs. 8♂♂, 8j♂♂, 16♀♀, Helen Read leg.
- Guipuzkoa: Errenteria, (Aiako Harria P.N.) Goikoarkaitzeta (Añarbe), 43.29, -1.89, 350 m, 6.04.2007. 1♂, S. Pagola-Carte leg.
- Guipuzkoa: Aiako Harria P.N., Oiartzun, Oieleku, 43.248, -1.83, 600 m, 6-15.05.2007, *Fagus* forest, Kaila trap on *Fomes*. 1♂, S. Pagola-Carte leg. (NHMD).



Figs. 68-74.— *Cylindroiulus pyrenaicus* Brölemann, 1897. 68. Male gonopods in mesal view. 69. Male gonopods in lateral view. 70. Photograph of male gonopods in mesal view illustrating membranous area between solenomerite and paracoxal process. 71. Anterior gonopods in anterior view. 72. Posterior gonopods in posterior view. 73. Graph showing stadial spectrum. Numbers of individuals in each stadium for males. 74. Graph showing stadial spectrum. Number of individuals in each stadium for females. Scale bars: 68-69 = 0.05 mm; 71-72 = 0.21 mm.

Figs. 68-74.— *Cylindroiulus pyrenaicus* Brölemann, 1897. 68. Gonópodos de un macho en vista mesial. 69. Gonópodos de un macho en vista lateral. 70. Fotografía de gonópodos de un macho en vista mesial, mostrando el área membranosa entre el solenomerito y el proceso paracoxal. 71. Gonópodos anteriores en vista anterior. 72. Gonópodos posteriores en vista posterior. Gráfico que muestra el número de machos en cada estadio. 74. Gráfico que muestra el número de hembras en cada estadio. Escalas: 68-69 = 0.05 mm; 71-72 = 0.21 mm.

Navarra: Leitzza, Ariz Mendiak, at area “Kornieta”, 43.0698, -1.8823, 910 m, 4.2.2010, *Fagus* woodland, poor understorey, rocky, siliceous soils, mosses, *Helleborus* under bark & in leaf litter. 1♀, Helen Read & Mark Frater leg.

MATERIAL COLLECTED IN 2009 AND IDENTIFIED BY HANS REIP:

- (3) Navarra: Leitzza, Ariz Mendiak, between area “Ustarleku” and “Karobieta”, above side stream to Gorriztaran, 43.0778, -1.8775, 615 m, 20.04.2009, grove of *Castanea*, pollard trees on the slope – *Ranunculus ficaria*, *Daphne*, *Helleborus*, *Salvia*, *Rubus*, *Lathraea* – soil loamy and calcareous. 7♂♂, 2♀♀, 7J, Hans Reip leg.
- (5) Navarra: Leitzza, Ariz Mendiak, between area “Ustarleku” and “Karobieta”, Gorriztaran/Ibaia-stream valley, 43.0789, -1.8839, 550 m, 20.04.2009, *Alnus* wood along stream under mosses on dead wood. 2♂♂, 5♀♀, 9J, Hans Reip leg.

TOTAL MATERIAL STUDIED: males: 45; juvenile males: 14; females/ juveniles: more than 94.

DIAGNOSIS

A medium sized species, chestnut brown, usually darker dorsally and often with paler head, but with dark band across the ommatidia patches. Large number of body rings. Strong, prominent and straight telson projection. Opisthomerite of gonopods unique in shape and very elongated with the flagellum projecting from the end.

DESCRIPTION

Length: ♂ 18-22 mm; ♀ up to 19 mm. Body height: ♂ 1.0-1.4 mm; ♀ up to 1.9 mm. Body rings: ♂ 44-54 podous rings; ♀ up to 57. Notable for the large number of body rings and the large number of apodous rings, even in mature individuals. Mature males had between 2 and 6 apodous rings. Body colour: Mid/chestnut brown, generally paler ventrally, with darker mid dorsal pattern (Fig. 75). Head often paler but with darker band extending across the ocular patches and the ‘forehead’. Sometimes collum and anal valves paler too. Overall body shape: Anterior constriction not obvious in dorsal view, although strangely narrowed ventro-dorsally. Body more or less parallel sided but apodous rings (usually high in number) reduced in height relative to rest of body. Head: Antennae generally pale with darker marks. Eye rows mostly clearly readable, ommatidia barely reduced in number. Stadia: ♂ VIII or IX; ♀ up to XI. Body rings: Metazonites with striae strong and regularly placed, quite wide apart. Limbus not appearing crenulate. Legs: Generally paler in colour. Accessory claw extending beyond claw to roughly 25% of the claw length. Telson: Preanal ring with very strong, level and pointed projection (Fig. 76). One pair of setae at end of projection and one pair ventrally. Subanal scale not enlarged and bearing 1 pair of setae. Anal valves with 3 pairs of setae.

Mature male secondary sexual characters: Mandibular stipites of mature males smoothly expanded and curved

ventrally, not extensively expanded (Fig. 77). First pair of legs in mature males small hooks. Keel of body ring 7 in mature males opening very wide.

Gonopods (Figs. 78-81): Promerite: Medium length and fairly wide; no ‘window’. Mesomerite: Considerably shorter than promerite, apex rounded. Opisthomerite: Very long and thin, expanded at proximal part to a small but distinct brachite and a membranous area between brachite tip and solenomerite. Smaller phylacum. Flagellum usually seen poking out of the tip of the opisthomerite. No obvious paracoxal process, just a slight broadening at posterior and base of opisthomerite.

RELATIONSHIPS WITH OTHER SPECIES

Gonopod shape in this species is relatively unusual and it does not easily fall into a group with any other species. It has some resemblance to *C. punctatus* (in habitat as well as appearance) although lacks the long paracoxal process of that species.

ASSOCIATED FUNGI

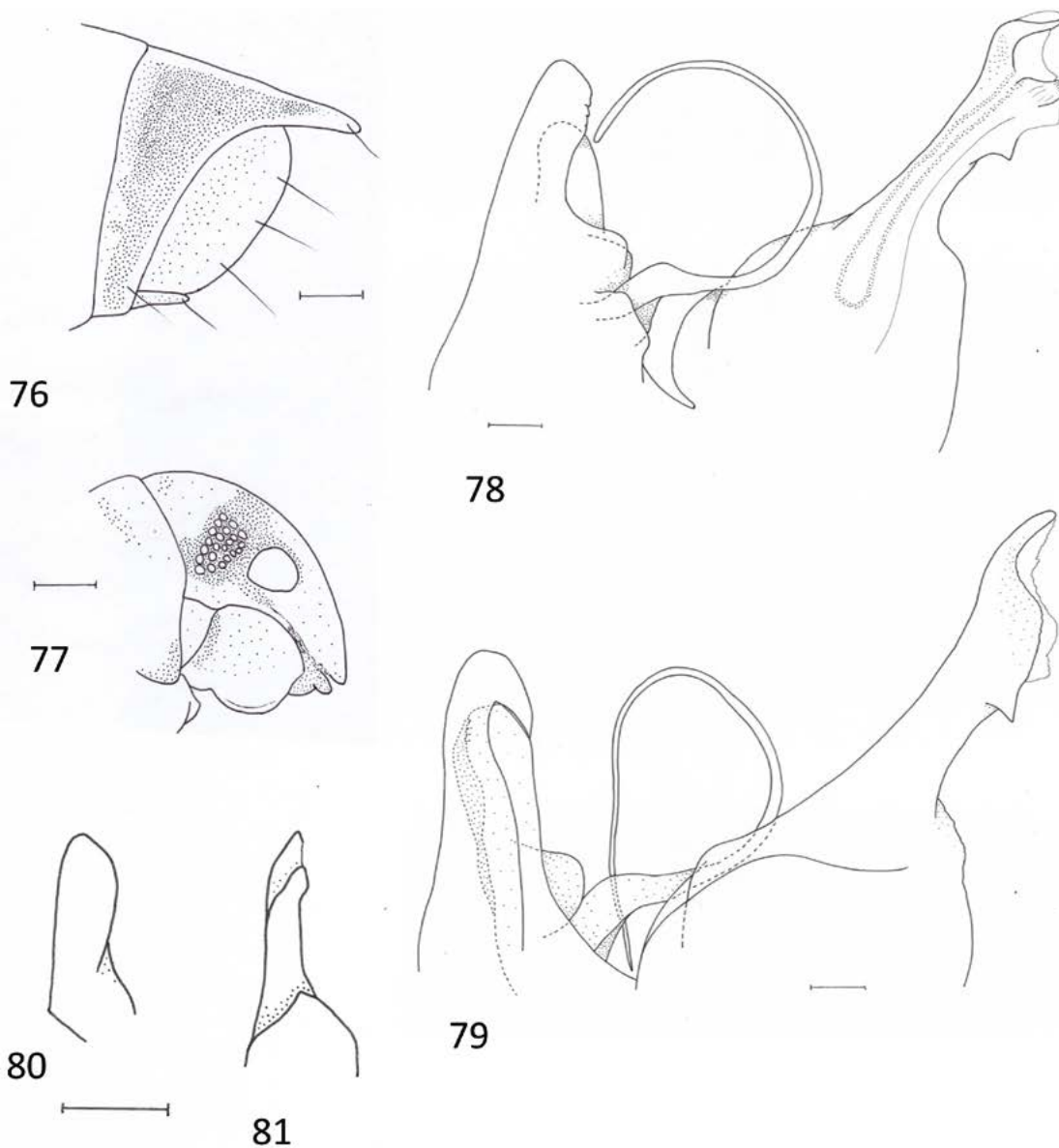
The species is notable for the fungus *Rickia laboulbenioides* found on the legs of some individuals (identified by Henrik Enghoff). In the current collection fungi were seen in 7 out of 21 mature males examined but only on two mature females. The fungus was found on the anterior legs, extending just beyond the gonopods. Some individuals appeared to have just a small quantity of fungi, but others had high densities making the legs appear ‘furry’.

ECOLOGY

This species always seems to be found in and around decaying wood, fulfilling a role that in the UK is occupied by *Cylindroiulus punctatus*, although it perhaps has a preference for wood in the later stages of decay. Many of the sites where it has been found are wood pasture with old trees, especially beech (*Fagus sylvatica* L.). *Cylindroiulus punctatus* is also found in the Pyrenees/Basque area but seems less common.

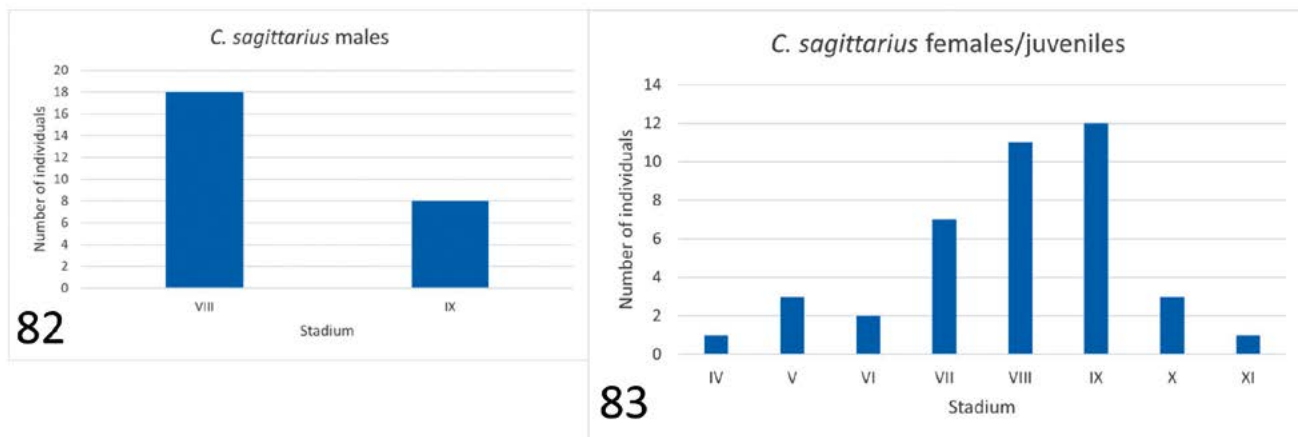
LIFE HISTORY

Collections were made in two different times of the year (April and September). Mature males were only found in stadia VIII and IX and the breakdown in number was almost identical for each season (9 in stadia VIII and 3 or 4 in stadia IX) so the two collections were combined to produce the stadal spectrum which is shown in Figs. 82-83. This shows that the males are clearly semelparous, in the females however, while there is a peak in stadia VIII and IX, a small number were found in stadia X and XI hinting that either some females mature later or that a small number may moult following reproduction and therefore may have the capacity to be iteroparous.



Figs. 75-81.— *Cylindroiulus sagittarius* Brölemann, 1897, from Oieleku, Aiko Harria (except Fig. 75). 75. Habitus, photograph of specimen from Leitza, Gorritaran by J. Paul Richards. 76. Posterior end showing telson projection. 77. Head of mature male showing expanded cheek plate. 78-81. Gonopods. 78. Mesal view. 79. Lateral view. 80. Anterior gonopods in anterior view. 81. Posterior gonopods in posterior view. Scale bars: 76-77, 80-81 = 0.21 mm; 78-79 = 0.05 mm.

Figs. 75-81.— *Cylindroiulus sagittarius* Brölemann, 1897, de Oieleku, Aiko Harria (excepto Fig. 75). 75. Habitus de un espécimen de Leitza, Gorritaran, fotografía de J. Paul Richards. 76. Extremo posterior mostrando la proyección del telson. 77. Cabeza de macho maduro mostrando el estipe expandido. 78-81. Gonópodos. 78. Vista mesial. 79. Vista lateral. 80. Gonópodos anteriores en vista anterior. 81. Gonópodos posteriores en vista posterior. Escalas: 76-77, 80-81 = 0.21 mm; 78-79 = 0.05 mm.



Figs. 82-83.— *Cylindroiulus sagittarius* Brölemann, 1897, graphs showing stadial spectrum. 82. Numbers of individuals in each stadium for males. 83. Graph showing stadial spectrum. Numbers of individuals in each stadium for females.

Figs. 82-83.— *Cylindroiulus sagittarius* Brölemann, 1897, gráfico mostrando el espectro de estadios. 82. Número de machos en cada estadio. 83. Número de hembras en cada estadio.

DISTRIBUTION

Cylindroiulus sagittarius was confined to the Pyrenees and north-west Spain (Kime & Enghoff, 2017) and the current collection does not extend the range in this area. It has recently been found in the UK (Gregory & Owen, 2019) where presumably it has been introduced.

Cylindroiulus cf. *sagittarius*

The following collections did not include mature males, but as this species has been recorded from the same location on different dates, and they appear identical, it is highly likely they are this species.

Guipuzkoa: Aiako Harria P.N., Oiartzun, Oieleku, 43.248, -1.83, 600 m, 13.07.2007, *Fagus* forest, under bark of *Fagus* log. 2j♂, 4♀, S. Pagola-Carte leg. No mature males but look very much like *C. sagittarius*.

Guipuzkoa: Aiako Harria P.N., Oiartzun, Oieleku, 43.248, -1.83, 600 m, 15.06.2007, *Fagus* forest, under bark of *Fagus* log. 1♀, S. Pagola-Carte leg. No mature males but look very much like *C. sagittarius*.

Cylindroiulus sanctimichaelis Attems, 1927

Figs. 84-88, 91, 96-97

MATERIAL STUDIED:

- Navarra: Pamplona, Airport, 42.7669 -1.6431, 430m, 19.04.2009. 1♂, 4♀, Karin Voigtländer (1♂, 3♀, 1j, SMNG VNR 014741-4) & Hans Reip (Reip-E511-F2426-AS176) leg.
- Navarra: Pamplona, south of Airport, near Salinas de Pamplona, at Río Elortz, 42.7539, -1.6431, 440 m, 19.04.2009, edge of deep stream valley, meadow slope, dry area. 3♂♂, 5♀♀ (Reip-E512-F2430). Hans Reip leg.
- Navarra: Leitzza, Ariz Mendiak, road to area “Kornieta”, between area “Ustarleku” and “Karobieta”, above spring Gorritzaran/Ibaia-stream, 43.0794, -1.8699, 750 m, 20.04.2009, *Fagus* pollards, calcareous soils under logs and in leaf litter. 1♀, Steve Gregory leg.
- Guipuzkoa: Sierra de Aralar, Tolosa, 500 m south of Bedaio/Goikoa, 43.0494, -2.04, 420 m, 21.04.2009, farm buildings & stone wall, logs, wood, stones and rubble under stones and logs. 3♂♂, 2♀♀, Helen Read leg.
- Guipuzkoa: Sierra de Aralar, 10 km SSE Beasain: Kaxeta (at junction of road from Lazkao to Etxarri-Aranaz [GI-120] and road to Aia [GI-4153], Arrandoa, Kaxeta (stream “Arroyo Marumendi”), 42.9581, -2.1564, 310 m, 21.04.2009, Stream bank. 2♂♂, 8♀♀, Steve Gregory, Hans Reip (Reip-E533-F2497-AS177) & Norman Lindner leg.
- Guipuzkoa: Sierra de Aralar, Beasain, road from Lazkao to Etxarri-Aranaz, Pass Puerto de Lizarrusti, 42.9614, -2.0983, 690 m, 21.04.2009, forest of *Fagus*, on slope under stones & in leaf litter. 1♂, 1♀, Per Djursvoll leg.
- Navarra: Sierra de Aralar, south Baraibar, on road NA-7510 to Santuario de San Miguel, 42.9851, -1.9203, 670 m, 22.04.2009, open pasture with some *Fraxinus* and *Quercus*, stony, calcareous under stones, in *Corylus* litter. 12♂♂, 22♀♀/J, Per Djursvoll, Helen Read (1♂), Karin Voigtländer (2♂♂, 3♀♀, SMNG VNR 014765-19) & Hans Reip (5♂♂, 1♀ Reip-E538-F2519) leg.
- Navarra: Sierra de Aralar, Sierra de San Miguel, mountain point Artxueta at radio mast, 42.9525, -1.9668, 1300 m, 22.04.2009, Karst area with bare limestone rocks, pasture under stones and dung & in leaf litter. 8♂♂, many females and juveniles but badly preserved so dried and broken and precise number difficult to determine. Helen Read, Per Djursvoll, Karin Voigtländer (1♂, 3♀♀, 1J, SMNG VNR 014817-1) & Hans Reip (4♂♂, 3♀♀, 1j, Reip-E544-F2543) leg.
- Navarra: Sierra de Aralar, Sierra de San Miguel, southern lower slope at Iraneta, 42.9258, -1.9597, 500 m, 22.04.2009, dry *Quercus* wood in leaf litter. 1♂ (Reip-E546-F2554), Hans Reip leg.
- Navarra: Between Sierra de Urbasa and Sierra de Andía, road (NA-120) from Lizaraga to Puerto de Lizaraga, north of cliff, 42.8631, -2.0114, 930-960 m, 22.04.2009, steep slope below cliff, stony meadow. 1♂, 1♀, J. Paul Richards leg.
- Navarra: Between Sierra de Urbasa and Sierra de Andía, road (NA-120), Puerto de Lizarraga (direction south), 42.8589, -2.0122, 1030 m, 22.04.2009, meadow with big stones & some bushes (*Sambucus*). 2♂♂, 6♀♀, Steve Gregory, J. Paul Richards, Hans Reip (1♀, 2j Reip-E548-F2560) & Norman Lindner leg.
- Navarra: Sierra de Andía, at road NA-7330 (from Lezáun to Arizaleta), at area “Los Ristros”, ca. 500 m WNW Arizaleta,

- 42.7589, -1.9833, 700 m, 22.04.2009, Mediterranean *Quercus* forest (evergreen), used as wood pasture, incl. some small areas with dry meadows (with small thorny bushes, some bigger stones, some small *Buxus* bushes, *Quercus ilex*, *Genista*, shrubby *Thymus*, shrubby *Lonicera*, *Sedum*, grasses) on the meadow under stones. 1♂, 8♀♀, Steve Gregory leg.
- (31) Navarra: Sierra de Andía, Valle de Goñi, 500m NE Goñi at area "Mustillogorri", 42.855, -1.8992, 930 m, 22.04.2009, grazed deciduous *Quercus* woodland, within agricultural areas (pastures) under stones. 4♂♂, 7♀♀, 2j♂, J. Paul Richards, Steve Gregory & Desmond Kime leg. (GEE).
- (35) Navarra: Sierra de Urbasa, on top at southern cliff border, east of road NA-7182, 42.7989, -2.1417, 930 m, 23.04.2009, pasture on stony ground, some thorny bushes, occasional trees or groups of *Fagus* under stones. 1♂, 1♀, Per Djursvoll & Karin Voigtländer (1♀, SMNG VNR 014826-5) leg.
- (37) Navarra: Sierra de Urbasa, under southern cliff border, Valle de Amescoa Alta, south of road NA-7130, between Larraona and Aranaarache, at site "Karrerabide", 42.7722, -2.2408, 770 m, 23.04.2009, small wood of *Quercus*, grazed by livestock, pronounced shrub layer: *Sambucus nigra* L., *Viburnum* L., *Crataegus*, *Rubus*, *Rosa* L., mainly without herb layer, neighbouring: pasture and arable field in the soil, upper layer. 1♂, 10♀/J, Hans Reip leg.
- (39) Navarra: Sierra de Urbasa, under southern cliff border, Valle de Amescoa Alta, south of road NA-7130, south of Larraona, 42.7697 -2.2605, 780m, 23.04.2009, wood pasture with *Quercus* and scrub and grassy trackside verges under stones. 4♂♂, 4♀♀, 1j♂ (1♂, 1♀, MNCN 20.07/2093-2094) Helen Read, J. Paul Richards & Steve Gregory leg.
- (44) Guipuzkoa: Montes de Alzania, Sierra de Urquilla, south of mountain chain Aikorriko Mendikatea, southwest of Mountain Aitzgorri – north of end of road from Salvatierra road to Ordonana, Zalduondo, Zumarraundi – high plain Alizania, north of Portua Zarra, 42.9354, -2.3298, 1160 m, 24.04.2009, karst plain with small growing *Fagus* trees and open grasslands under stones, in accumulations of leaves between the stones. 4♂♂, 15♀♀/J, Karin Voigtländer (1♂, 2♀♀ SMNG VNR 014828-7 & SMNG VNR 014786-6) & Hans Reip (3♂♂, 8♀♀, 5j, Reip-E559-F2600), leg.
- (54) Navarra: Pamplona, south, Sierra de Izco, Sierra de Alaiz, north of Altos de la Cruz, south of village Guereñdian, 42.7047, -1.6011, 640 m, 25.04.2009, Northern slope, closed area of *Buxus* bushes with some *Quercus* trees, *Crataegus*, *Hedera helix*, *Trifolium* L, no humus layer in leaf litter. 1♂, 1♀, Karin Voigtländer (1♀, SMNG VNR 014822-5) & Hans Reip (1♂, SMNG VNR 014822-5) leg.
- (55) Alava: south Salvatierra, Campezo, near village Oteo, 42.726, -2.3628, 710 m, 25.04.2009, *Quercus faginea* wood; *Q. ilex*, *Arbutus unedo*, *Viburnum lantana*, *Juniperus* under stones and leaf litter. 1♂, 2♀♀, Helen Read leg.
- (56) Alava: south Salvatierra, Campezo, near village Oteo, Parque Santa Lucia, 42.701, -2.319, 610 m, 25.04.2009, *Quercus ilex* forest with *Buxus sempervirens*, in leaf litter. 6♂♂, 20+♀♀/J, Helen Read, Desmond Kime (GEE) & Per Djursvoll leg.
- (59) Alava: Sierra Chiquita, northern side, Santa Cruz de Campezo, south of Ermita de Ivernalo, 42.6655, -2.3329, 680 m, 26.04.2009, evergreen forest of *Quercus*, with *Buxus* and *Erica* in leaf litter. 2J (Reip-E570-F2647), Hans Reip leg.
- Bizkaya: Leioa, Jauregia Jardines del Palacio Arataza, 18.04.2015. 2♂♂, V. Martínez -Pillado leg. (NHMD).
- Bizkaya: Leioa, Peruri, Auzoa, 31.10.2015. 2♂♂, 2♀♀, V. Martínez -Pillado leg. (NHMD).
- Bizkaya: Leioa, road to Porto Zahorro (Algorta), 17.04.2015. 1♂, 1♀, V. Martínez -Pillado leg. (NHMD).
- Bizkaya: Leioa, 30.10.2015, captured at night. 1♂, 3♀♀, V. Martínez-Pillado leg. (NHMD).
- Teruel: Cretas, Tumulos. 40.952, 0.224. 4.04.2015. 1♂, 4♀♀, J.D. Gilgado & V. Martínez leg. (NHMD).
- Guipuzkoa: Urkillaga a Lareo Ataun, 42.97, -2.14, 650 m, 16.03.2004. 2♂♂, I. Zabalegui leg.

TOTAL MATERIAL STUDIED: males: 66; juvenile males: 3; females/ juveniles: more than 129.

DIAGNOSIS

A chunky, dark brown species, similar to *C. caeruleocinctus* but with differences in the shape of the opisthomerite of the gonopods. Larger specimens have a distinct 'golden glow'.

DESCRIPTION

Length: ♂ 21-23.5 mm; ♀ up to 39 mm. Body height: ♂ 1.4-1.9 mm; ♀ up to 2.9 mm. Rings: ♂ 39-44 podous rings +2 apodous; ♀ up to 50+1 rings. Body colour: Chestnut brown metazonites, alternating with darker brown prozonites, slightly paler ventrally, some markedly so. Many specimens with a gold sheen to the metazonites, not as strongly metallic as *C. caeruleocinctus* but larger specimens with a 'golden glow' Fig. 84, collum generally dark in preserved specimens. Legs yellow brown. Overall body shape: Anterior constriction present, with distinct narrower 'neck'. Posterior attenuation quite strong, posterior quarter to fifth of body length noticeably narrower. Head: Antennae brown. Eye rows apparently clear and easy to 'read' but, in reality rows rather muddled so difficult to be sure of exact number in most mature specimens. Stadia: ♂ probably mostly 9 rows = X but up to 11 rows = XII; ♀ up to 11 or 12 rows = XII-XIII. Body rings: Metazonites with striae fairly strong, even and relatively widely spaced. Limbus not crenulate. Legs: Brown, accessory claw slightly longer than claw. Telson: No projection beyond anal valves. One pair of setae dorsally and one pair ventrally (Fig. 85). Subanal scale normal and not projecting. With one pair of setae. Anal valves usually with three pairs of setae but ranges from 1 to 5 pairs.

Mature male secondary sexual characters: Mandibular stipites of mature males relatively strongly projecting both anteriorly and ventrally. First pair of legs in mature male forming a small tight hook. Body ring 7 in mature males expanded ventrally to a distinct keel with anterior gonopods of some males projecting through the gap in ring 7.

Gonopods (Figs. 96-97): Promerite: Long and slender. Mesomerite: Slender, shorter than promerite, blunt tipped. Anterior gonopods appearing identical to *caeruleocinctus*. Opisthomerite large, angular brachite, slightly convex in outline (*C. caeruleocinctus* is generally slightly concave). Opisthomerite more prominent and irregular in comparison to *C. caeruleocinctus*. There is an obvious division between the solenomerite and the phyllacum (as in *C. caeruleocinctus* and different to *C. londinenis*

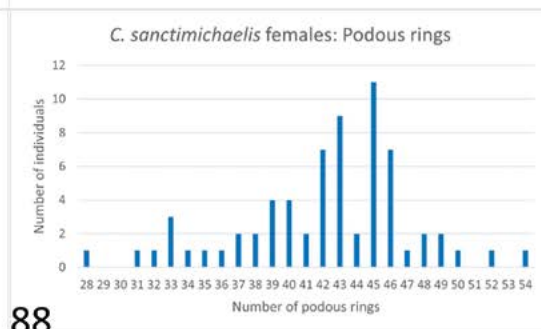
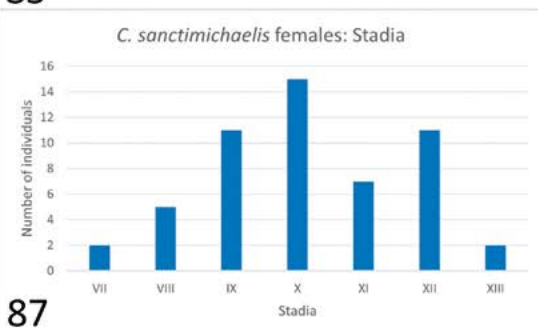
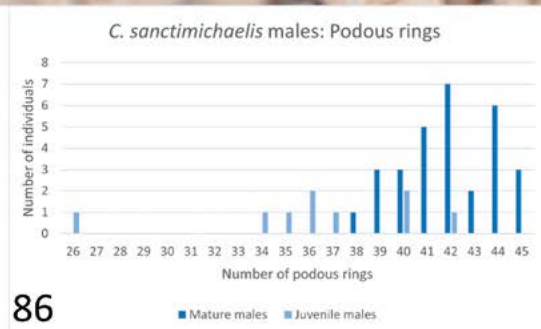
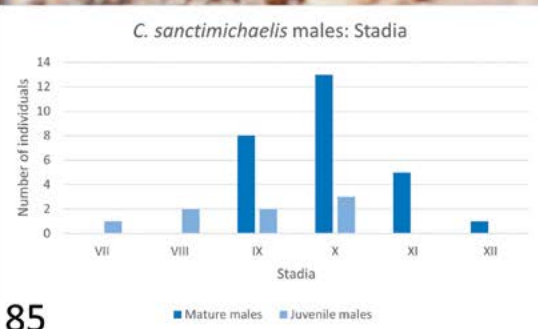


Fig. 84-90.– 84-88. *Cylindroiulus sanctimichaelis*. 84. Specimen from Teruel showing typical golden glow, photograph by José Domingo Gilgado. 85. Graph showing stadial spectrum, numbers of male individuals in each stadium. 86. Number of males against number of podous rings. 87. Graph showing stadial spectrum, numbers of females in each stadium. 88. Graph showing numbers of females against numbers of podous rings. 89-90. *Cylindroiulus cf. sanctimichaelis*. 89. Posterior rings and telson of male from Zaragoza. 90. Male gonopod in mesal view, specimen from Zaragoza.

Fig. 84-90.– 84-88. *Cylindroiulus sanctimichaelis*. 84. Ejemplar de Teruel con el típico resplandor dorado, fotografía de José Domingo Gilgado. 85. Gráfico mostrando el espectro de estadios, número de machos en cada estadio. 86. Gráfico mostrando el número de machos frente al número de anillos con patas. 87. Gráfico mostrando el espectro de estadios, número de hembras en cada estadio. 88. Gráfico mostrando el número de hembras frente al número de anillos con patas. 89-90. *Cylindroiulus cf. sanctimichaelis*, ejemplar macho de Zaragoza. 89. Anillos posteriores y telson. 90. Gonópodo en vista mesial.

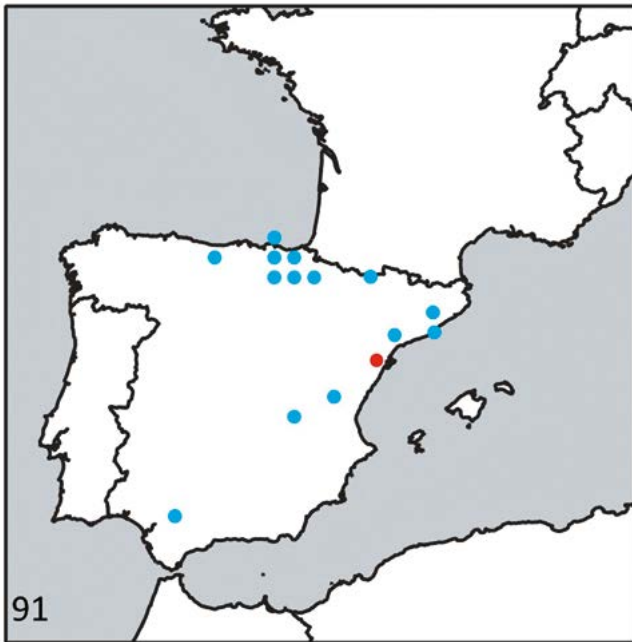


Fig. 91.— Distribution map of *C. sanctimichaelis*. Blue spots are previous records, as published in Kime & Enghoff (2017), red spot shows new location from the current collection.

Fig. 91.— Mapa de distribución de *C. sanctimichaelis*. Los puntos azules son registros anteriores, según Kime & Enghoff (2017); el rojo, muestra la nueva localidad del material actual.

(Blower 1985)). High paracoxal rim. No paracoxal process, although perhaps a small ‘nick’ in the posterior line of the gonopods basally.

ECOLOGY

Vicente (1981) noted that this species was very abundant in *Quercus ilex* forest, amongst the leaves. For Serra *et al.* (1997) it was the second most abundant Julid species in a sclerophyllous forest consisting of *Q. ilex* with an understorey of *Arbutus unedo*. Serra *et al.* (*loc. cit.*) recorded a mean annual density of 35.22 individuals per meter squared for this species with peaks in later summer and autumn. He also recorded a preference for the intermediate and deeper soil horizons and that it was notable for the high proportion of females relative to males. Sampling by Serra *et al.* (1997) was carried out by taking soil cores and extraction using Berlese-Tullgren devices. In the present collection it was found in the leaf litter of various woodlands, but the most extensive collection was made in a *Quercus ilex* forest where it was very abundant.

LIFE HISTORY

The current collection had a good number of specimens, so opportunity was taken to count eye rows and podous segments in order to attempt to shed a light on the life history of this species. Unfortunately, the eye patches were composed of a large number of ommatidia and, while appearing from a distance to be regular and easy to count, they were actually more

difficult to determine than expected, especially for older individuals. The graphs include data for some individuals in which a ‘best guess’ has been made.

The stadal spectrum for the males (Fig. 85) shows a relatively tight group of mature stadia and that of the number of podous rings (Fig. 86) seems to substantiate this. The females show a wider range of both stadia (Fig. 87) and podous rings (Fig. 88), not only through the inclusion of juveniles but also to the right of the graphs. That for the stadia is bimodal and this indicates that while it seems likely that the majority of males reach maturity and die following reproduction, some of the females may well survive to reproduce more than once.

DISTRIBUTION

This species has a widespread but scattered distribution within Spain (Fig. 91), from the foothills of the Pyrenees to Andalucía and down the eastern side of the Iberian Peninsula. There seem more records in the north, but this may be the result of greater collecting effort in these regions. Despite it being found frequently in the current collections the known range has barely been increased.

Cylindroiulus cf. *sanctimichaelis*

MATERIAL STUDIED:

Castilla-La Mancha: Guadalajara, Embalse de Tajera (cerca de Cifuentes). 14.3.2015. 2♂♂, J.D. Gilgado leg. (NHMD).
Zaragoza: Luesia, Casa Forestal, 2.42378940825893, -1.0053219496876111, 14.5.2015, 2♂♂, 7♀♀, J.D. Gilgado leg. (NHMD).

The specimens from these collections were very similar to each other and clearly fall in the *C. londinensis* group (see below), probably closest to *C. sanctimichaelis*. In terms of size and ring number they fit within *C. sanctimichaelis* range (Figs. 16-17), although some were towards the low end of the height range. The eye rows appeared rather more regular, and the males appeared to have slightly longer legs in relation to the body size (Fig. 89) although this was clearly an illusion. Body height divided by total mid-body leg length (using the method described in Enghoff (1982) gave figures of 1.38 and 1.35 for males from Zaragoza and Guadalajara respectively and 1.33 and 1.40 for males from Parque Santa Lucía and Oteo respectively. The brachite, solenomerite and phylacum of the gonopods are all in a line (Fig. 90) and the brachite and phylacum are both large, thus resembling *sanctimichaelis*. However, the phylacum is more pointed distally and more rounded in overall shape, with less distinction between it and the solenomerite. The margin of the brachite also has a flatter profile. It is not easy to determine if these specimens are sufficiently consistently different to consider them a separate species or if they are individuals within an overall variable species. Genetic studies would be useful to help elucidate.



Figs. 92-97.– Gonopods of species of *Cylindroiulus* in the *londinensis*-group. 92. *C. caeruleocinctus* from England, mesal view. 93. *C. caeruleocinctus* from England, lateral view. 94. *C. londinensis* from Kornieta, Navarra, mesal view. 95. *C. londinensis* from England, lateral view. 96. *C. sanctimichaelis* from Parque Santa Lucia, mesal view. 97. *C. sanctimichaelis* from Parque Santa Lucia, lateral view.

Figs. 92-97.– Gonópodos de especies de *Cylindroiulus* del grupo *londinensis*. 92. *C. caeruleocinctus* de Inglaterra, vista mesial. 93. *C. caeruleocinctus* de Inglaterra, vista lateral. 94. *C. londinensis* de Kornieta, Navarra, vista mesial. 95. *C. londinensis* de Inglaterra, vista lateral. 96. *C. sanctimichaelis* del Parque Santa Lucia, vista mesial. 97. *C. sanctimichaelis* del Parque Santa Lucia, vista lateral.

RELATIONSHIPS BETWEEN *C. SANCTIMICHAELIS* AND SIMILAR SPECIES

Cylindroiulus sanctimichaelis is one of a group of seven very similar species all found in the Iberian peninsular: *C. sanctimichaelis*, *C. caeruleocinctus*, *C. caramelos* sp. nov., *C. chalandei*, *C. finitimus*, *C. ibericus*, 1913 and

C. londinensis. All have a relatively large body size for *Cylindroiulus* and similar gonopods with a large and obvious brachite, a phyllacum of varying size, a small or absent paracoxal process but a high paracoxal rim.

In the present collection, several people (including myself) initially misidentified *C. sanctimichaelis* as

C. caeruleocinctus and it was only when looking more critically at the gonopods that it became evident that they were closer to *C. sanctimichaelis*. The specimens from the Basque region appear to be slightly smaller, and generally with slightly fewer podous rings, than previous descriptions. In addition, the number of pairs of setae on the anal valves was more variable and ranged from 1 to 5 (with a mean of 3.2). However, careful examination of the gonopods revealed them to be most like *C. sanctimichaelis*.

Cylindroiulus sanctimichaelis was described by Attems (1927) who distinguished it from the similar *C. ibericus*, a species described previously by Brölemann (1913). Several previous publications have also compared groups of 2-3 species such as Mauriès (1964) for *C. finitimus*, *C. londinensis* and *C. caeruleocinctus* and Vicente (1981) for *C. chalandei*, *C. finitimus* and *C. sanctimichaelis*. Older literature can be misleading because of the confusion with *C. teutonicus* (now regarded as *C. caeruleocinctus*) and that of *C. londinensis*/*C. finitimus* (*C. finitimus* was previously considered a subspecies of *C. londinensis*).

Attems (1927) compared *C. sanctimichaelis*, *C. ibericus* and *C. teutonicus* (i.e. *C. caeruleocinctus*) and considered them to be very similar. He noted that *C. sanctimichaelis* had a clear notch in the gonopod between the brachite and the solenomerite. In his key he separates *C. caeruleocinctus* from the other two on the basis of the presence of the teeth on the apex of the solenomerite and then *C. sanctimichaelis* as having 3 pairs of setae on anal valves (*C. ibericus* having 5-6 pairs), and shape of the posterior gonopods. However, in the current collection the number of setae on the anal valves of what is here considered to be *C. sanctimichaelis* is variable and there are often more than 3 pairs, however the gonopods do look more like those figured by Attems as *C. sanctimichaelis*. While the number of pairs of setae on the anal valves may be indicative of particular species it may not be a reliable character and sometimes the setae are worn off and the point of insertion difficult to see.

Mauriès (1964) looked in detail at *C. caeruleocinctus*, *C. londinensis* and *C. finitimus* and decided they were all good species, despite Ribaut (1905) originally describing *C. finitimus* as a variety of *C. londinensis*. Mauriès (*loc. cit.*) separated them by the telson shape (in *C. londinensis*) and the relative length of brachite to the solenomerite (and phylacum). He also noted the clear division or notch between the brachite and the solenomerite in *C. caeruleocinctus* and *C. finitimus*. A character also used by Blower (1985) to separate *C. caeruleocinctus* from *C. londinensis*.

Mauriès (1964) concluded that *C. finitimus* is a distinct species with constant characters, a geographic division (higher altitudes and in the valleys of the central and eastern Pyrenees) and a well-defined habitat.

Vicente (1981) compared *C. chalandei*, *C. finitimus* and *C. sanctimichaelis* and was clearly able to distinguish

between them, with *C. sanctimichaelis* seeming to have been quite common and *C. finitimus* rather rarer in her region. Vicente's (1981) figures of gonopods show the brachite of *C. sanctimichaelis* much longer than the solenomerite and phyllacum, (like Mauriès's drawings of *C. londinensis*) and a phyllacum more pronounced, both in size and definition from the solenomerite, than in *C. chalandei* and *C. finitimus*. The brachite was also flat topped and not pointed in *C. finitimus*, a feature shown in some of the illustrations in Mauriès (1964). Vicente (1981) also lists *C. finitimus* as being slightly larger than *C. sanctimichaelis* but with fewer body rings. Vicente & Ascaso (1990) subsequently made a detailed study of the ecology of *C. ibericus* suggesting that there were no difficulties distinguishing it as a species.

Table 1 shows the characteristics of these similar species with details taken from the literature, both the original descriptions and previously published comparisons. Some information was added from personal observation where specimens were available, for example the shape of the tip of the mesomerite in posterior view, something indicated in the literature as being potentially of help in distinguishing some species. The relative lengths of the three main structures of the opisthomerite (brachite, solenomerite and phylacum) have been used previously by authors to distinguish the species and this does seem helpful for some of them. See also Figs. 92-104 which illustrate the gonopods of the various species. Specimens of *C. finitimus* in NHMD were checked by Henrik Enghoff and a comparison made with photographs from the current collection. They were found to clearly differ and had a much smaller phylacum. No specimens of *C. chalandei* or *C. ibericus* were available for study.

In summary:

- *C. chalandei* has a pointed telson projection and the overall gonopod shape seems reasonably distinct (no specimens seen) (Fig. 98)
- *C. ibericus* also seems to have a distinct gonopod shape with a large and angular brachite and a very slight phyllacum (Figs. 101-104). The shape of the brachite depends at least partly on orientation but more detailed sketches of the gonopods by Bröleman, unpublished (see Figs. 101-102) do show the brachite to be noticeably more angular than any other specimens seen. The mesomerite also looks a little strange in some illustrations, for example that from Attems (1927) (Fig. 104). No specimens were seen as part of the current study, however.
- *C. londinensis* usually has a distinct telson projection (see also Figs. 94-95), although in *C. finitimus* it appears also to be variable and could perhaps be similar in some specimens; it is distinctly stout for the body length.
- *C. finitimus* appears to have a much reduced phylacum in comparison to others in the group

Table 1. – Comparison of characteristics for species in the *Cylindroiulus londinensis* group. Text in bold indicates characters that could be helpful for distinguishing the species.
 Tabla 1. – Comparación de características de las especies del grupo *Cylindroiulus londinensis*. El texto en negrita señala caracteres de utilidad para diferenciar las especies.

Species	<i>caeruleocinctus</i> (Wood, 1864)	<i>caramelos</i> sp. nov.	<i>chalandei</i> (Ribaut, 1904)	<i>finitimus</i> (Ribaut, 1905)	<i>ibericus</i> Brölemann, 1913	<i>londinensis</i> (Leach, 1815)	<i>sanctimichaelis</i> Attems, 1927
Information from	Blower (1985); Mauriès (1964)	Current description	Ribaut (1904)	Ribaut (1905); Mauriès (1964); Vicente (1981)	Brölemann (1913)	Blower (1985); Mauriès (1964)	Attems (1927) with additional information from Vicente (1981)
Shape of preanal ring	No projection	No projection	Tapering to a broad blunt point/pointed	Variable. A point, rounded, cylindrical or clubbed	No projection (barely exceeds the dorsal angle of the valves)	Distinct projection, cylindrical with rounded tip, sometimes less pronounced	No projection
Colour	Metallic sheen	Dark with paler stripes round the body	Chestnut gold	Golden brown	Black-brown	Brown-black	Metazonites yellowish; larger specimens with 'golden glow'
Setae on anal valves	3-4 pairs	3 pairs	Row of large setae		5 to 6 pairs of setae on anal valves	3 prs	3 pairs of setae on anal valves
Ventral margin of brachite	Concave	Slightly convex	Clearly convex	Flat or very slightly convex	Perhaps convex but whole structure angular	Convex	Probably convex but variable in diagrams
Distinct cleft between solenomerite and brachite	Present	Present	Probably not, appear more or less symmetrical	Present	Lack of clear distinction and no cleft	No clear distinct division, not separated by a cleft	Present
Relative lengths of brachite, solenomerite & phylacum	All more-or-less the same length	Brachite clearly longer, then solenomerite, then phylacum	One shorter than the others; difficult to determine parts with certainty	All much the same length	All much the same length and short	Brachite early longer; phylacum short	All much the same length
Phylacum	Extensive, pointed posteriorly	Extensive, not rounded but with a rounded posterior apex	Probably present but not extensive	Present but small	Probably present but not well developed	Present, pointed posteriorly	Extensive, rounded posterior point
Relative size of anterior and posterior gonopods	More or less equal in size	Anterior gonopods relatively larger than posterior	More or less equal in size	Posterior gonopods probably larger	Posterior gonopods probably larger	Anterior gonopods relatively large, posterior gonopods quite narrow	Posterior gonopods bulkier than anterior
Body rings	♂ 32-34 ♀ 32-46	♂ 57 ♀ to 62	♂ 48+3 47-49 (Vicente) ♀ 50-54 (Vicente)	♂ 45-59 ♀ 44-51 (Vicente)	♂ 46-47 ♀ 47-50	♂ 41 ♀ 41	♂ 49-51 ♂ 48-54 (Vicente) ♀ 45 to 60 (Vicente)
Length (mm)	♂ 20-25 ♀ 22-30	♂ 38 ♀ to 51	♂ 23 ♂ 28-35 (Vicente) ♀ 37-40 (Vicente)	♂ 34-39 ♀ 35-40 (Vicente)	♂ 17 ♀ 20-26	20-48	♂ 28-32 (Vicente) ♀ 28-35 (Vicente)
Diameter (mm)	♂ 1.8-2.0 ♀ 2.0-2.6	♂ 2.1 ♀ 2.1-3.06	♂ 1.7 ♂ 2.7 (Vicente) ♀ 2.8-3.0	♂ 2.0 ♀ 2.5-4.5	♂ 1.4 ♀ 1.8-2.5	♂ 3.5 ♀ 3.5-4.5	♂ 1.7 ♂ 2.5 (Vicente) ♀ 3.0 (Vicente)
Distribution	Widespread in northern Europe	Tarragona (Catalunya)	Pyrenees	West central Pyrenees	Huesca province 1,500 m (June)	Widespread	Barcelona province (April)
Additional comments		Anterior margin of brachite raised and with strong step		Mesomerite appears narrow and 'snake-like' in some illustrations			

Characters also examined were the shape of mesomerite, teeth on solenomerite, the anterior margin of brachite and the shape of paracoxal process. In general, the differences between species for these characters were not helpful in distinguishing them except where stated in the 'additional comments' line of the table.

(specimen observed by H. Enghoff) and see Figs. 99-100.

- *C. sanctimichaelis*, *C. caeruleocinctus*, *C. finitimus* and *C. caramelos* sp. nov. all have a distinct notch in the gonopods between the brachite and the solenomerite but while this was considered a reliable character by Mauriès (1964) (when discussing the first three species) it is not always easy to determine.
- *C. caramelos* sp. nov. has a large number of body rings for the body height and anterior gonopods relatively large in comparison the posterior ones.
- *C. londinensis* and *C. sanctimichaelis* are illustrated by Vicente (1981), Mauriès (1964) and Blower (1985) as having a brachite substantially longer than the solenomerite, (as opposed to *C. finitimus* and *C. caeruleocinctus*) where it is of similar length. This is less obvious in the specimens illustrated here and orientation is important for this feature.

Other characters that might be worth considering in future include the colour. Larger preserved specimens of *C. sanctimichaelis* observed here appeared to have a 'golden glow' which is rather different to the metallic copper colour seen in *C. caeruleocinctus*, but the literature suggests that other species have a tendency to be golden too (such as *C. finitimus* and *C. chalandei*). *C. caramelos* sp. nov. (see above) is apparently black with white legs. The ventral margin of the brachite could also be useful as it can be more-or-less flat, or with a convex or concave curve.

The distributions of the species may also help. Kime & Enghoff (2017) show that *C. ibericus* has a very narrow distribution in Huesca. *Cylindroiulus finitimus* seems also only to have been found at high altitude in the Pyrenees and Mauriès (1964) referred to it as an altitudinal variant of *C. londinensis*. The locations of both of these species fall within the range of *C. sanctimichaelis* which is considerably more extensive. *Cylindroiulus londinensis* and *C. caeruleocinctus* are much more widely distributed across Europe but it seems likely that they may have originated in Iberia. *Cylindroiulus caramelos* sp. nov. has only been found from area of mountains near Tarragona connected to the Sistema Iberia but not part of the Pyrenees, however also within the range of *C. sanctimichaelis*, but it may also be common further south around the Ebro delta (H. Reip pers. comm.)

It is possible that some of these species, particularly *C. caeruleocinctus* and *C. sanctimichaelis*, form a complex in Iberia but that one morph has become more widespread in northern Europe and remained relatively consistent in form. This situation is perhaps similar to that of *Ommatoiulus moreletii* (Lucas, 1860) which seems to be variable in Spain and Portugal but those introduced to Australia are less so (Baker, 1984). Another *Ommatoiulus* species, *O. diplurus* (Attems, 1903), also seems to be polymorphic in Spain, with considerable variation in gonopod structure (Akkari & Enghoff, 2012).

In conclusion, it seems likely that all the six previous described species, plus that newly described here, are reliable and can be distinguished, but they are challenging to determine. Carefully scrutiny is needed to separate them and there is some variation within some of the apparent species as here understood. It may be that there are fewer, more variable species, with *C. caeruleocinctus* and *C. sanctimichaelis* (for example) two ends of a spectrum, however they are here regarded as two separate species. The specimens from Zaragoza and Guadalajara seem a little different from the 'typical' *C. sanctimichaelis* as seen in other specimens in this collection, but not different enough to be confident in ascribing them to a new species. This approach was supported by the graphs showing rings vs body height, where they fall within the current variability of *C. sanctimichaelis* (Figs. 16-17).

It is clear that many previous workers have struggled to determine species within this group, and it would benefit from combined genetic and morphological study to explore the species concept within this group and to look at the variation within some of the more widespread species, both within the Iberian Peninsula and across other parts of northern Europe.

In light of the number of Iberian species of millipede that have been found in Britain in recent years (see under *C. pyrenaicus* and *C. sagittarius* above) it is potentially possible *C. sanctimichaelis*, which seems quite a widespread species in Iberia, may also be found, so specimens of *C. caeruleocinctus* should be scrutinised carefully.

Cylindroiulus unciger Attems, 1952 Figs. 105-112

MATERIAL STUDIED:

Aragón: Zaragoza, Monegros, region 'Retuerta da Pina, near Pina de Ebro, 1.10.1993, stones. 1♂, 1♀, J. Blasco-Zumeta leg. (NHMD).
Madrid: Guadalix de la Sierra beside Embalse de Pedrezuela, 14.04.2015, under stones in a meadow with *Quercus ilex* ssp. *rotundifolia* (Lam.) Tab. Morais and *Fraxinus* sp., calcareous soil. 1♂, 7♀, J.D. Gilgado leg. (NHMD).

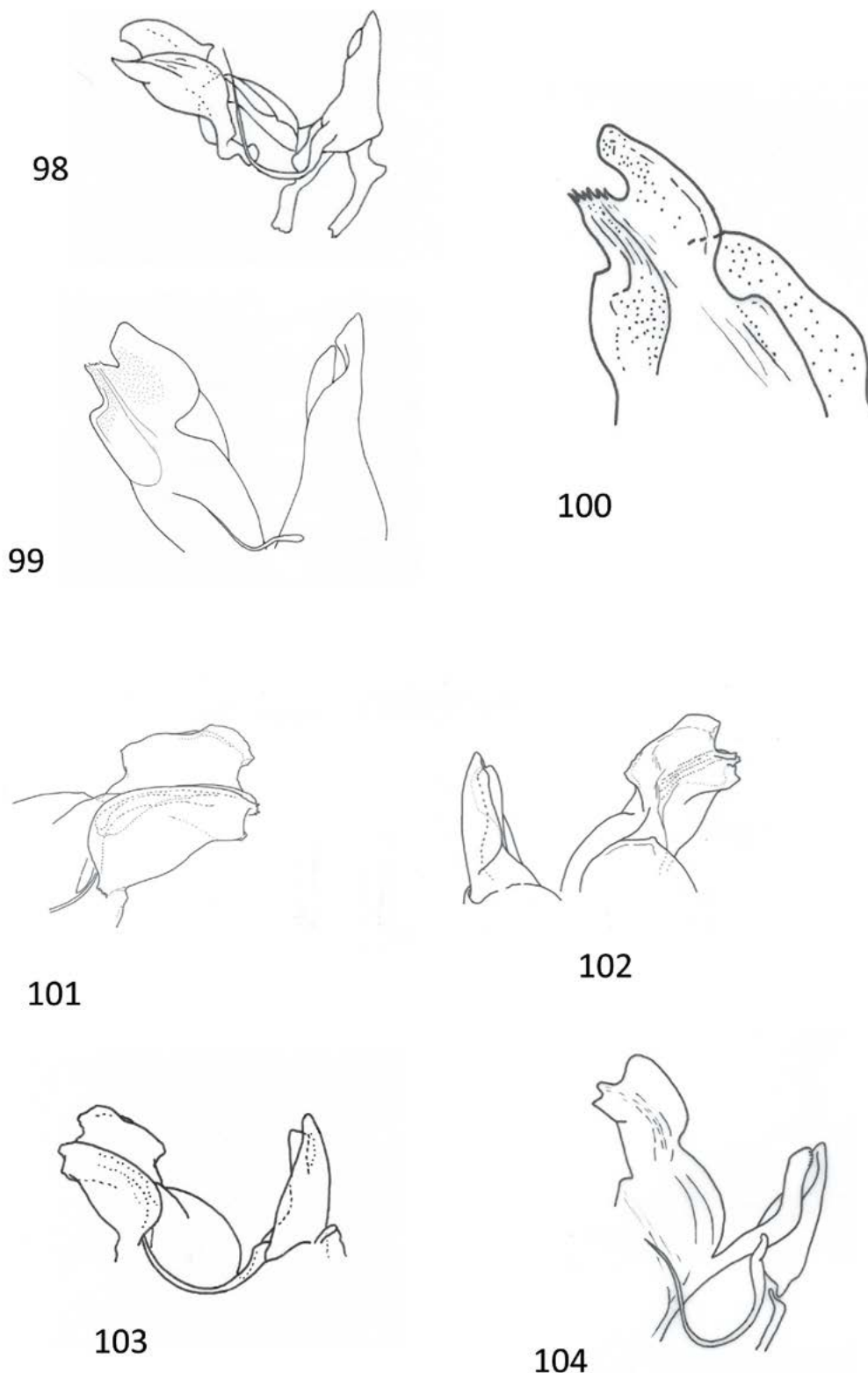
TOTAL MATERIAL COLLECTED: males (2), females (8)

DIAGNOSIS

A small species, lacking any telson projection or distinguishing external characteristics, but with posterior gonopods unlike any other species in the genus so far described.

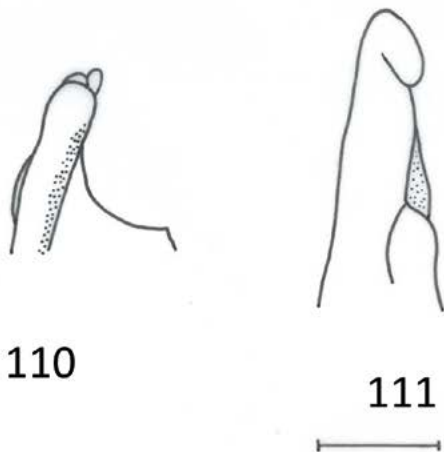
DESCRIPTION

Length: ♂ 19-21.1 mm; ♀ up to 25 mm. Body height: ♂ 1.2-1.3 mm; ♀ up to 1.8 mm. Body rings: ♂ 49-50 podous + 2 apodous, ♀ up to 55 podous rings + 1 apodous. Body colour: Pale brown with darker brown head with usual *Cylindroiulus* colour pattern on the head, darker collum. Metazonites golden/straw brown and prozonites grey. Darker both dorsally and



Figs. 98-104.— Gonopods of species of *Cylindroiulus* in the *londinensis*-group. 98. *C. chalandei* redrawn from Ribaut (1904), mesal view. 99. *C. finitimus* redrawn from Vicente (1981), mesal view. 100. *C. finitimus* redrawn from Mauriès (1964), mesal view. 101. *C. ibericus* redrawn from Brölemann unpublished, mesal view. 102. *C. ibericus* redrawn from Brölemann unpublished, lateral view. 103. *C. ibericus* redrawn from original description by Brölemann (1913), mesal view. 104. *C. ibericus* gonopod redrawn from Attems (1927), mesal view.

Figs. 98-104.— Gonópodos de especies de *Cylindroiulus* del grupo *londinensis*. 98. *C. chalandei* redibujado de Ribaut (1904), vista mesial. 99. *C. finitimus* redibujado de Vicente (1981), vista mesial. 100. *C. finitimus* redibujado de Mauriès (1964), vista mesial. 101. *C. ibericus* redibujado de Brölemann (inédito), vista mesial. 102. *C. ibericus* redibujado de Brölemann (inédito), vista lateral. 103. *C. ibericus* redibujado de la descripción original de Brölemann (1913), vista mesial. 104. Gonópodo de *C. ibericus* redibujado de Attems (1927), vista mesial.



Figs. 105-111.— *Cylindroiulus unciger* from Guadalix de la Sierra. 105. *C. unciger* from Guadalix de la Sierra, photograph by José Domingo Gilgado. 106. Telson and posterior body rings. 107. Head and anterior body rings. 108. Male gonopods in lateral view. 109. Detail of opisthomerite in lateral view. 110. Posterior gonopods in posterior view. 111. Anterior gonopods in anterior view. Scale bars = 0.21 mm.

Figs. 105-111. *Cylindroiulus unciger* de Guadalix de la Sierra. 105. *C. unciger* from Guadalix de la Sierra, foto de José Domingo Gilgado. 106. Telson y anillos corporales posteriores. 107. Cabeza y anillos corporales anteriores. 108. Gonópodos de macho en vista lateral. 109. Detalle de opisthomerito en vista lateral. 110. Gonópodos posteriores en vista posterior. 111. Gonópodos anteriores en vista anterior. Escalas = 0.21 mm.

anteriorly. Photographs of a live animal provided by the collector (Fig. 105) show a pretty banding pattern at least dorsally. Overall body shape: With little variation, anterior constriction slight and no posterior attenuation. Head: Antennae brownish in colour. Eye rows making a full equilateral triangle and rows reasonably 'readable'. Stadia: ♂ X-XI; ♀ up to XI or XII. Body rings: Striae regular and vaulting negligible. Limbus not crenulate. Legs: golden with brown markings, darker anteriorly. Accessory claw of similar length to claw. Telson: Pre anal ring lacking dorsal projection, not dark in colour but with darker margins. Bearing one pair of setae ventrally and another pair on the tip of the telson (Fig. 106). Subanal scale bearing one pair of setae. Anal valves darker basally, becoming more orange/brown posteriorly. With three pairs of setae.

Mature male secondary sexual characters: Mandibular stipites of mature males expanded ventrally, with almost vertical anterior margin, (Fig. 107). First pair of legs in mature male tight hooks with slight 'knee'. Keel of body ring 7 in mature male projecting ventrally to a low ridge around a wide ventral opening.

Gonopods (Figs. 108-111): Promerite clearly longer than mesomerite, with no perforation or 'window'. Flagellum of normal length. Mesomerite flat topped, parallel-sided and fitting into a slight 'cavity' in the promerite. Large and high paracoxal process. Opisthomerite distally divided into two parts with large gulf between them. Solenomerite expanded along the length by a phylacum. Brachite large and bird-like in shape with a 'beak' pointing towards the solenomerite opening. The shape of the opisthomerite is characteristic but much more complex than that illustrated in the original description. No obvious paracoxal process but slight 'bump' on posterior margin of opisthomerite.

RELATIONSHIPS WITH OTHER SPECIES

Attems (1952) described *C. unciger* in the subgenus *Alpicylindrus*, together with *C. festai* Manfredi, 1937, *C. limitaneus* (Brölemann, 1905), *C. tricuspis* Verhoeff, 1932 and *C. aostenus* Verhoeff, 1932, which are all Italian and have gonopods that look nothing like the those illustrated by him for *C. unciger*. Attems (1952) also described differences between the gonopods of *C. unciger* and those of *C. bouvieri* which he considered a similar species. Again, the gonopods in the description of *C. bouvieri* by Brölemann (1896) (= *C. parisorum*) look nothing like those illustrated by Attems (1952) for *C. unciger*.

The present specimens are in accord with the original description in terms of size and telson shape although the type was black in colour and had 56 body rings. The illustrations of the gonopods in the original description are very simplistic but the overall shape, the relative length of the promerite to mesomerite and the high paracoxal process all accord with the current specimens. The location in the province of Madrid also seems to indicate that they are this species.

ECOLOGY & LIFE HISTORY

There are insufficient specimens from the current collection or in the original description to make any comments about the ecology or life cycle of this species.

DISTRIBUTION

The type specimen was found in El Pardo, Madrid Province, just north of the city. Guadalix de la Sierra is just a little further north. Kime & Enghoff (2017) show an additional location near Zaragoza collected in dry gypsum ground with planted *Pinus halepensis* Mill., probably not far from Monegros which is just east of Zaragoza, thus the two specimens add slightly to our knowledge of the distribution of this species (Fig. 112). Both referees commented that this species is locally common in many areas in and around Madrid Province.

Cylindroiulus indet.

Two collections of females and juveniles could not be identified to species and could be *C. latestriatus* or *C. britannicus* (Verhoeff, 1891).

- (43) Alava: Salvatierra/Agurain, in the town (urban), 42.8539, -2.3923, 590 m, 23.04.2009. in *Castanea sativa* Mill. litter. 1 ♀, 1 J, J. Paul Richards leg.
- (14) Navarra: Sierra de Aralar, village Erratzin, village square, 43.0075, -1.9603, 400 m, 21.04.2009, open village habitat, meadow (synanthropic) under stones and in dead wood. Steve Gregory leg.



Fig. 112.— Distribution map for *Cylindroiulus unciger*. Blue spots are previous records, as published in Kime & Enghoff (2017), red spots shows new locations from the current collection.

Fig. 112.— Mapa de distribución de *Cylindroiulus unciger*. Los puntos azules son registros anteriores, según Kime & Enghoff (2017); los rojos, nuevas ubicaciones del material actual.

Key to species of *Cylindroiulus* from Spain and Portugal

1. Blind2
- With eyes3
2. Anterior gonopods very squat, opisthomerite with prominent projection and spine..... ***C. gregoryi*** (Galicia)
- Anterior gonopods less squat, opisthomerite lacking prominent projection and spine. Only known from one cave in central Portugal.....***C. villumi***
3. Subanal scale elongated into pointed projection (also with pointed telson projection).....4
- Subanal scale not elongated, not extending beyond anal valves (may have pointed telson projection).....6
4. Telson projection more or less straight, subanal projection distinct but not long, gonopods with flagellum reduced in length, opisthomerite with small spines on ventral edge ***C. propinquus*** (North and mid Portugal)
- Telson projection curved downwards, ventral scale projection long. Gonopods with flagellum of normal length, no spines on ventral edge of opisthomerite5
5. Larger in size (adults 16-24 mm long) and well pigmented, may have paler head and first few body rings.....
- ***C. pyrenaicus*** (Pyrenees and adjacent areas of Spain and France)
- Smaller (adults 9-19 mm long), straw coloured, may have darker body but due to gut contents showing through rather than pigmented exoskeleton..... ***C. elosegiorum*** sp. nov. (Basque Country and Navarra)
6. Telson with long projection. Clearly reaching beyond the anal valves.....7
- Telson without projection14
7. Telson projection rounded and blunt.....8
- Telson projection pointed9
8. Telson projection knob shaped, enlarged at the tip. Smaller in size (up to 27 mm long and 2 mm high).....
- ***C. punctatus*** (Pyrenees and north coast of Spain, also northern and western Europe including UK, Norway and Germany)
- Telson projection rounded, parallel sided. Larger in size (more than 20 mm long and 3.5 mm high).....
- ***C. londinensis*** (see also couplet 23) (northeast Spain and Pyrenees (also France and UK)
9. Gonopods with large hook-shaped brachite ***C. iluronensis*** (Pyrenees)
- Gonopods either lacking a brachite or with one that is not clearly hook shaped10
10. Paracoxal process large, broad and with two projections apically, promerite with perforation
..... ***C. fenestratus*** (Galicia & northern Portugal)
- Paracoxal process small or almost absent, promerite without perforation but may have a transparent region..... 11
11. Brachite large, with angular anterior margin ***C. chalandei*** (Pyrenees)
- Brachite absent or not extensive12
12. Opisthomerite long, clearly narrower at mid-point than apically, paracoxal process lacking, or tiny ‘bump’.....
..... ***C. sagittarius*** (Pyrenees and northwest Spain)
- Paracoxal process present, though not large, opisthomerite more or less parallel sided.....13
13. Promerite with transparent region, opisthomerite narrow with hook shaped brachite arising from the mesal surface and other apparent projections apically ***C. angliclectus*** (Galicia & northern Portugal)
- Promerite opaque, opisthomerite broader, with single projection apically ***C. boreoibericus*** (Galicia & northern Portugal)
14. Promerite with transparent region or perforation15
- Promerite opaque, with no transparent region.....16
15. Paracoxal process broad and angular, with several pointed projections apically ***C. ventanaea*** (Galicia)
- Paracoxal process smoothly rounded, ending in a single point apically..... ***C. perforatus***
(Portugal and western/southern Spain)

16. Paracoxal process large and/or obvious, clearly separated from opisthomerite17
 – Paracoxal process absent, very small or if present, linked to opisthomerite via membranous area20
17. Paracoxal process relatively short, blunt ended and/or with ragged margin **C. franzi** (Andalucía)
 – Paracoxal process pointed apically18
18. Less than 10 mm in length, pale brown in colour **C. parisiorum** (not recorded from Spain or Portugal but on the French border and scattered records across northern Europe)
 – More than 10 mm in length, pale brown or black-brown in colour19
19. Dark brown in colour, with large and strong paracoxal process extending to roughly two thirds the length of the opisthomerite, anal valves each with more than three setae **C. truncorum** (northern Portugal, also sparse records in France)
 – Pale brown in colour, anal valves each with one to three setae, paracoxal process clearly defined but less than half the length of the opisthomerite **C. karinhansorum** sp. nov. (Andalucía)
20. Brachite large and strongly hook shaped, with pointed apex apparently fitting into hood in the solenomerite
 **C. unciger** (central and north east Spain)
 – Brachite maybe present but never hook shaped21
21. Membranous area between small paracoxal process and opisthomerite. Anal valves each with three setae22
 – No such membranous area. Anal valves each with 3 or more setae23
22. Prominent projection on end of solenomerite extending beyond the tip and which may be directed anteriorly, wide range of habitats **C. britannicus** (Galicia, northern and mid Portugal, Basque area, one locality near Madrid, also northern and eastern Europe, but no/few records in France)
 – Pointed tip to solenomerite but no projection extending well beyond its tip. On sandy soils, often coastal
 **C. latestriatus** (Pyrenees, north coast of Spain, northern and western Portugal. Also widespread in Europe north to Norway, west to Ireland and east to Russia)
23. Brachite present but relatively small and discrete. Phylacum with characteristic flat apical margin. Medium sized (around 15 mm), telson slightly projecting but not exceeding the extent of the anal valves **C. dahl** (Galicia, northern Portugal, also Azores and Scotland)
 – Brachite very large, smoothly expanded, extending beyond the apex of the solenomerite; may also have large phylacum, generally large sized (over 20 mm) and usually dark coloured
 **C. londinensis** group (*C. caeruleocinctus*, *C. caramelos* sp. nov., *C. finitimus*, *C. ibericus*, *C. londinensis* and *C. sanctimichaelis*).
 See figures of gonopods 81-93 to identify to species.
 (Note that *C. londinensis* may key out here or in couplet 8 as the telson projection is variable).
 C. caeruleocinctus – Pyrenean region
 C. caramelos sp. nov. – Tarragona (Cataluña) and perhaps around the Ebro Delta
 C. chalandei – eastern Pyenees
 C. finitimus – Pyrenean region
 C. ibericus – eastern Pyrenees
 C. londinensis – northeast Spain and Pyrenees (also France and UK)
 C. sanctimichaelis – scattered across Spain, more records in the north

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References

- Akkari, N. & Enghoff, H. 2012. Review of the genus *Ommatoiulus* in Andalusia, Spain (Diplopoda: Julida) with description of ten new species and notes on a remarkable gonopod structure, the fovea. *Zootaxa*, 3538: 1-53. <https://doi.org/10.11646/zootaxa.3538.1.1>
- Akkari, N., Gilgado, J. D., Ortuño, V. M. & Enghoff, H. 2018. Out of the dark void: *Ommatoiulus longicornis* n. sp., a new julid from Spain (Diplopoda, Julida) with notes on some troglomorphic traits in millipedes. *Zootaxa*, 4420(3): 415-429. <https://doi.org/10.11646/zootaxa.4420.3.7>
- Attems, C. 1927. Myriopoden aus dem nördlichen und östlichen Spanien gesammelt von Dr. F. Haas in den Jahren 1914-1919. Nebst Beiträgen zur Kenntnis der Lithobiiden, Glomeriden sowie der Gattungen *Brachydesmus* und *Archiulus*. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 39(3): 233-289.
- Attems, C. 1952. Myriopoden der Forschungsreise Dr. Hans Franz in Spanien 1951. *Eos*, 28:323-366.
- Baker, G.H. 1984. Distribution, morphology and life history of the millipede *Ommatoiulus moreleti* (Diplopoda: Julidae) in Portugal and comparisons with Australian populations. *Australian Journal of Zoology*, 32(6): 811-822. <https://doi.org/10.1071/ZO9840811>
- Blower, J.G. 1985. *Millipedes*. Synopses of the British Fauna (new series) No. 35. The Linnean Society of London. 242 pp.
- Brölemann, H.W. 1896. Matériaux pour servir a une Faune des myriapodes de France. *Feuille des jeunes naturalistes*, 26(311): 1-5. <https://doi.org/10.3406/bsef.1896.21771>
- Brölemann, H.W. 1897. Matériaux pour servir a une Faune des myriapodes de France. *Feuille des jeunes naturalistes*, 26(308): 1-11.
- Brölemann, H.W. 1913. Notules myriapodologiques. *Bulletin de la Société entomologique de France*, 1: 51-55. <https://doi.org/10.3406/bsef.1913.25235>
- Djursvoll, P. 2019. Two new species of *Polydesmus* Latreille, 1802/1803 from northern Spain with reinstatements of two species, and a key to the Iberian *Polydesmus* species (Diplopoda, Polydesmida, Polydesmidae). *ZooKeys*, 888: 51-65. <https://doi.org/10.3897/zookeys.888.37816>
- Enghoff, H. 1982. The millipede genus *Cylindroiulus* on Madeira – an insular species swarm (Diplopoda, Julida: Julidae). *Entomological Scandinavica Supplement*, 18: 1-142.
- Geoffroy, J.J., Read, H.J. & Enghoff, H. in press. *Cylindroiulus bouvieri* (Brölemann, 1896) a long-overlooked synonym of *C. parisorum* (Brölemann & Verhoeff, 1896) (Diplopoda: Julida: Julidae). *Bulletin of the British Myriapod and Isopod Group*.
- Gilgado, J.D., Enghoff, H., Tinaut, A., Mauriès, J-P. & Ortuño, V.M. 2015a. Sierra Nevada (Granada, Spain): a high-altitude biogeographical crossroads for millipedes (Diplopoda), with first data on its MSS fauna and description of a new species of the genus *Ceratosphys* Ribaut, 1920 (Chordeumatida: Opisthocheiridae). *Zootaxa*, 4044(3): 391-410. <https://doi.org/10.11646/zootaxa.4044.3.4>
- Gilgado, J. D., Enghoff, H., Tinaut, A. & Ortuño, V. M. 2015b. Hidden biodiversity in the Iberian Mesovoid Shallow Substratum (MSS): New and poorly known species of the millipede genus *Archipolydesmus* Attems, 1898 (Diplopoda, Polydesmidae). *Zoologischer Anzeiger*, 258: 13-38. <https://doi.org/10.1016/j.jcz.2015.06.001>
- Gilgado, J. D., Ledesma, E., Enghoff, H., Mauriès, J. P., & Ortuño, V. M. 2017. A new genus and species of *Haplobainosomatidae* (Diplopoda: Chordeumatida) from the MSS of the Sierra de Guadarrama National Park, central Spain. *Zootaxa*, 4347(3), 492-510. <https://doi.org/10.11646/zootaxa.4347.3.4>
- Gilgado, J.D., Martínez Pillado, V. & Prieto, C.E. 2020. A new green-coloured *Lusitanipus* Mauriès, 1978 from the Iberian Peninsula (Diplopoda: Callipoda: Doryperalidae). *European Journal of Taxonomy*, 714: 1–14. <https://doi.org/10.5852/ejt.2020.714>
- Gregory, S., Owen, C., Jones, G. & Williams, E. 2018. *Ommatoiulus moreleti* (Lucas) and *Cylindroiulus pyrenaicus* (Brölemann) new to the UK (Diplopoda, Julida: Julidae) and a new host for *Rickia laboulbenioides* (Laboulbeniales). *Bulletin of the British Myriapod Group*, 30: 48-60.
- Gregory, S. & Owen, C. 2019. *Cylindroiulus sagittarius* (Brölemann, 1897) new for the UK (Diplopoda, Julida: Julidae) and a new host for *Rickia laboulbenioides*. *Bulletin of the British Myriapod Group*, 31: 3-8.

- Kime, R.D. & Enghoff, H. 2017. Atlas of European millipedes 2: Order Julida. *European Journal of Taxonomy*, 346: 1-299. <https://doi.org/10.5852/ejt.2017.346>
- Mauriès, J.-P. 1964. Notes sur les diplopodes pyrénéens 1. Les *Cylindroiulus* de sous-genre *Bracheoiulus* Verhoeff. *Bulletin de la Société d'histoire naturelle de Toulouse*, 99(3-4): 444-449
- Mauriès J.-P. 1975. Diplopodes épigés et cavernicoles des Pyrénées Espagnoles et des Monts Cantabriques. VIII. Liste récapitulative, additions, corrections, conclusions. *Bulletin de la Société d'histoire naturelle de Toulouse*, 111: 126-134.
- Mauriès, J.-P. 1978. Myriapodes - Diplopodes du sud de l'Espagne. Description d'une espèce nouvelle, d'espèces mal connues et révision de types du Muséum de Vienne. *Annalen des Naturhistorischen Museums in Wien*, 81: 575-588.
- Mauriès, J.-P. 2014. Taxa nouveaux de Diplopodes Craspedosomatides collectés dans le nord-ouest de la Péninsule ibérique par les missions britanniques de 1993 et 2004 (Diplopoda, Craspedosomatida). *Bulletin de la Société d'histoire naturelle de Toulouse*, 150: 27-57.
- Mauriès, J.-P. 2015. Diplopodes platydesmides et polyzonides collectés dans le Nord-ouest de la Péninsule Ibérique par les missions britanniques de 1993 et 2004 (Diplopoda: Platydesmida, Polyzoziida). *Russian Entomological Journal*, 24(4): 325-341. <https://doi.org/10.15298/rusentj.24.4.08>
- Mauriès, J.-P. 2018. Le genre *Hirudisoma* Fanzago, 1881 dans la péninsule Ibérique: description de deux espèces atypiques, *Hirudisoma espadanensis* n. sp. et *H. brusteli* n.sp. du Levant d'Espagne (Diplopoda, Polyzoziida, Hirudisomatidae). *Bulletin de la Société d'histoire naturelle de Toulouse*, 154: 41-55.
- Mauriès, J.-P. & Barraqueta, P. 1985. Myriapodes Diplopodes épigés nouveaux et peu connus de la Province de Viscaye (Espagne); *Vascanthogona* et *Krauseuma*, genres nouveaux de Craspedosomatides. *Bulletin du Muséum national d'histoire naturelle, 4^e série*, 7: 433-449.
- Mauriès, J.-P. & Vicente, M.C. 1977a. Diplópodos cavernícolas nuevos y poco conocidos de España, recolectados por A. Lagar. Descripción de tres géneros nuevos. *Miscelánea Zoológica*, 4(1): 109-134.
- Mauriès, J.-P. & Vicente, M.C. 1977b. Myriapodes Diplopodes nouveaux ou peu connus des Pyrénées espagnoles, des monts Cantabrique et de Galice. *Bulletin du Muséum national d'histoire naturelle, 3^e série*, 452: 529-546.
- Read, H.J. 1988. The life histories of millipedes: a review of those found in British species of the order Julida and comments on endemic Madeiran *Cylindroiulus* species. *Revue d'Écologie et Biologie du Sol*, 25(4): 451-467.
- Read, H.J. 1989. The *Cylindroiulus perforatus*-group, with the description of a new species and notes on variation within *C. perforatus* Verhoeff, 1905 (Diplopoda, Julida: Julidae). *Entomologica Scandinavica*, 20: 243-249. <https://doi.org/10.1163/187631289X00311>
- Read, H.J. 1990. The generic composition and relationships of the *Cylindroiulini* - a cladistic analysis (Diplopoda, Julida: Julidae). *Entomologica Scandinavica*, 21: 97-112. <https://doi.org/10.1163/187631290X00085>
- Read, H.J. 1992. The genus *Cylindroiulus* Verhoeff 1894 in the faunas of the Caucasus, Turkey and Iran. *Senckenbergiana biologica*, 72(4/6): 373-433.
- Read, H.J. 2007. The millipede genus *Cylindroiulus* Verhoeff, 1894 in northwest Spain and northern Portugal: Recent records and descriptions of four new species (Diplopoda, Julida, Julidae). *Graellsia*, 63(2): 279-294. <https://doi.org/10.3989/graellsia.2007.v63.i2.95>
- Reboleira, A.S. & Enghoff, H. 2018. First continental troglobiont *Cylindroiulus* millipede (Diplopoda, Julida, Julidae). *ZooKeys*, 795: 93-103. <https://doi.org/10.3897/zookeys.795.27619>
- Ribaut, H. 1904. Description de quatre nouvelles espèces françaises du genre *Iulus* (myriopodes). *Bulletin de la Société d'histoire naturelle de Toulouse*, 37(1-2): 15-27.
- Ribaut, H. 1905. Notes Myriapodologiques I. *Bulletin de la Société d'histoire naturelle de Toulouse*, 38: 3-7
- Serra, A. & Mauriès, J.-P. 2018. Contribution à la connaissance des Chamaesomatinae, avec description, ontogenèse et ecologie de *Xystrosoma santillorence* n. sp. (Diplopoda, Chordeumatida, Craspedosomatidea, Chamaesomatidae). *Bulletin de la Société d'histoire naturelle de Toulouse*, 154: 57-70.
- Serra, A., Miquel, C., Mateos, E. & Vicente, C. 1997. Study of a soil Julidae community in Mediterranean forest (Diplopoda, Julida). *Entomologica Scandinavica Supplement*, 51: 291-299
- Spelda, J. 2015. Orden Julida. *Revista IDE@ - SEA*, 27A: 1-18. Available from http://sea-entomologia.org/IDE@/revista_27A.pdf [accessed 17 Jan. 2022].
- Verhoeff, K. W. 1891. Ein Beitrag zur mitteleuropäischen Diplopodenfauna. *Berliner entomologische Zeitschrift*, 36(1): 115-166. Berlin
- Vicente, M.C. 1981. Diplópodos epigeos de Cataluña II (Iulidos). *Eos*, 61(1-4): 321-350.
- Vicente, M.C. & Ascaso, C. 1990. Análisis de la composición faunística y variación estacional de los diplópodos de tres hábitats del Montseny (Barcelona). Minelli, A. (Ed). *Proceedings of the 7th International Congress of Myriapodology*: 403-412.
- Voigtländer, K. & Reip, H. 2013. Morphological, taxonomical and ecological contributions to the chilopod fauna of Andalusia (Sierra de Grazalema and Los Alcornocales), Spain. *Graellsia*, 69(2): 217-241. <https://doi.org/10.3989/graellsia.2013.v69.088>