

FIRST RECORDS OF *LOUREEDIA* (ARANEAE, ERESIDAE) FROM EUROPE, WITH THE DESCRIPTION OF A NEW SPECIES AND A SURVEY OF THE GENUS

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Abstract: The genus *Loureedia* Miller, Griswold, Scharff, Řezáč, Szűts & Marhabaie 2012 is recorded from Europe for the first time, with the description of a new species *L. colleni* sp. n. from south-eastern Spain, differing markedly from other species of this genus in biogeography, genital morphology and in the striking white dorsal pattern of the males. *Eresus albopictus* and *E. lucasi* are considered separate species, and we transfer the latter to *Loureedia* as *L. lucasi* comb. n., a species which we propose as a senior synonym of *L. maroccana*, n. syn. We therefore recognise three valid species in the genus: *L. colleni* sp. n., *L. lucasi* and *L. annulipes*; we record the latter as occurring in Libya for the first time, while reporting this genus from Iran for the first time, thus considerably extending its current known range.

Key words: Araneae, Eresidae, spider, taxonomy, Ben Collen, Spain, Morocco, Libya, Iran.

Primeros registros del género *Loureedia* (Araneae, Eresidae) de Europa, con la descripción de una especie nueva, una nueva combinación y la primera cita de *L. annulipes* de un nuevo país

Resumen: Se cita por primera vez el género *Loureedia* Miller, Griswold, Scharff, Řezáč, Szűts & Marhabaie, 2012 de Europa, con la descripción de una nueva especie del sureste de España, *L. colleni* sp. n., que difiere notablemente del resto de especies del género tanto en los aspectos biogeográficos como en la morfología de sus genitales y por la existencia de un patrón de diseño abdominal muy característico, de color blanco sobre fondo negro, en los machos. Consideramos que *Eresus albopictus* Simon, 1873 y *E. lucasi* Simon, 1873 son especies distintas, y proponemos la transferencia de esta última al género *Loureedia* como *L. lucasi* comb. n. A su vez, proponemos que dicha especie sea considerada como sinónimo anterior de *L. maroccana* n. syn. Por consiguiente, reconocemos tres especies válidas en el este género: *L. colleni* sp. n., *L. lucasi* y *L. annulipes*; esta última se cita por primera vez de Libia, y se registra el género por primera vez de Irán, ampliando considerablemente su área de distribución conocida hasta el momento.

Palabras clave: Araneae, Eresidae, arañas, taxonomía, Ben Collen, España, Marruecos, Libia, Irán.

Taxonomy/Taxonomía:

Loureedia lucasi comb. n.

Loureedia maroccana Gál, Kovács, Bagyó, Vári & Prazsák, 2017 syn. nov.

Loureedia colleni sp. n.

This work is dedicated to Ben Collen's daughter Otilie Collen.

Introduction

Velvet spiders (family Eresidae) occur in a variety of habitats in the Palearctic, Afrotropical, Indomalayan, and Neotropical regions (Jocqué & Dippenaar-Schoeman, 2006; Miller *et al.*, 2012; World Spider Catalog, 2018). The family includes nine genera and almost one hundred species, most of them with African distribution (World Spider Catalog, 2018) and only one in the New World (Kraus & Kraus, 1990). Despite their wide distribution (World Spider Catalog, 2018), appealing appearance, recognized conservation value (Franc, 2000; Řezáč *et al.*, 2018; Seppälä *et al.*, 2018), and the fascination they have instilled in scientists for centuries (Schaeffer, 1767), our knowledge on this family is scarce, and even the taxonomy of the presumably well studied Central European species has only recently been clarified, and much remains to

be done for it to be fully understood (Řezáč *et al.*, 2008; Pérez-Zarcos & Sánchez-Piñero, 2016). It is therefore not surprising that an understudied biodiversity hotspot, such as the Iberian Peninsula, still contains several undescribed species (Cardoso & Morano, 2010).

According to website “Araneae. Spiders of Europe” (Nentwig *et al.*, 2018) the eresid species currently recorded in Europe belong to four genera: *Eresus* Walckenaer, 1805; *Adonea* Simon, 1873; *Stegodyphus* Simon, 1873; and *Loureedia*, Miller *et al.*, 2012 (Nentwig *et al.*, 2018; Gál *et al.*, 2017). This revision work is aimed at producing a revision of the latter, as its records in Europe were never confirmed or published, and were in fact misidentified.

Methods

Taxonomic analysis

Specimens were analysed using a Zeiss SV11 stereomicroscope coupled with Canon EOS 450D camera, extended depth of field images were obtained by stacking photos using Helicon Focus v. 5.2 software, which assisted in preparing the illustrations, at the Sackler Biodiversity Imaging Lab., Natural History Museum, London.

A male specimen was critical point dried, then mounted on stubs or round-headed rivets using a combination of white glue, nail polish, and adhesive copper or aluminum tape. They were sputter coated with platinum-palladium and scanned with a Hitachi, S-510 scanning electron microscope, at the “Centro de Instrumentación Científica”, Universidad de Granada.

Morphological terminology follows Miller *et al.* (2012), and has been adapted to describe the fine morphological structures of the male pedipalp.

Potential distribution mapping

There are numerous methods for predicting species distributions based on ecological niche modelling. Often with attempts to determine the environmental space occupied by a study species and to produce maps of these preferences in geographical space as potential species distributions (e.g. Guisan & Zimmermann, 2000; Scott *et al.*, 2002).

In our study, the hypothetical distribution of species, the range of which included North Africa and the Middle East (*L. annulipes* and *L. lucasi*), was adapted with the recently revised semi-arid climatic zones of the Köppen-Geiger climate classification (Kottek *et al.*, 2006; Rubel & Kottek, 2010; Rubel *et al.*, 2017, available online at <http://koeppen-geiger.vu-wien.ac.at>).

The species distribution model, the range of which was mainland Spain (*L. colleni* sp. n.), was tested by logistic regression making adjustments to expected binomial distributions of the environmental variables in sampled sites. We used Generalized Linear Models (GLMs), a standard and well known method extensively used in ecology and closely related fields (see basics of GLM e.g. in Dobson, 1990, Crawley, 1993, Dunteman & Ho, 2006).

This approach has proved reliable when considerable presence-absence data are available (which we were able to gather for mainland Spain), as it allows to reduce the impact of false absences in the potential distribution. Presence-absence data of *L. colleni* sp. n. was gathered by generating a sampling network of 350 localities in the South of the Iberian Peninsula. These localities were randomly arranged within the main altitude and aridity gradients from the records of this region.

A spatial database was generated containing the environmental characteristics of these sampled sites represented by the values of different bioclimatic variables, under a 1 km² spatial resolution (UTM 1x1 km grid). We used 19 bioclimatic variables as provided by the Worldclim database (Hijmans *et al.*, 2005) derived from temperature and rainfall values. Altitude and other ecologically-relevant variables such steepness and cardinal directions of slopes and hillsides were measured using Geographic Information System (GIS) software and using Digital Elevation Model (DEM) with a 90 x 90 m spatial resolu-

tion of the Iberian Peninsula, as part of NASA's Shuttle Radar Topography Mission, SRTM v.1, (Farr & Kobrick, 2000), and curated by the CGIAR-Consortium for Spatial Science (available online at <https://srtm.esi.cgiar.org>).

The selection process of the most significant models was carried out in R v. 3.3.2 (R Core Team, 2016) using the ‘glm’ function to analyse the link between the different variables and the presence/absence of the species. GLM was used in a binomial function with the script "*glm (formula, family = 'binomial', (link = 'logit'), data = 'data source')*". Each variable was formulated, tested and contrasted against all other options, using a step-by-step procedure with automated protocols for the different formulas in their linear and quadratic forms. Data transformation was considered when a normal distribution was not present in the raw data of independent variables.

The GIS software used in the cartographic representations were GRASS (2016) and QGIS (2016). DEM was also used to create a shaded 3D mapping of background (self-developed colour palette). On this background mapping, coloured vectorial polygons were added representing cumulative probability of occurrences of *L. colleni* sp. n. Dark blue areas representing 90% of localities where *L. colleni* sp. n. potentially occurs. Light blue representing the areas where the probability of finding populations of this species is between 5 and 10%. The section coloured by both blue tones hence representing an area where at least 95% of localities with this species are predicted to be found. Therefore, our models predicts that at most 5% of *L. colleni* sp. n. localities are found outside the coloured areas, likely in habitats with poorly suited ecological niches, where observations might still be made in the future, but where the conditions for the species to thrive are poor.

The Mediterranean basin map was made under the Times Projection System (WGS84 Datum), while the inset with the species records from the Southeast Iberian Peninsula is projected in UTM System (Zone 30, WGS84 Datum).

No exact coordinates are provided for the locality data, and only 10 x 10 km spatial resolution in Military Grid Reference System - MGRS (UTM grid) are given, except when that data has already been reported in previous publications. This was done once we fear, that if disclosed, exact localities will endanger those populations by exposing them to the illegal pet trade (Lindenmayer & Scheele, 2017). We understand the importance of open data and reproducible science, and we believe our approach achieves a reasonable compromise between transparency and species conservation concerns. We would welcome a taxonomical data management system where sensitive data can be safely stored and only made available upon request by verifiable trustworthy entities that adhere to data privacy and safety protocols.

Biological Data

The phenology of *L. colleni* sp. n. was inferred from photographic records of males, and the collection dates of analysed material.

Diet and microhabitat, was inferred from the observation of nests content and their location, which were validated as belonging to *Loureedia* sp. (rather than nests of other erisid genera) by the collection and identification of the individual specimens which were found inside the nest. No abandoned nest were therefore used for this analysis.

Abbreviations

HUJ - Hebrew University of Jerusalem.
NHM - National Museum of Natural History (London).
MCNB - Museo de Ciencias Naturales (Barcelona).
MNHN - Muséum National d'Histoire Naturelle (Paris).
MNCN - Museo Nacional de Ciencias Naturales (Madrid).
Some specimens used for this research are deposited in the personal collection of:
JKPC - Johan van Keer private collection.
JMC - Jesús Miñano private collection.
RPC - Milan Řezáč private collection.
SHPC - Sérgio Henriques private collection.

Results

Loureedia Miller, Griswold, Scharff, Řezáč, Szűts & Marhabaie, 2012
urn:lsid:zoobank.org:act:5FEC8D28-5F6F-4E58-A5C2-5EEBD35B0090
<http://species-id.net/wiki/Loureedia>

Loureedia lucasi (Simon, 1873)

Eresus lucasi Simon, 1873: 353, pl. 10, f. 8-9. Comb. nov.
Loureedia maroccana Gál, Kovács, Bagyó, Vári & Prazsák, 2017:
13, figs 1-4 Syn. nov.

DISTRIBUTION: **Algeria:** 1 ♂ 1 ♀ Oran [no date] Lucas, MNHN, type series; 1 ♂ Lalla-Maghnia [no date] Lucas (not examined, MNHN), type series. **Morocco:** 1 ♂, Sidi Boukhalkhal, 04 September 2013, J. Gál; 2 ♂, Sidi Boukhalkhal, 28 September 2015, R. Bagyó (not seen but analysed via depictions in Gál *et al.*, 2017).

TAXONOMIC HISTORY: This species was originally described as *E. lucasi* Simon, 1873 and was later synonymized with *Eresus albopictus* (Simon, 1910) but our analysis has proven this synonym not to be accurate as the holotype of *E. albopictus* clearly belongs to the *Eresus* genus, whereas *E. lucasi* possesses *Loureedia* features (Fig. 1 a-f).

The first recorded specimens of *L. lucasi* were a male and female from Algeria collected by Lucas in the outskirts of Oran and a second male from Lalla-Maghnia, near the Algerian border with Morocco (Simon, 1873).

Several other specimens reported as *E. albopictus*, that might belong to *L. lucasi* were reported from Orléansville and Daya in Algeria (collected by L. Bedel), from the North African enclave of Melilla (collected by Arias) and from Morocco, when de la Escalera collected conspecific male and female from Essaouira (Simon, 1910). However, none of these specimens are currently available for analysis, and is yet unclear which of these records may have been misidentified *L. lucasi* specimens, and which truly belong to *E. albopictus*.

The taxonomic identity of these records, and the revised distribution of *E. albopictus* is part of an upcoming revision of the *Eresus* genus, and was considered to be beyond the scope of this publication, which is aimed at addressing the *Loureedia* genus.

SPECIES DESCRIPTION: *L. lucasi* males were originally illustrated and described as having a highly elevated and convex, carmine red cephalothorax, and abdomen with longitudinal bands of red (Simon, 1873). Characters which also match *L. annulipes* (Miller *et al.*, 2012).

However similar, the taxonomic distinction between these two species, *L. annulipes* and *L. lucasi* (as *L. maroccana*) have already been comprehensively explored (Gál *et al.*,

2017). Therefore, here we will solely focus on recording specimens from *L. lucasi* type series, particularly the male specimen (Figure 1 a-d), in order to validate the genus transfer of *E. lucasi* to *Loureedia* (comb.nov.) and its synonym with *L. maroccana* (syn. nov.), recording the most relevant characters of the females of this species for the first time (Fig. 1 e-f). For more detailed information on the traits of this species, see the original description of *E. lucasi* (Simon, 1873), and the comprehensive description of *L. maroccana* (Gál *et al.*, 2017).

Loureedia annulipes (Lucas, 1857)

http://species-id.net/wiki/Loureedia_annulipes

DISTRIBUTION: **Egypt:** 1 ♂, Alexandrie [no date] (AR836, original code 471, original label written by Simon, MNHN, syntypes); **Israel:** 1 ♂, Haluqim Ridge (n. Sede Boqer), 17 November 1990, Y. Lubin (MR008, HUJ not seen but analysed via depictions in Miller *et al.*, 2012); 1 ♂, Negev, Nitzana [Nitzanna] village, 1 October 2004 (MR018, HUJ, not seen but analysed via depictions in Miller *et al.*, 2012); 1 ♀, Negev, Wadi Mashash, 4 December 2004, J. Kral (MR019, RPC); **Libya:** 1 ♂, Benghazi District, 1984 (labelled as: 84) D. Pearson (NHM).

TAXONOMIC HISTORY: Previous publications mentioned that *Eresus annulipes* was first recorded as a female from Rio de Janeiro, while it was later noted that the type specimen is in fact labelled as *Patria Ignota* (Miller *et al.*, 2012).

Although we don't dispute that the lack of location in the specimen's label [*Patria ignota*] disagrees with the locality recorded in the original description [Rio de Janeiro], our analysis of the original publication also revealed that the holotype was in fact not a female but indeed a colourful male, as made clear in Lucas (1857)'s quote: "l'organe excitateur est rougeatre, globuliforme, et armé à son extrémité d'un crochet corné, noir, bi-épineux." which accurately describes the male palp reported for *L. annulipes* (Miller *et al.*, 2012).

Perhaps what originated the confusion on the gender of the specimen mentioned in this description, was the sentence "Cette jolie espèce, dont je ne connais que le male" [This beautiful species, of which I know only the male]. Perhaps the French word "dont" has been misinterpreted with the English "don't", causing some readers to infer that the male was not analysed.

SPECIES DESCRIPTION: *L. annulipes* was first illustrated with considerable detail for the cover of "*Initiation à l'étude systématique des araignées*" (Ledoux & Canard, 1981), descriptive illustrations and measurements had also been published from Egyptian type material, originally identified as *E. semicanus* (El-Hennawy, 2004) and both males and females were comprehensively described and photographed when the genus was erected to hold this species (Miller *et al.*, 2012).

FURTHER NOTES ON LOUREEDIA. For clarity in communication, in this publication we informally distinguish this genus into two morphological groups. One with the species currently known from North Africa and the Middle East with brightly red males (*L. annulipes* and *L. lucasi*), which we call the *L. annulipes* group, and species from the Western Mediterranean with white patterned males (currently with only one species: *L. colleni* sp. n.), which we call the *L. colleni* sp. n. group. We present further information on the first group.

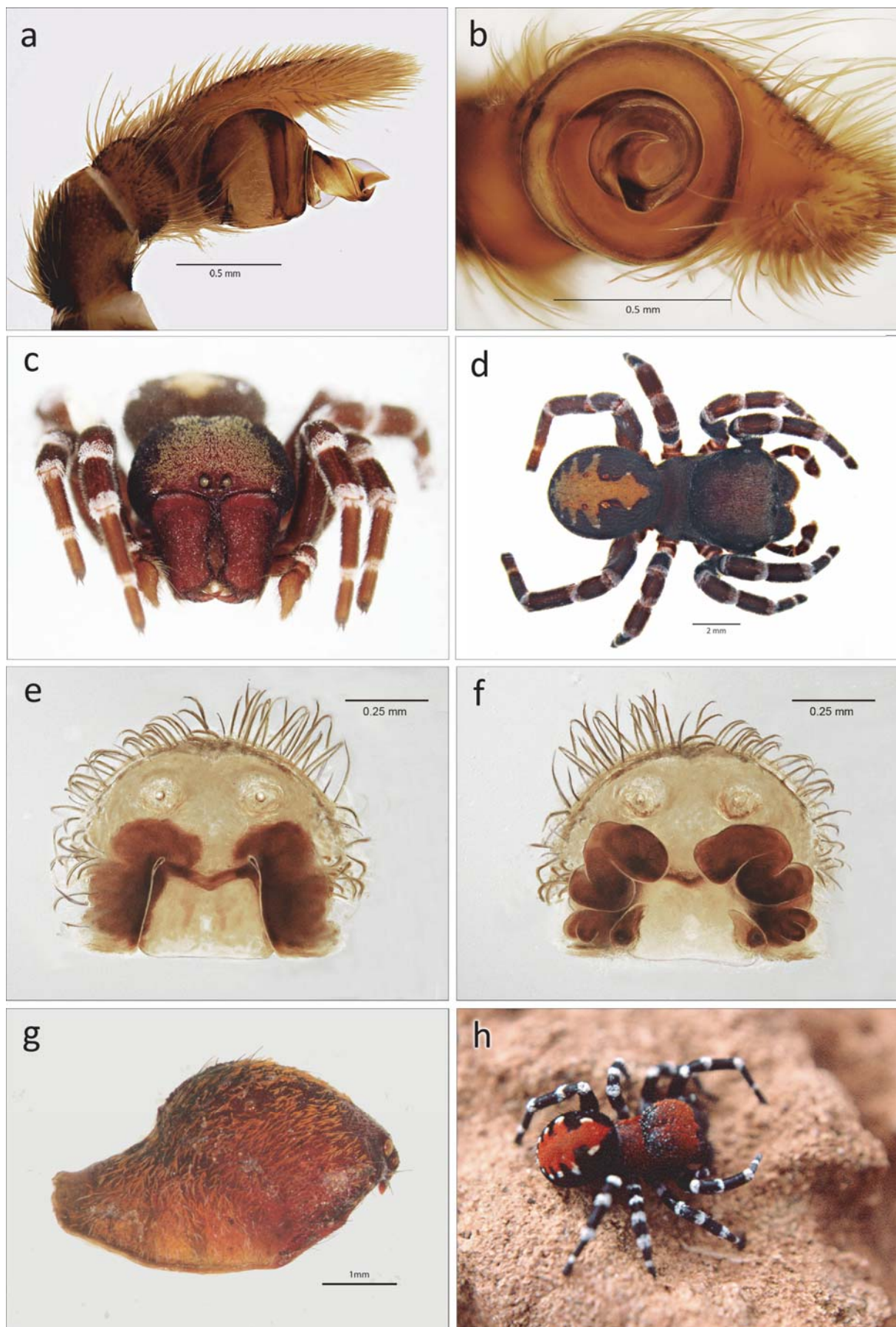


Fig. 1. *Loureedia lucasi*. [a] Lateral view of the male pedipalp of *Loureedia lucasi*, [b] Axial view of the male bulb of *L. lucasi* (type series); [c] Frontal view of a male *L. lucasi* (type series); [d] Dorsal view of a male *L. lucasi* (type series); [e] Ventral view of the female genitalia of *L. lucasi* (type series); [f] Dorsal view of the female genitalia of *L. lucasi* (type series); [g] Lateral view of a male carapace of *Loureedia* cf. *lucasi* found in a female's nest (Agadir-Ida Ou Tanane, province, Morocco); [h] Male *Loureedia* cf. *lucasi* (Kénitra Province, Morocco) Photo by Luis García-Cardenete.

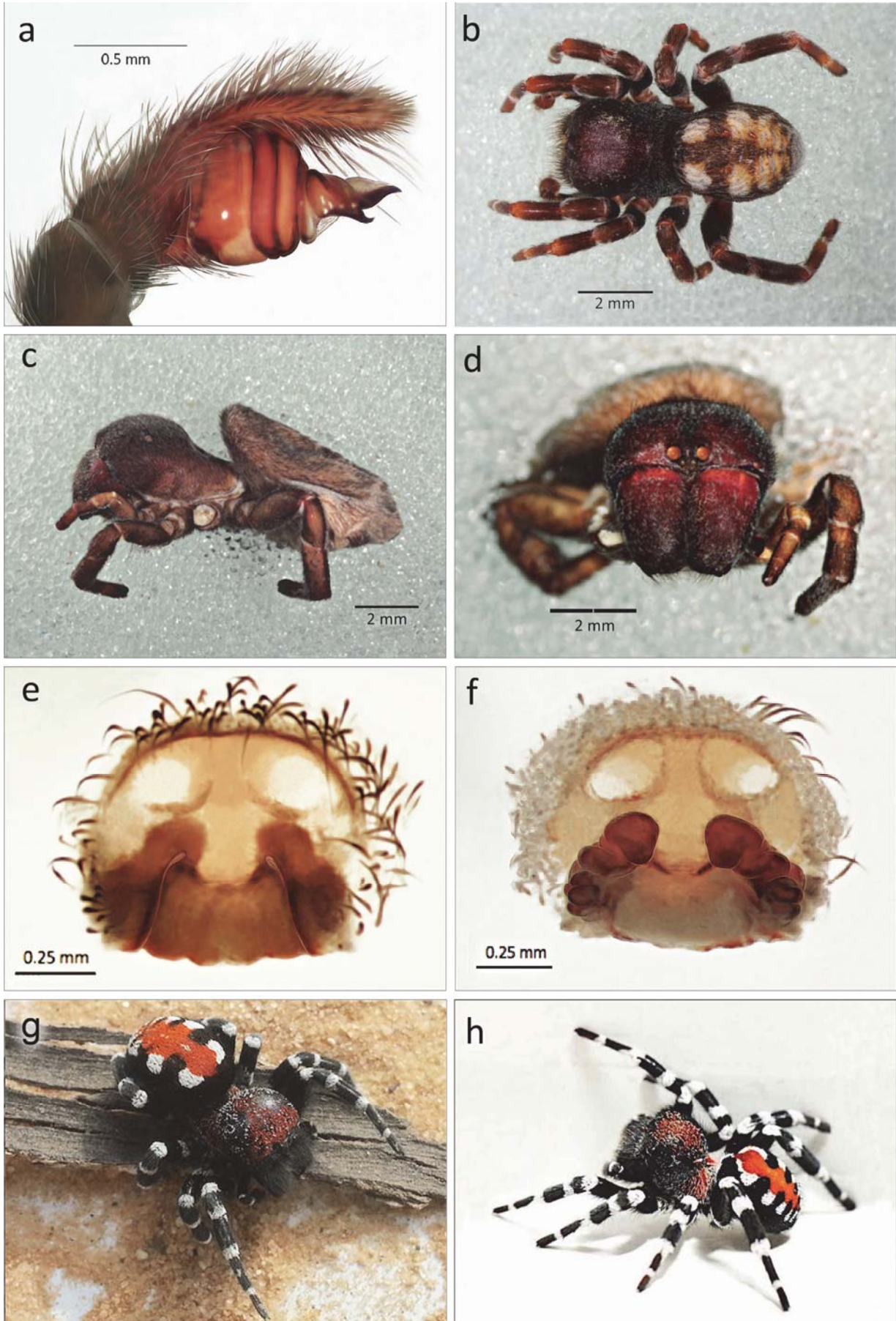


Fig. 2. *Loureedia annulipes*: [a] Lateral view of a male palp of *L. annulipes* (Benghazi, Libya); [b] Dorsal view of a male *Loureedia annulipes* (Benghazi, Libya); [c] Lateral view of a female *L. annulipes* (Israel); [d] Frontal view of a female *L. annulipes* (Israel); [e] Ventral view of the genitalia of female *L. annulipes* (Israel); [f] Dorsal view of the genitalia of female reproductive organs *L. annulipes* (Israel); [g] Dorsal view of male *Loureedia* sp. from Zawiya District, Libya (Photo by Osama O. Etewish); [h] Dorsal view of male *Loureedia* sp. from Tehran, Iran (Photo by Amir Hossein Bolhari).

GEOGRAPHICAL DISTRIBUTION. Thus far the *L. annulipes* group was only known from the South and Eastern Mediterranean (Algeria, Israel, Egypt and Tunisia). In this work we report the occurrence of *L. annulipes* in Libya for the first time (Fig. 2 a,b). Also noting that similar specimens (Fig. 2 f) pertaining to *L. annulipes* or *L. lucasi* have been sighted at several points along the Libyan coast (Osama O. Etewish pers. comm.).

We also believe it is worth reporting on the remarkable photographic records from Iran, that clearly bears features from the *L. annulipes* group (Fig. 2 h):

Iran: 1 ♂, Tehran Province, October, 2015, Amir Hossein Bolhari (photographic record), ♂, Tehran Province, November, 2016, Alireza Zamani (photographic record).

These records extend the genus range considerably eastwards. Photos of other specimens with similar features from a distinct independent source in the country were also observed, providing compelling evidence that the genus is likely native to the country, although human introduction can't be excluded. It is likely that these Iranian records belong to a distinct and undescribed *Loureedia* species. Unfortunately, the photographed specimen was not collected, and preserved specimens from other records have been lost or not been made available.

BEHAVIOUR: Identifiable parts of the bright red males, including a carapace (Fig. 1 g) have been found in a female's nest possibly accounting for post-mating cannibalism.

***Loureedia colleni* Henriques, Miñano & Pérez-Zarcos sp. n.**

HOLOTYPE: SPAIN: Andalucía: **Granada province:** Granada municipality, 820m, 1 ♂, manual collection, 10 October 2010, (deposited at MNCN - 20.02/19374), Carlos Jerez del Valle Leg. [30SVG51].

PARATYPES: SPAIN: Andalucía: **Almería province:** Almería municipality, 27m, 1 ♂, manual collection, 10 October 2018, MNCN 20.02/19375, Francisco Rodríguez leg. [30SWF47]; Vicar 82 m 1 ♀, manual collection, 26 March 2014, MNCN 20.02/19376, Francisco Rodríguez leg. [30SWF37]; Vicar 82 m 1 ♀, manual collection, 11 April 2014, MNCN 20.02/19377, Francisco Rodríguez leg. [30SWF37]; Sorbas, 370 m, 1 ♂ (MCNB - MZB 2018-0674) + 1 ♀ (MCNB - MZB 2018-0674), pitfall, 06 September to 05 December 2017, (MCNB), J. Miñano leg. [30SXH16]; Murcia Region: **Murcia province:** Fortuna, 120 m, 1 ♂ + 1 ♀, manual collection, 26 April 2004, (MNHN), J. Miñano leg. [30SXH62]; Abanilla, 155 m, 2 ♂, pitfall, 01-30 October 2003, (MNHN), J. Miñano leg. [30SXH87].

ADDITIONAL SPECIMENS: SPAIN: Andalucía: **Almería province:** Albos, 770 m, 1 ♂, manual collection, 08 November 2010, (JMC), J. Miñano leg. [30SXG13]; Cabo de Gata, 12 m, 1 ♂, pitfall, 10-17 May 2004, (JMC), A. Aguirre leg. [30SWF67]; Cabo de Gata, 6 m, 1 ♂, wandering, 01 April 2009, (JMC), J. Miñano leg. [30SWF49]; Cuevas de Almanzora, 135 m, 1 ♀, pitfall, 07-28 April 2011, (JMC), J. Miñano leg. [30SXH57]; El Ejido, 15 m, 1 ♂, wandering, 14 April 2006, (JMC), J. Miñano leg. [30SWF37]; Nijar, 40 m, 1 ♂, under stone, 19 February 2010, (JMC), J. Miñano leg. [30SXG64]; Tabernas, 300 m, 2 ♂, pitfall, 11 March to 05 June 2017, (JMC), J. Miñano leg. [30SXG65]; Velez-Rubio, 840 m, wandering, 20 May 2008, (JMC), J. Miñano leg.; Vicar, 390 m, 1 ♂, wandering, 28 September 2009, (JMC), J. Miñano

leg. [30SVG51]; **Granada province:** Cenes de la Vega, 750 m, 1 ♂, wandering, 02 July 2006 (JMC), J. Miñano leg. [30SVG51]; Benamaurel, 770 m, 1 ♂, wandering, 16 June 2012, (JMC), J. Miñano leg. [30SXH55]; Castilla-La Mancha: **Albacete province:** Hellín, 580 m, 1 ♂, under stone, 05 May 2003, (JMC), J. Miñano leg. [30SWG26]; Hellín, 500 m, 1 ♂, under stone, 20 September 2007, (JMC), J. Miñano leg. [30SXH16]; **Ciudad Real province:** Ruidera, 800 m, 1 ♂, 27 October 1980, SHPC, M. A. Valentin leg [30SWJ11]; Alhambra, 860 m, 1 ♂, under stone, 20 September 2007, (JMC), J. Miñano leg. [30SWJ91]; Murcia Region: **Murcia province:** Mazarrón, 200 m, 1 ♂, pitfall, 15 July to 30 November 1999, JKPC, Johan van Keer leg. [30SXG46]; Abanilla, 155 m, 1 ♂, pitfall, 01-30 October 2003, (JMC), J. Miñano leg. [30SXH87]; Alhama de Murcia, 380 m, 1 ♂, pitfall, 02-24 November 2005, (JMC), J. Miñano leg. [30SWG63]; Alhama de Murcia, 380 m, 1 ♂, wandering, 28 May 2005, (JMC), A. Millán leg. [30SXH42]; Cartagena, 150 m, 1 ♂, under stone, 28 August 2001, (JMC), J. Miñano leg. [30SXH62]; Cartagena, 175 m, 1 ♂, prey in web of *Steatoda paykuliana*, 01 May 2000, (JMC), J. Miñano & J. Martínez-Avilés leg. [30SXG86]; Cartagena, 5 m, 1 ♂, pitfall, 01-30 April 2008, (JMC), J. Miñano & BIOCIMA S.L. leg. [30SWF76]; Cartagena, 80 m, 1 ♂ + 1 ♀, manual collection, 02 June 1999, (JMC), J. Miñano & J. Martínez-Avilés leg. [30SXG86]; Cartagena, 80 m, 1 ♂, pitfall, 2 September 2006 to 23 September 2006, (JMC), J. Miñano & Environmental Volunteering CARM leg. [30SXG96]; Cieza, 370 m, 1 ♂, pitfall, 13 February to 20 March 2004, (JMC), J. Miñano leg. [30SXH94]; Fortuna, 190 m, 2 ♂, pitfall, 16 June to 15 July 2005, (JMC), J. Miñano leg. [30SXH62]; Jumilla, 640 m, 1 ♂, pitfall, 15 October to 15 November 2017, (JMC), J.L. Lencina leg. [30SWG86]; Jumilla, 690 m, 1 ♂, pitfall, 16 July to 02 August 2015, (JMC), J.L. Lencina leg. [30SYH13]; Jumilla, 840 m, 2 ♂, pitfall, 12 June to 28 June 2014, (JMC), J.L. Lencina leg. [30SXH61]; Lorca, 510 m, 1 ♀, manual collection, 23 June 2012, (JMC), J. Miñano leg. [30SXG17]; Lorca, 700 m, 1 ♂, under stone, 24 October 2006, (JMC), J. Miñano leg. [30SXH52]; Mazarrón, 170 m, 1 ♂, under plant *Stipa tenacissima*, 22 May 2003, (JMC), J. Miñano leg. [30SXG39]; Mazarrón, 190 m, 2 ♂, pitfall, 05 May to 20 June 2008, (JMC), J. Miñano leg. [30SXG45]; Mazarrón, 210 m, 1 ♂, under plant *Thymus hymalis*, 20 February 2011, (JMC), J. Miñano leg. [30SWJ91]; Mazarrón, 70 m, 3 ♂, under plant, 26 February 2004, (JMC), J. Miñano leg. [30SXG45]; Murcia Municipality, 148 m, 2 ♂, pitfall, 01-31 June 2010, (JMC), V. Zapata & J. Miñano leg. [30SXH35]; Murcia Municipality, 170 m, 1 ♂, pool fall, 08 July 2004, (JMC), J. Miñano leg. [30SXH78]; Murcia Municipality, 175 m, 2 ♂, pitfall, 01-15 September 2006, (JMC), J. Miñano leg. [30SXG67]; Puerto Lumbreras, 425 m, 1 ♂, wandering, 14 July 2003, (JMC), J. Miñano leg. [30SXG39]; Ricote, 370 m, 1 ♂, pitfall, 01 June to 12 July 2010, (JMC), J. Miñano leg. [30SXG17]; San Javier, 125 m, 1 ♂, manual collection, 24 April 1995, (Lost), J. Miñano & J. Martínez-Avilés leg. [30SXG45]; Ulea, 155 m, 1 ♂, pitfall, 15 October to 11 November 2010, (JMC), J. Miñano leg. [30SXG35]; Yecla, 805 m, 2 ♂, pitfall, 25 April to 30 May 2016, (JMC), J.L. Lencina leg. [30SXH57]; Valencian Community: **Alicante province:** Agost, 360 m, 1 ♂, under stone, 29 April 2006, (JMC), J. Miñano leg. [30SWG77]; Aspe, 280 m, pitfall, 03 May to 17 June 2013, (JMC), J. Miñano leg. [30SYH55]; Elche, 20 m, 1 ♂, under plant, 20 May 2008, (JMC), J. Miñano leg. [30SWG99]; Orihuela, 165 m, 1 ♂, wandering, 09 No-

vember 2008, (JMC), J. Miñano leg. [30SXH24]; Alicante Municipality, 30 m, 1 ♂, manual collection, 20 February 2011, (JMC), J. Miñano leg. [30SXG47].

ADDITIONAL SPECIMENS ONLY RECORDED BY PHOTO: See Supporting Information (Figs. S1- S12) for more details.

SPAIN: Andalucía: 1 ♂, 3 October 2009, Eva de Más (Fig. S1); 5 ♂, 14 October 2010 (Fig. S2), 10 October 2011 (Fig. S3), 06 October 2012 (Fig. S4) and 25 September 2014 (Fig. S5), Francisco Rodríguez; 1 ♂, **Granada province:** 4 October 2014, Fernando Molina Sánchez (Fig. S6); 2 ♂, 30 September 2016 (Fig. S7) and 3 October 2017 (Fig. S8), Simon Oliver; Madrid Community: **Madrid province:** 1 ♂, 6 October 2014, José Antonio Gómez (Fig. S9); Murcia Region: **Murcia province:** 1 ♂, 12 October 2007, José Luis Palacios, (Fig. S10); Valencian Community: **Alicante province:** 1 ♂, 2 October 2012, Stevie Smith (Fig. S11); 1 ♂, 11 October 2005, Hugh J Griffiths (Fig. S12).

ETYMOLOGY. The species is named after Dr. Ben Collen (12 February 1978 – 19 May 2018), internationally recognized conservation scientist (Jones & Purvis, 2018) who loved Spain (the type locality of this species) where he taught numerous students and conducted multiple field courses. He supervised, supported and inspired the first author of this publication until his untimely death.

TAXONOMIC HISTORY. *L. annulipes* has until this publication only been recorded from Algeria, Tunisia, Egypt, and Israel. However according to the “Araneae Spiders of Europe” website (Nentwig *et al.*, 2018) this species is also recorded from southern Spain, quoting M. Řezáč (pers. comm.). This recorded occurrence has proven not to belong to *L. annulipes*, but rather to the new species described here as *L. colleni* sp. n.

SPECIES DESCRIPTION

Male. Pattern and coloration. -The most remarkable feature of *L. colleni* sp. n. is the complete absence of a bright coloration pattern (Fig. 3 and 4 b,c), unlike the one found in the two other species of this genus, which always display bright red sections, both in the opisthosoma, as well as often in the prosoma (Fig. 1 h, Fig. 2 g - h). *L. colleni* sp. n. also has scattered white setae in the prosoma, which are often compact in the thoracic section (Fig. 3).



Fig. 3. General overview of the habitus in vivum of *Loureedia colleni* sp. n. female (above) and male (below), both from Murcia Region.

Prosoma and legs tend to be whiter in individuals living in driest habitats with white soils where the only black regions in the male’s prosoma is reduced to the ocular area and the chelicerae (Fig. 3). Individuals from less arid habitats have darker coloration patterns (black with brown shades).

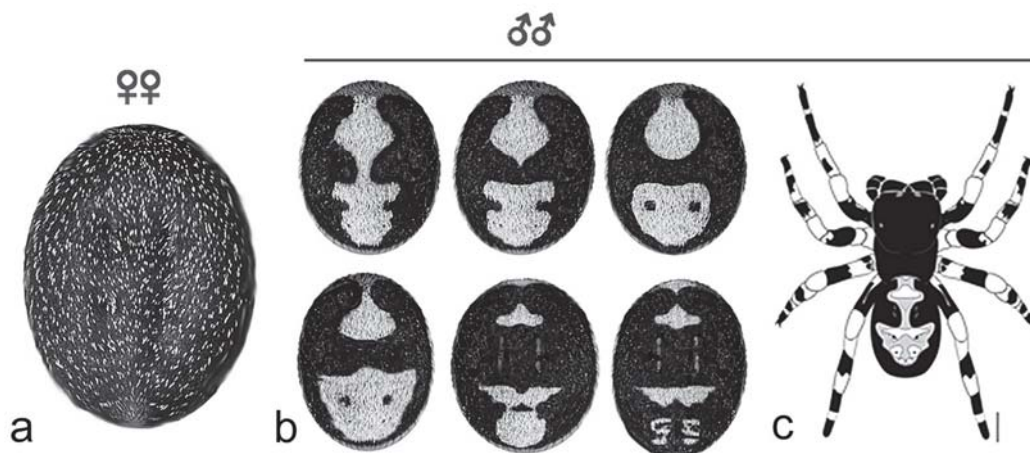


Fig. 4. Dorsal view of opisthosoma pattern in *Loureedia colleni* sp. n.: [a] Females; [b] Males; [c] Schematic illustration of overall shape and coloration of male in *L. colleni* sp. n., using colour code to represent the abdominal pattern variability. White areas representing regions where white coloration was always observed, and grey areas indicating regions where white colorations were at times observed, dotted lines represent areas where the pattern has more often terminated (scale 1 mm).

The white rings found in this genus legs (probably the cause for *L. annulipes* etymology) are very broad in the *Loureedia colleni* sp. n. and give the appearance of white legs interrupted by black rings (Fig. 3, Fig. 4 c and S1-S12). Although remarkably different in colour, the male's abdominal pattern in all *Loureedia* species share some similarities, which we consider important to analyse as coloration is often lost in the preservation process.

The anterior region is almost identical in all species to what concerns shape, and the region between the first two pairs of muscular insertions, although thicker in *L. annulipes* and *L. lucasi*, is also often present in *L. colleni* sp. n. (Fig. 4 c) The posterior region is where more distinctions can be noticed, as *L. colleni* sp. n. pattern was always recorded as having white markings on the posterior muscular insertions (Fig. 4 c, Fig. 5 b), whereas in *L. annulipes* and *L. lucasi* it is discoloured and merges with the lateral region of the black field (Fig. 1 c, d, h; Fig. 2 b, h).

Male genitalia. Although very similar to other male genitalia described for this genus, it presents several distinctive features, which we summarized (Fig. 5).

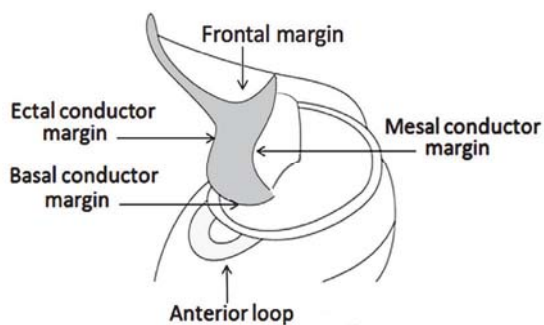


Fig. 5. Schematic illustration of the bulb pedipalp of *Loureedia colleni* sp. n. Ventral view with relevant morphological nomenclature.

Ventral view of the male pedipalp

Trait 1. The mesal conductor margin is very straight in *L. annulipes* (Fig. 7 a) somehow sinuous in *L. lucasi* (Fig. 7 b) and highly concave in *L. colleni* sp. n. (Fig. 6, Fig. 7 c), perhaps as a consequence of this feature, the angle formed by the mesal and basal conductor margins ends abruptly at an 90° angle in *L. annulipes*, producing an “L” shape (Fig. 7 a), producing an inverted “c” shape in *L. lucasi* (Fig. 1 a, Fig. 7 b) and a “>” shaped corner in *L. colleni* sp. n. (Fig. 7 c).

Trait 2. The ectal margin of the conductor is only slightly curved inwards in the *L. colleni* sp. n. (Fig. 6, Fig. 7 c), in opposition to the highly concave ectal margin of *L. annulipes* (Fig. 7a) and the straight margin of *L. lucasi* (Fig. 7 b).

Trait 3. The dorsal conductor tip is very similar between all species, but it is thicker at its base in *L. lucasi* and *L. colleni* sp. n. and considerably straighter in *L. annulipes* and *L. colleni* sp. n. The ventral conductor tip is also similar among all species, but it faces upwards at a slightly steeper angle in *L. annulipes*, making the margin that joins both tips closer to 90°.

Trait 4. From a ventral view two sections of the sperm channel are visible through the *tegulum* of the conductor bulb. The posterior loop near the embolus is considerably small-

er and thinner in *L. annulipes* and has a much wider and ectal position in *L. lucasi*, whereas in *L. colleni* sp. n. this section of the channel is both ectal and small, completing its anterior loop just at the edge of the conductor's basal margin.

Lateral view of the male pedipalp

Laterally, it becomes clearer that the dorsal conductor tip is not only longer in *Loureedia colleni* sp. n. but also thinner, particularly at its tip (Fig. 6 a, c), and its shape clearly distinguishes it from *L. lucasi* (Fig. 1 a) and *L. annulipes* (Fig. 2 a). In all three species the tip of the ectal conductor tooth is raised higher than its base, but this is most notable in *L. colleni* sp. n. even though the basal region of the dorsal margin is only slightly curved downwards (Fig. 6 c) or even appear almost straight (Fig. 6 a), while it is further curved downwards in *L. lucasi* (Fig. 1a) and strongly curved downwards *L. annulipes* (Fig. 2 a).

The ventral margin of the ectal conductor tooth in *L. colleni* sp. n. is highly convex throughout its entire length (Fig. 6 c), while in *L. annulipes* it is only slightly convex (Fig. 2 a) and is almost straight in *L. lucasi* (Fig. 1 a).

In *L. colleni* sp. n. mesal conductor tooth appears more exposed from the ectal one (Fig. 6 c), because of its lesser torsion, which enables its tip to be more easily seen, while in *L. lucasi* and *L. annulipes* a higher rotation towards its ventral side is required to expose it (Fig. 1 a and Fig. 2 a). Which becomes clearer from a frontal view.

From a frontal angle the mesal conductor tooth of *L. colleni* has lesser torsion, which is perceived as more open, wider or as a less coiled spiral (Fig. 8 c) in *L. lucasi* this torsion is greater and the tooth reaches further into the center of the structure (Fig. 1 b), whereas in *L. annulipes* it has the highest torsion and is coiled even further (Miller et al. 2012, Fig. 63F).

Microstructures of the male palp

The frontal margin of the conductor appears different under SEM observation. It is smooth in *L. annulipes* (Miller et al., 2012, fig. 63 F), but serrated in *L. lucasi* (Gál et al., 2017, fig. 4 D) and *L. colleni* sp. n. (Fig. 8).

From an apical view of the male pedipalp it is clear that the mesal conductor is linked to a complex flame-shaped lamellated structured -FSL- (Fig. 8), which appears to be bi-dimensional, but it is in fact elaborated and probably has got taxonomic value in *Loureedia* or other Eresidae genera.

FSL is a well-developed sheet in *Loureedia colleni* sp. n., while is a small keel in *L. annulipes* (Miller et al., 2012, fig. 63 F) and has a row of flame shaped structures in *L. lucasi* (Gál et al., 2017, fig. 4 A,D) which are brush-like in appearance.

These micromorphological differences might be related to different reproductive strategies: 1) intraspecific recognition within a key-lock strategy, 2) to stimulate specific regions inside the female, 3) to scrape internal structures within the female, to remove semen of competing males for example (Eberhard, 1996). Further research is needed to understand both the function of the FSL and the sperm competition strategies in *L. colleni* sp. n., as we have found mating plugs (Fig. 15 b) and phenology data as well as some empirical observations (Fig. 1 g) suggests that mate-guarding might occur.

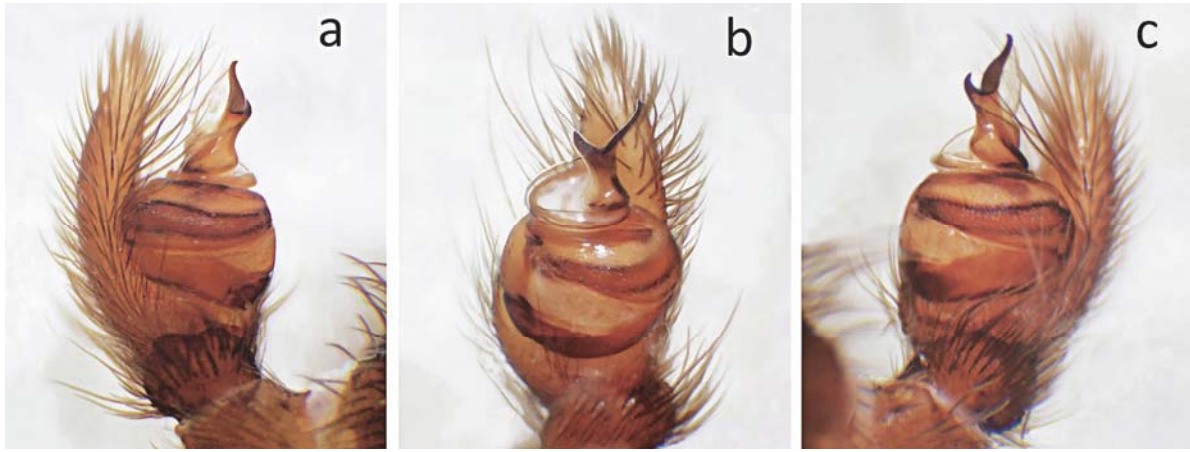


Fig. 6. Left male pedipalp of *Loureedia colleni* sp. n.: [a] lateral mesal view, [b] ventral view, [c] lateral ectal view (turned).

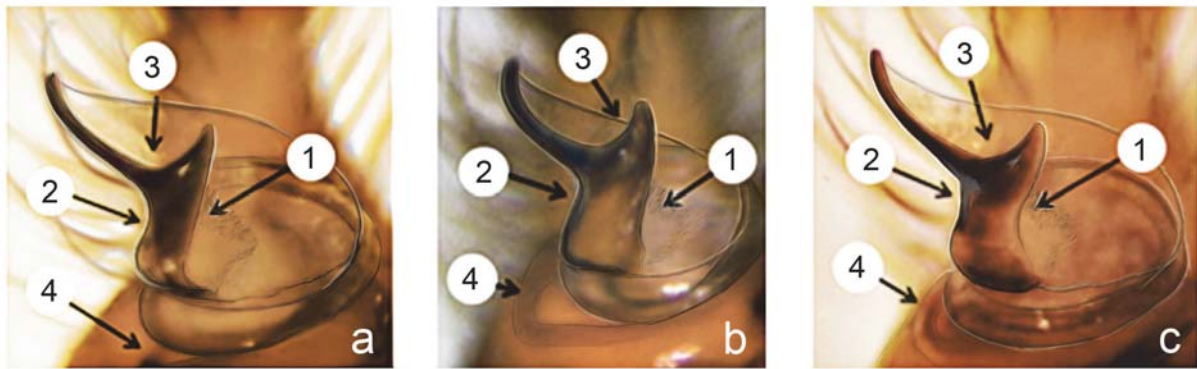


Fig. 7. Ventral view of male pedipalp (right) in the *Loureedia* genus: [a] *L. annulipes* (from Libya), [b] *L. lucasi* (type series) [c] *L. colleni* sp. n. (holotype). Numbers 1-4 indicating the four traits considered most relevant to distinguish them (see results for more details).

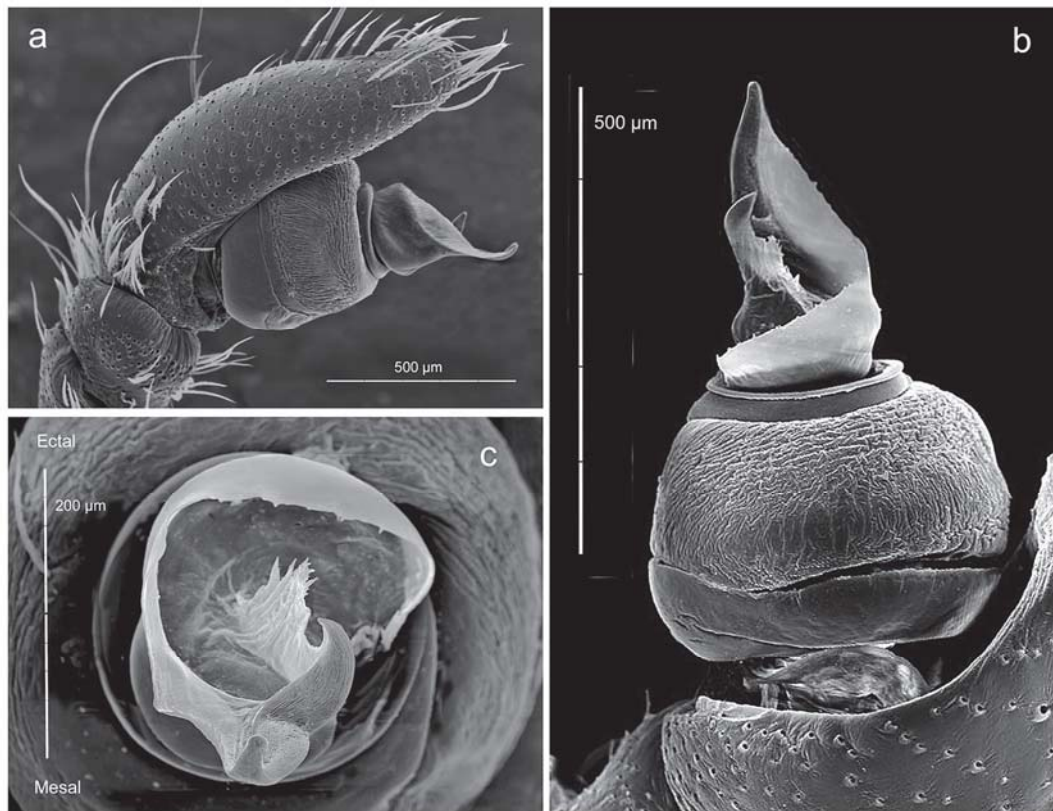


Fig. 8. Male pedipalp of *Loureedia colleni* sp. n. under SEM: [a] lateral mesal view; [b] lateral ectal view; [c] apical or axial view.

Female. General greyish appearance due to the presence of white hairs between the black hairs in the background (Fig. 3 and Fig. 4 a), which can lead to misattribute to immature *Eresus* spp. Opisthosoma greyish background with white spots, larger in the anterior region, occasionally arranged in arcs in the posterior region. The carapace of prosoma often displays dorsal white marks that can be distributed in diffuse longitudinal stripes. Some females have a “mask” of yellowish hairs in the front ocular area and chelicerae surface, similar to some *Eresus* females (Fig. 3).

The legs are greyish in all their length or may present some white marks near the articulations of the segments. Some specimens can also present whitish marks that run longitudinally along most of segments, especially in the legs I and II (Fig. 3).

Loureedia colleni sp. n. females and males are often smaller than adult of *Eresus* species found in the Iberian Peninsula, although considerable size variation can be observed on both genera. Measurements of the total body length are difficult to produce accurately for several reasons. The first one is that a considerable section of the prosoma is covered under the anterior part of the opisthosoma. The second one is that the opisthosoma volume can vary considerably depending on the abdominal gastric contents -making it an unreliable character. Furthermore, adult females can continue growing,

via new ecdysis after maturation, as moulting has been recorded in other Eresidae with completely developed female genitalia (Kraus & Kraus, 1989).

Female genitalia. This is a structure which is notoriously variable in the family, and the analysis present isn't nearly as reliable as the one based on male genitalia. However from the material currently available, the anterior lobe in *L. colleni* sp. n. (Fig. 9 c) can be much smaller than *L. annulipes* (Miller *et al.*, 2012) both in height as in width, which in turn can be smaller than the anterior lobe of *L. lucasi* (Fig. 1 e, f).

The size of the anterior lobe often positions the spermathecal heads much closer to each other in the *L. colleni* sp. n. than in any other species, and presents a very distinctive almost lanceolate shape (Fig. 9 b), whereas they are spherical in *L. annulipes* (Miller *et al.*, 2012), and in *L. lucasi* (Fig. 1 f) but much closer in the later while almost pointing downwards.

The epigyne bar is always very visible both ventrally and dorsally, (Fig. 1 e, f, Fig. 9 c, d, Miller *et al.*, 2012), dorsally it is almost straight in *L. annulipes* (Miller *et al.*, 2012), concave in *L. colleni* sp. n. (Fig. 9 c) and obtuse in *L. lucasi* (Fig. 1 e). The spermatheca is quite homogenous in width both in *L. annulipes* (Fig. 9 d) and *L. lucasi* (Fig. 1 f) but it becomes narrower at the base in *L. colleni* sp. n. (Fig. 9 d).

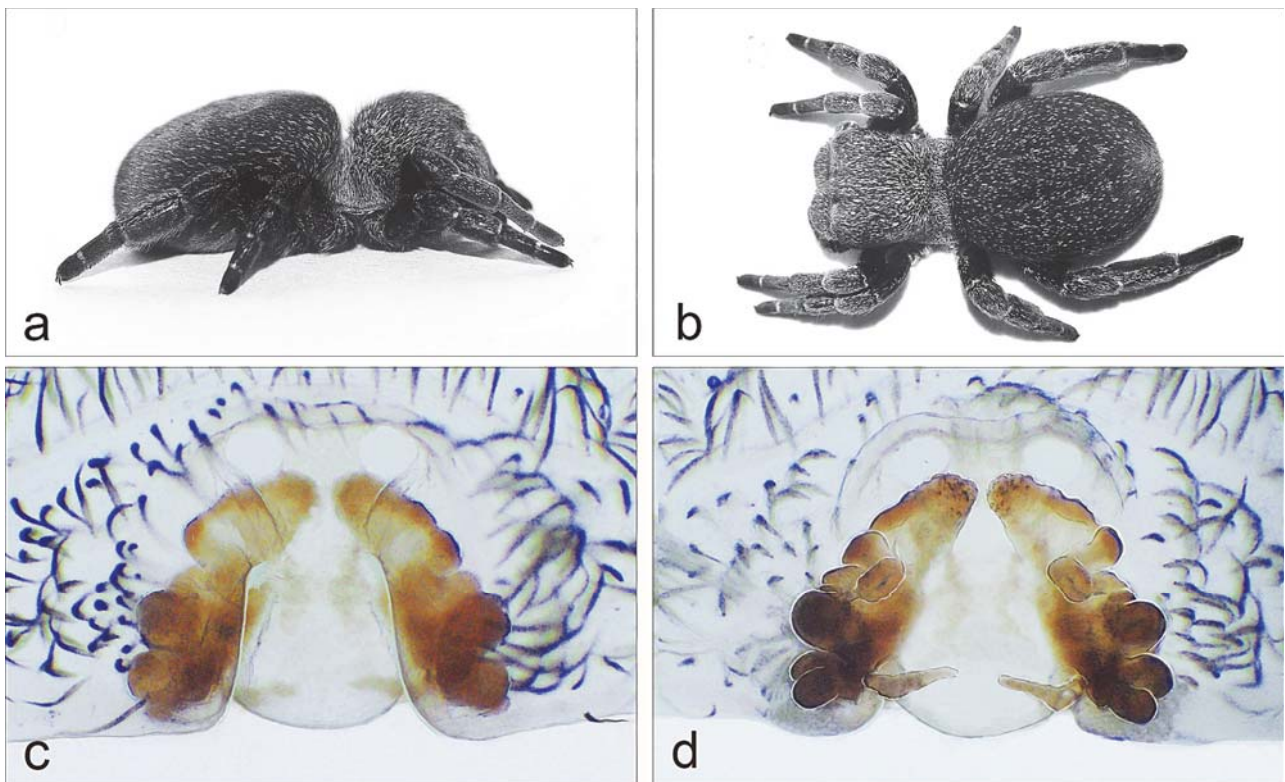


Fig. 9. Female *Loureedia colleni* sp. n. (paratype). *Habitus in vivum*: [a] Lateral view, [b] dorsal view; Genitalia: [c] ventral view; [d] dorsal view.

HABITAT. This species is adapted to semiarid environments, with preference for steppe habitats with good solar exposure and low density of scattered vegetation, such as shrublands or low shrubs with grasslands. In Mediterranean shrubland (with *Thymus* sp., *Rosmarinus* sp., *Anthyllis* sp., *Stipa* sp., *Lygeum* sp., among other species) and very open woodlands of *Quer-*

cus sp. (in its northern range). It also appears in degraded areas such as re-wild farmlands, grasslands and in marginal areas of crops. Regarding soil type, *L. colleni* sp. n. occurs in limestone, sandy, loamy and clay soils, in both flat areas and hillsides (Fig. 10). Habitats with a mean annual temperature below 14°C appears to be a limiting factor for this species. It

is much more frequent in lowest altitude levels and warm areas (15-18°C annual mean temperature), than in more temperate zones occupied by Mediterranean forest (*Quercus* sp. and *Pinus* sp.). It occurs predominantly in areas with high

aridity index (average yearly precipitation below 350 mm coupled with a strong potential evapotranspiration, four times higher than accumulated rainfall).

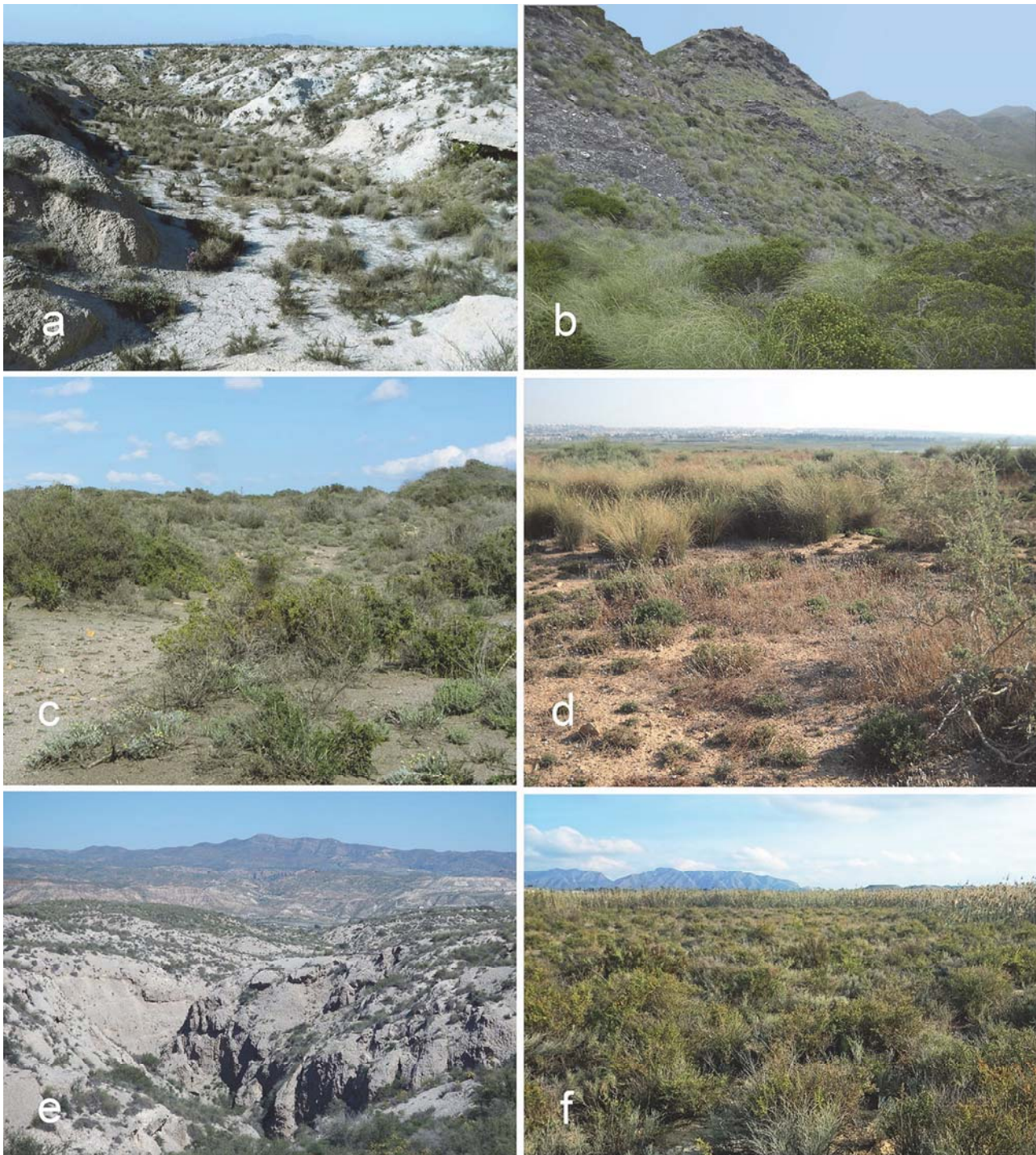


Fig. 10. Different habitats where *Loureedia colleni* sp. n. has been collected: [a] Grassland of *Stipa tenacissima* with erosive clay loams. [b] Mediterranean shrub lands on metamorphic substrate. [c] Shrubland in a coastal sand dune ecosystem with secondary vegetation and stable soil. [d] Grassland of Poaceae in sandy soil. [e] Arid steppe in gypsiferous soils. [f] Steppe halophyte on margins of salt marsh wetlands.

DISTRIBUTION. The species proved to have a considerably large range, from sea level up to 800 m, occurring in the south eastern and central regions of Spain (Fig.11). Most of these natural habitats are threatened by urban development, extensive agriculture (mostly olive and almond tree growths), eco-

nomical reforestation programs, and vast greenhouses (primarily in the south of Spain).

As most of this species populations are predicted to occur in some of the hotter and driest regions of Europe (Hijmans *et al.*, 2005), the species is likely to inhabit its criti-

cal or lethal thermal limits. As extreme weather events become more prevalent under climate change (UNEP, 2006), intensity and duration of thermal stress is likely to increase, which might cause high mortality rates (Rezende *et al.*, 2014) as this species is pushed outside its thermal tolerance.

Our models predict that at most 5% of *L. colleni* sp. n. localities occur in the central and northern Iberian Peninsula (uncoloured areas in Fig. 11), populations in those areas are likely to inhabit poorly suited ecological niches with high

fragmentation which has likely been exacerbated by human activity over the last century and particularly over the last decade. The probable low dispersal ability of this species, as inferred from low dispersal ability of other members of the same family (Řezáč *et al.*, 2008), indicates that such small isolated populations are unlikely to support long term viable colonies of the species, even as climate change causes these areas to become more thermally suitable for this species (UNEP, 2006).

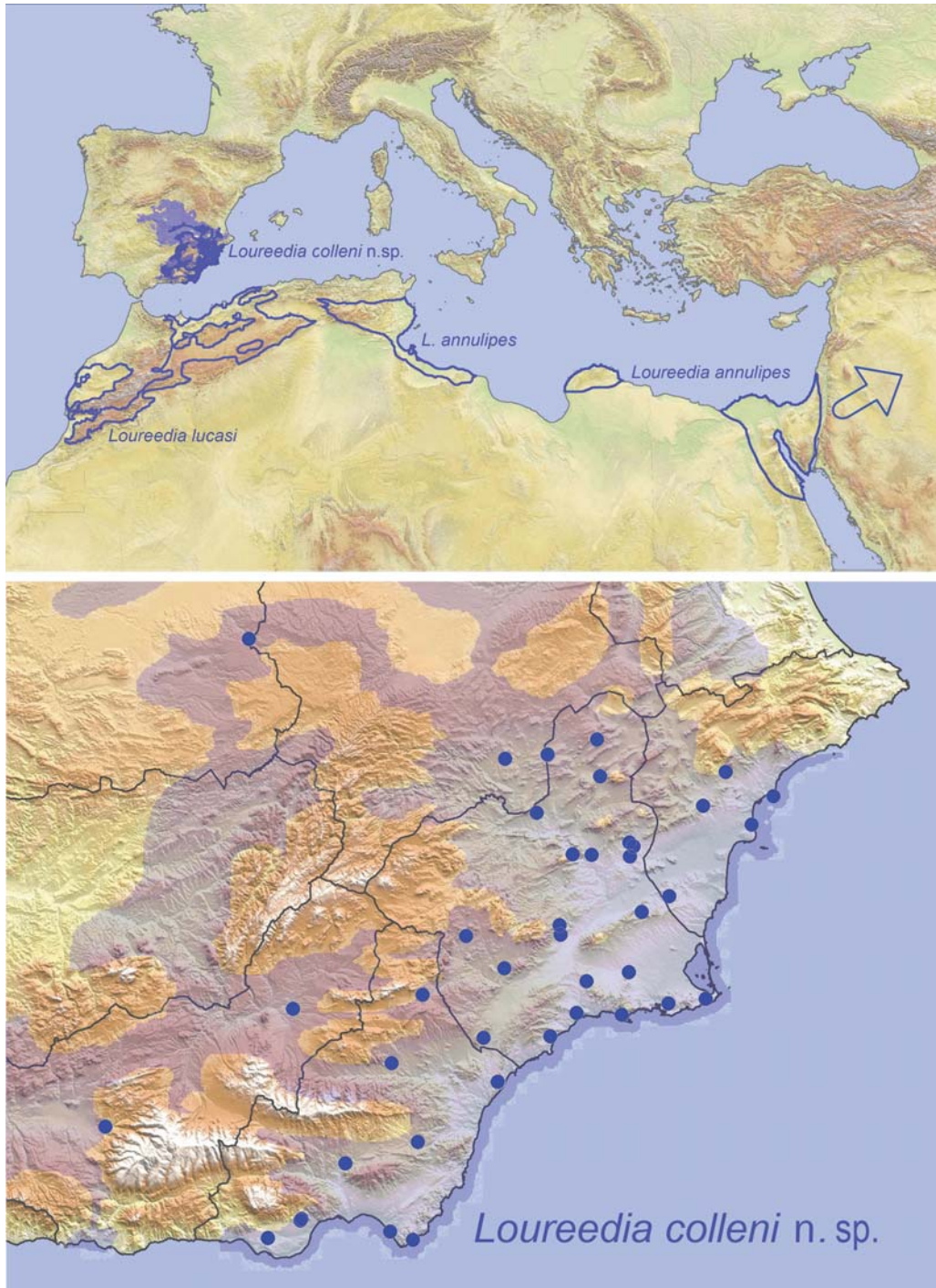


Fig. 11. [Above] Mediterranean Basin using coloured polygons to represent the potential species distribution of *Loureedia colleni* sp. n. (area where 90% of localities are expected to occur in dark blue, both tones of blue representing the area where 95% of localities are expected to occur both tones of blue) and using empty polygons to represent the potential distribution of *L. annulipes* and *L. lucasi*, empty arrow indicates the direction of the Iranian record [Below] Detail of the South East of the Iberian Peninsula, potential species distribution of *L. colleni* sp. n. illustrated as darkened area (90% probability of occurrence), blue circles indicating known records of the species.

BIOLOGY:

Phenology: Most of our records and observations of *L. colleni* sp. n. males occurred mostly in two periods, during Spring and Autumn (Figs. S1-12). Males of the species appear to search for females throughout most of the year, except for January (coldest month) and August (driest month), specially, in the hotter and most arid areas of its distribution (with mean annual temperatures above 16° C).

Nest: *Loureedia* species build burrow about 10 cm deep in several types of soil (Fig. 10) where they remain most of their lives, inside a refuge zone. Laterally from the hole, they weave a funnel with a dense and insulating mesh of silk,

which they use as hunting zone (Fig. 12 b). This funnel is covered by a white-silk sheet raised from ground with tensioning threads and where individuals add some vegetal material or clay debris which they use as concealing zone (Fig. 12 a), and under which they store most of the prey remains, as a storage zone (Fig.13 a). Nests can usually be found on open areas, but are more often found under shrubs, occasionally built partially or completely under a rock (Fig. 13 a), nests which might be found without a vertical refuge area (as found elsewhere), but will rather have an horizontal irregular burrow.



Fig. 12. Nests of *Loureedia colleni* sp. n.: Undisturbed active nest in soil, and same nest after raising the white-silk sheet exposing the structure of the funnel and burrow leading to the refuge zone.

Diet: Prey remains in nests mainly include Tenebrionidae, and in nests close to wetlands, Isopoda.

Some identified prey are: *Scaurus rugulosus*, *Opatrum (Colpophorus) baeticum* ssp. *almeriense* and *Tentyria* sp. (Fig. 13 a).

Reproductive traits: Females of *Loureeidia colleni* sp. n., have been found with mating plugs (Fig. 13 b), and there is evidence to suggest that the *Loureeidia* genus can practice sexual cannibalism (Fig. 1 g). In other spider species with low paternal investment but with frequent sexual cannibalism, non-promiscuous mating was recorded and evidence

suggests that it predisposes males to become competitive and selective towards females (Andrade & Kasumovic, 2005). Similarly, if *Loureeidia* mating plugs prove effective at preventing females from being inseminated by multiple males, and the single male who does get to mate is killed by the female or dies while guarding her (terminal investment), this would entail that *Loureeidia* spiders would be physically unable to practice promiscuous mating, and would suggest that in these monogamous species, the males are also likely to become competitive and selective towards females.

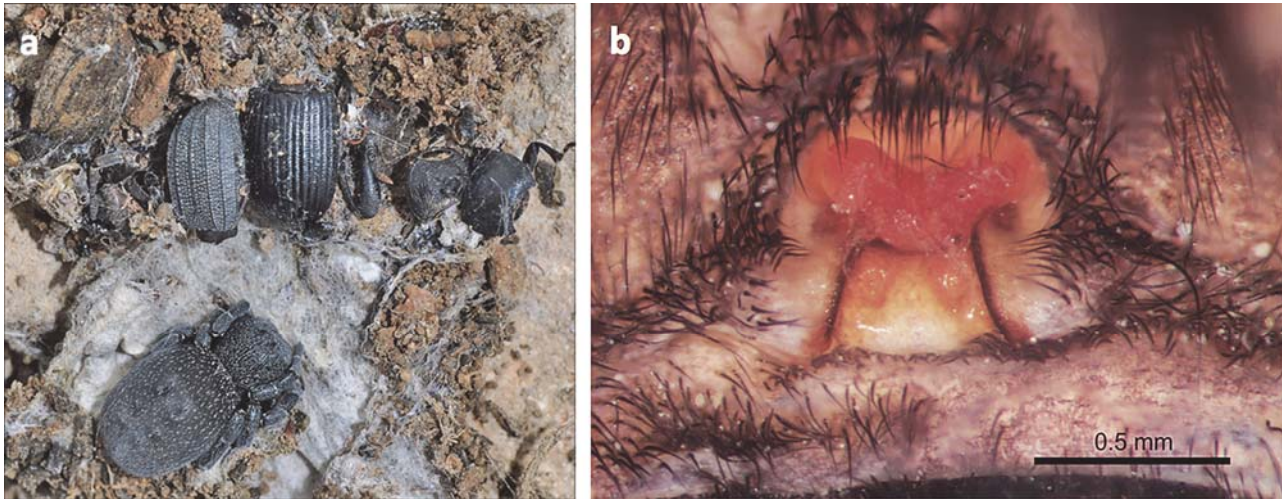


Fig. 13. [a] Adult female of *Loureeidia colleni* sp. n. (paratype), in her nest with prey remains. [b] Female with mating plug (second female paratype).

Discussion

The analysis of a broader set of species of *Loureeidia* spiders allowed us to reanalyse the traits that were originally set to define the genus, based solely on *Loureeidia annulipes* (Miller *et al.*, 2012).

The bifid conductor process, which was pointed out as a unique feature of this genus (Miller *et al.*, 2012), is present both in *L. colleni* sp. n. and in *L. lucasi*, and should remain as the most distinctive feature of the group, although bifurcation also occurs in the pedipalps of *Stegodyphus dumicola*, *S. tentoriicola*, and *Paradonea striatipes*, it does not occur to the same extent, as these aforementioned species only have terminally bifid processes, whereas in all *Loureeidia* species the conductor tip is entirely composed of two bifurcating teeth, a ventral tooth and a dorsal one which bears a basal lamella (Fig. 7), which is similar to the structural complexity of the pedipalp in other Eresidae, but highly distinctive in its shape.

Posterior medium eyes (PME) are clearly larger than the anterior medium eyes (AME) in all *Loureeidia* species (AME/PME ca. 0.5) as well as the lack of prominent tubercles bearing the ALE, although these are not unique features to this genus they do allow it to be easily differentiated from *Dorceus* and *Dresserus*, respectively (Miller *et al.*, 2012).

Once that previous analysis on the *Loureeidia* genus have had reduced access to females (Miller, pers. comm.) or no access to female specimens at all (Gál *et al.*, 2017). Analysis of distinctive genus traits in females have been lacking. Once that we were able to analyse females of all the recognized species, we have observed that the epigynum morphol-

ogy of this genus is also very distinct from other Eresidae, with its unique anterior depression and by the compact configuration of the reproductive duct system.

The striking black and white coloration of *L. colleni* sp. n. males is so distinct from other *Loureeidia* species that it allows for photographic records to be identified to the species level reliably (supporting information Fig. S1-S12). However, despite this remarkable colour difference, all *Loureeidia* males analysed in this publication, share strong morphological similarities and a common pattern design (Fig. 1d, 1h, 2b, 2g, 2h, 3[bellow], S1-S12).

Contrary to the clearly distinct *Loureeidia* males, the females have a simple design and can be easily mistaken with *Eresus* females, with which they can share their habitat. Therefore photographic diagnosis of females is not recommended as an accurate record in this group. Nonetheless, female sightings are rare, as only males disperse to find a partner, and the more reclusive and cryptic *Loureeidia* females don't present strong coloration in the anterior cephalic regions, whereas *Eresus* females often do.

The cephalic region shape, described as potentially distinctive in the original genus description (Miller *et al.*, 2012), is not present in all species and as a genus character must now be redefined to encompass all three species. We observed that it is wider than long in *L. annulipes* and longer than wide in *L. colleni* sp. n., rendering this character unreliable for this genus distinction with *Dresserus* and *Paradonea*.

As mentioned earlier, females can be challenging to identify or distinguished by photos alone, but males of *L. colleni* sp.

n. are very distinct from any other Iberian eresids and photographic records have, and should continue to be, used to monitor this species distribution, phenology or even population density. We consider this to be a valuable trait, as it places *L. colleni* sp. n. as a potential model species to develop citizen science and non-invasive species monitoring.

It appears difficult to distinguish between *L. annulipes* and *L. lucasi* by photographic record alone, but the genus pattern design is surely distinctive, and we hope this publication will drive the research of this genus further, to the point where we can better understand the distribution of these species across the genus range.

Despite the striking differences between the black and white males of *L. colleni* sp. n. and the brightly red coloration of the *L. annulipes* and *L. lucasi* males, both coloration types appear to be aposematic in nature, as *L. colleni* sp. n. is quite a noticeable species against the mostly brown, light green background of the Southern Spanish areas where it occurs. As we know very little about *L. colleni* sp. n. ecology it is difficult to know how this species is perceived by its predators, and if its coloration could be considered cryptic in some way (when considering the UV spectrum for example). This is beyond the scope of this work, but should be the focus of future research.

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SUPPORTING INFORMATION



Fig. S1-S6. Edited photos from the original photographic records of *Loureedia colleni* sp. n. [S1] by Eva de Más in 2009; [S2] by Francisco Rodríguez in 2010; [S3] by Francisco Rodríguez in 2011; [S4] by Francisco Rodríguez in 2012; [S5] by Francisco Rodríguez in 2014; [S6] by Fernando Molina Sánchez in 2014.



Fig. S7-S12. Edited photos from the original photographic records of *Loureedia colleni* sp. n. [S7] by Simon Oliver in 2016; [S8] by Simon Oliver in 2017; [S9] by José Antonio Gómez in 2014; [S10] by José Luis Palacios in 2007; [S11] by Stevie Smith in 2012; [S12] by Hugh J Griffiths in 2005.