Distinctive Collombola Communities in the Mesovoid Shallow Substratum: Entomobryomorpha of the Sierra de Guadarrama National Park (Central Spain)

Enrique BAQUERO, Rafael JORDANA & Vicente M. ORTUÑO

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Habitus and color patterns of some species described in the article.
Distinctive Collembola Communities in the Mesovoid Shallow Substratum: Entomobryomorpha of the Sierra de Guadarrama National Park (Central Spain)

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ABSTRACT

The material for this study was obtained after intensive sampling in the colluvial mesovoid shallow substratum, or MSS, of the Sierra de Guadarrama National Park using 33 subterranean sampling devices (SSD). The data were obtained from the first extraction of the traps between May and October of 2015. This paper presents the results for the Entomobryomorpha Börner, 1913, which was part of the Collembola captured. Four families and 12 genera have been studied: Isotomidae Schäffer, 1896 (Folsomia Willem, 1902, Tetracanthella Schött, 1891, Uzelia Absolon, 1901, Folsomides Stach, 1922, Isotomurus Börner, 1903, Parisotoma Bagnall, 1940, Pseudisotoma Handschin, 1924 and Pachyotoma Bagnall, 1949), Orchesellidae Börner, 1906 (Orchesella Templeton, 1835 and Heteromurus Wankel, 1860), Entomobryidae Schäffer, 1896 (Entomobrya Rondani, 1861) and Lepidocyrtidae Wahlgren, 1906 (Lepidocyrtus Bourlet, 1839 and Pseudosinella Schäffer, 1897). The species of Orchesella were studied in a previous paper (Baquero et al. 2017). The richness of the habitat sampled is defined by twenty-one species, eight of which are new: Pachyotoma penalarensis Baquero & Jordana n. sp., Entomobrya guadarramensis Jordana & Baquero n. sp., Entomobrya ledesmai Jordana & Baquero n. sp., Lepidocyrtus labyrinthi Baquero & Jordana n. sp., Lepidocyrtus paralignorum Baquero & Jordana n. sp., Lepidocyrtus purgatori Baquero & Jordana n. sp., Pseudosinella valverdei Baquero & Jordana n. sp. and Pseudosinella gonzaloi Baquero & Jordana n. sp. Entomobrya intermedia Brook, 1884 (England) is discussed and a new name Entomobrya katzi Jordana & Baquero n. sp. is proposed for E. intermedia sensu Katz et al. (2015) based on the American specimens.

KEY WORDS
Mesovoid shallow substratum (MSS), subterranean sampling devices (SSD), ecology, new species.
RÉSUMÉ

Communautés distinctes de collemboles dans le milieu souterrain superficiel : Entomobryomorpha du parc national de la Sierra de Guadarrama (centre de l’Espagne).


INTRODUCTION

Entomobryomorpha Börner, 1913 are Collembola Lubbock, 1870 with an elongated body and conspicuous segmentation, three thoracic and six abdominal segments (some Isotomidae have four or five abdominal segments), prothorax not developed and without tergal chaetae. There are some habitual dwelling inhabitants of the ground and litter, but less specialized than Poduromorpha Börner, 1913. While more than 265 species have been found in the entire Iberian Peninsula since the publication of the catalogue by Jordana et al. (1990), five families with 21 genera and 59 species – seven of which were originally described in the Sierra de Guadarrama – have been found in the study area. This information is shown in 12 publications published between 1929 and 1995 (Cassagnau 1954; Steiner 1955; Selga 1961, 1962a, b, 1963, 1966a, 1966b, 1971; Simón 1971; Simión & Selga 1977 [Somosierra]; Acón 1980). All those researchers worked intensely in the area because of the proximity of the National Museum of Natural Sciences and major university centers in Madrid.

The milieu souterrain superficiel or mesovoid shallow substratum (MSS), consists of a network of interstices and fissures in the subsoil, and harbours diverse epigean species of a stenoic nature, and strictly hypogean species that permanently inhabit this environment (Gers 1992; Ortuño et al. 2013). Previous studies focused on ecology (Juberthie et al. 1980; Ledesma et al. 2020), while others explored some faunal aspects (Rúžička et al. 1995; Nitzu et al. 2010; Jiménez-Valverde et al. 2015). This paper is a continuation of two previously published papers that study the biodiversity of the MSS collembolean fauna of the Sierra de Guadarrama (Baquero et al. 2017; Jordana et al. 2020). All these studies document the importance of the MSS biocenosis, demonstrating the enormous potential of this subterranean habitat as a refuge for fauna, and constitute a good tool for the management of natural spaces.

MATERIAL AND METHODS

SITE

The sampling was conducted in the Sierra de Guadarrama National Park, which is in the eastern half of the Central System (i.e., the Iberian Peninsula) and consists of an area of 33 960 hectares, surrounded by a peripheral buffer zone of 62 687.26 hectares (MAPAMA 2017). The mountain range on which the Sierra de Guadarrama National Park is located, is formed by three mountainous axes (Siete Picos, La Mujer Muerta, Montes Carpetanos, and Cuerda Larga and associated mountainous complex) that converge at two mountain passes, those of Navacerrada and Los Cotos (Fig. 1A). The lithology is dominated by the presence of orthogneiss (Valette et al. 1987; PNSG a), a metamorphic rock. In the Sierra de Guadarrama, the fragmentation and accumulation of these rocks originated from glacial (Pedraza & Carrasco 2005) and periglacial events (Sanz 1986). Almost the entire study area has numerous scree slopes that allow the development of the MSS. The climate is Mediterranean, with marked continentality. As a general rule, summers are cool and dry, and winters are cold. However, the diverse topography of the mountains favors a considerable variety of microclimates (PNSG b; Salazar Rincón & Via García 2003; JCL & CAM 2010; Palomo Segovia 2012). The study area is divided into three bioclimatic zones: supra-Mediterranean, oro-Mediterranean and cryo-Mediterranean (Rivas-Martínez 1984; Rivas-Martínez et al. 1987). The most outstanding char-
Fig. 1.—A, basicography of the Sierra de Guadarrama National Park; B, location of the subterranean sampling devices (SSD) in the Sierra de Guadarrama National Park; C, collection sites of the species collected with the SSDs; D, relative abundance of Entomobryomorpha Börner, 1913 species (excluding Orchesella Templeton, 1835); E, relative abundance by SSDs; F, species richness by SSD. Abbreviations: exx, specimens; spp, species. Species authorships: see Index of species.
acceristics of these bioclimatic zones in the Sierra de Guadarrama and their most conspicuous vegetation are summarized in Ortuño et al. (2019). On the scree slopes, the rupicolous plant and lichen species communities acquire special relevance (JCL & CAM 2010). Also of importance is precipitation in the form of snow, which is more intense in the cryo-Mediterranean plant and lichen species communities acquire special relevance in Ortuño rama and their most conspicuous vegetation are summarized characteristics of these bioclimatic zones in the Sierra de Guadarrama and their most conspicuous vegetation are summarized in Ortuño et al. (2019). On the scree slopes, the rupicolous plant and lichen species communities acquire special relevance (JCL & CAM 2010). Also of importance is precipitation in the form of snow, which is more intense in the cryo-Mediterranean

<table>
<thead>
<tr>
<th>Mountain areas</th>
<th>Code</th>
<th>Depth</th>
<th>UTM Coordinates</th>
<th>Toponymy/Province</th>
<th>Date of trap installation</th>
<th>Date of trap recovery</th>
<th>Orientation</th>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>30° T 4100 45166</td>
<td>Corrales de la Majada Mingüete/Segovia</td>
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<td>17.IX.2015</td>
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<td>17.IX.2015</td>
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<td>30° T 4166 45159</td>
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<td>22.IX.2015</td>
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<td>22.IX.2015</td>
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<td>22.IX.2015</td>
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<td>22.X.2015</td>
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<tr>
<td>TSP–1</td>
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<td>30° T 4314 45376</td>
<td>Puerto de Navafria/Segovia</td>
<td>24.VI.2015</td>
<td>22.IX.2015</td>
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<td>24.VI.2015</td>
<td>22.IX.2015</td>
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<td>Cuerda Larga and associated mountainous complex</td>
<td>SSD–12</td>
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<td>SSD–16</td>
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<tr>
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<td>SSD–18</td>
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<td>30° T 4193 45164</td>
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<td>SSD–19</td>
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<td>30° T 4211 45168</td>
<td>Cabeza de Hierro Mayor Menor</td>
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<td>06.XI.2015</td>
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<td>SSD–31</td>
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<td>SSD–32</td>
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<td>SSD–33</td>
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<td>30° T 4286 45188</td>
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<td>09.VII.2015</td>
<td>22.X.2015</td>
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</tbody>
</table>

Table 1. — Location of the traps in the mountain areas of the Sierra de Guadarrama. Values: depth: meter; UTM coordinates: 100 × 100 m; altitude: m a.s.l. Abbreviations: SSD, subterranean sampling devices; TSP, traps in a slope, pitfall.
the study instead of “abundance”, as it better characterizes a quantitative community parameter obtained by the capture method, pitfall trapping. It means that more active forms of Collembola tend to be caught in traps, thus covering only a part of the species pool that occupies the MSS.

After the preliminary triage to separate the Collembola Entomobryomorpha from the sampling fauna within the SSDs, some specimens were selected and mounted in Hoyer’s medium for observation under a compound microscope in a phase contrast and DIC. Some specimens were cleared in Nesbitt’s fluid. The remaining samples were stored in 70% ethyl alcohol.

In addition to the simplified formula of Jordana & Baquero (2005) as simplification of the dorsal macrochaetotaxy defined originally by Szepycki (1979), the general color pattern (Kat et al. 2015) and some selected morphological characters (labral papilla shape, claw and empodium form, and mucro shape (Christiansen 1958; Christiansen & Bellinger 1980; Soto-Adames et al. 2008; Jordana 2012) have been used for the identification of the Entomobrya species. The macrochaetotaxy for Pseudosinella follows Gisin & Da Gama (1969), Szepycki (1979), Mateos (2008) and Soto-Adames (2010). The characters defined by Christiansen et al. (1990) for Pseudosinella, and those used in a Delta key by Christiansen in Jordana et al. (2018), were used for identification and descriptions.

ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>a.s.l.</td>
<td>above sea level;</td>
</tr>
<tr>
<td>abd</td>
<td>abdomen or abdominal segment I-VI;</td>
</tr>
<tr>
<td>accp</td>
<td>accessory posterior row sensillum;</td>
</tr>
<tr>
<td>al</td>
<td>anterolateral s-chaeta;</td>
</tr>
<tr>
<td>am</td>
<td>anteromedial s-chaeta;</td>
</tr>
<tr>
<td>ant</td>
<td>antennal or antenna/ae;</td>
</tr>
<tr>
<td>Mc</td>
<td>macrochaeta/ae;</td>
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<td>mcs</td>
<td>microsensillum;</td>
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<td>mic</td>
<td>microchaeta;</td>
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<td>PAO</td>
<td>postantennal organ;</td>
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<td>psp</td>
<td>pseudopore;</td>
</tr>
<tr>
<td>s</td>
<td>sensillum;</td>
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<td>SSD</td>
<td>subterranean sampling devices;</td>
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<tr>
<td>Th</td>
<td>thorax, or thoracic segments II-III;</td>
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<td>UTM</td>
<td>Universal Transverse Mercator coordinate system.</td>
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Institutions

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<td>CAM</td>
<td>Comunidad de Madrid;</td>
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<td>JCL</td>
<td>Junta de Castilla y León;</td>
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<td>MNHN</td>
<td>Muséum national d’Histoire naturelle, Paris;</td>
</tr>
<tr>
<td>MZNA</td>
<td>Museum of Zoology at the University of Navarra, Pamplona.</td>
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GRAPHICS

The spatial distribution, and relative activity of the species were assessed based on samples obtained from the 33 sampling points (Table 1; Figs 1; 2) from the use of 33 SSDs of the MSS.
1 m depth, and four SSDs of 0.5 m that accompanied SSD-1, SSD-2, SSD-3 and SSD-4 (Table 1). The relative activity has been calculated, and expressed in two different ways in order to be able to compare, in percentage terms, the prominence of each of the species under the taxonomic perspective of order (excluding the Orchesella Templeton, 1835 genus, subject of another study: Baquero et al. 2017) (Fig. 1D) and family (Fig. 2).
Each of the 33 sampling points has been analyzed in terms of activity and specific diversity (Fig. 1E, F), and for this purpose, the following correspondence was established: sampling point = SSD (1 m). Data on the presence of a species registered in an SSD (0.5 m) were incorporated in only one case because in the corresponding SSD (1 m) the species did not occur, and given the evidence of presence at the site, it could not be excluded from the calculations of specific diversity.
**RESULTS**

In the total number of samples analyzed, the Entomobryo-morpha taxon (*Orchesella* excluded) accounted for 52.4% of the Collembola captured in the traps. Specimens of 22 species belonging to two families were captured: Isotomidae and Entomobryidae.

**SYSTEMATICS**

<table>
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<th>Class</th>
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<td>Schäffer, 1896</td>
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<td>ANUROPHORINAE</td>
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<td>Schött, 1891</td>
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*Folsomia triestata* Jordana & Ardanaz, 1981

(Fig. 5)

*Folsomia sexoculata* triestata Jordana & Ardanaz, 1981

(Fig. 5)

**MATERIAL EXAMINED. — Spain • 4 ♀, 1 ♂ on slide; SSD-14, slides 07, 08 and 13; Ortuño *et al.* leg.; MZNA.**

**REMARKS**

Until now, the distribution of this species was limited to the Pyrenean and pre-Pyrenean area (Potapov 2001), although it has been found in the Cantabrian Mountains (Santamaria *et al.* 2012). This new record adds a new biotope for the species, also in the mountains, but in the center of the Iberian Peninsula. The diagnostic characteristics are totally coincident with the original: antenna (Fig. 5A), head (Fig. 5B) and general chaetotaxy (Fig. 5C-E). Confirmation of the identity of the specimens found in the Sierra de Guadarrama was performed by comparing them with the type series specimens, and based on the presence of the three special long sensilla of the Abd V, which, in this case, are blunt (Fig. 5C, F), and the sensory chaetotaxy given by Potapov (2001), which is identical (Fig. 5F).

Since Potapov (2001) pointed out that this could be a synonym of *F. triestata* due to the coincidence of the manubrial chaetotaxy (13 chaetae on *F. sexoculata* var. *iberica* Steiner, 1958 and 11-12 *F. triestata*), it would be necessary to study Steiner's material (because at least seven *Folsomia* species have 13 chaetae in the manubrium ventral side).

**Genus Tetracanthella Schött, 1891**

*Tetracanthella orbaicetensis* Cassagnau, 1959


**MATERIAL EXAMINED. — Spain • 1 ♀ on slide; SSD-30, slide 03; Ortuño *et al.* leg.; MZNA.**

**REMARKS**

Species cited so far only in the Atlantic Pyrenees (France and Spain, between 600 and 2350 m), and also in the pre-Pyrenean area of Navarra, usually in beech forests at a certain altitude (400 m) (Deharveng 1987). In this study, it has been found in the Sierra de Guadarrama at an altitude of around 2000 m.

**Tetracanthella proxima** Steiner, 1955

*Tetracanthella proxima* Steiner, 1955: 337.

**MATERIAL EXAMINED. — Spain • 2 specimens; SSD-1, slide 04; Ortuño *et al.* leg.; MZNA • 18 specimens on slide and 158 in ethyl alcohol; SSD-2, slides 01, 02, 05, 07 and 12-14; same data; MZNA • 7 specimens; SSD-6, slides 04, 06 and 09; same data; MZNA • 1 specimen on slide and 27 in ethyl alcohol; SSD-25, slide 07; same data; MZNA • 1 juvenile; SSD-10, slide 05; same data; MZNA • 1 specimen; SSD-11, slide 16; same data; MZNA.**

**REMARKS**

Originally described from the Sierra de Guadarrama (Steiner 1955), according to Deharveng (1987), its distribution extends from the south of the Ebro River (Iberian Peninsula) to the Atlas Mountains in Morocco. Throughout Europe (de Jong *et al.* 2014), it is present from Bulgaria, North Africa, Portugal (mainland), Spain (mainland) and Ukraine. The citations of Cassagnau (1959) and Selga (1966a, 1971) probably refer to the nearby species *T. similis* Deharveng, 1987.
Fig. 5. — *Folsomia trisetata* Jordana & Ardanaz, 1981: A, antenna with detail of two sensilla; B, head chaetotaxy; C, body chaetotaxy (the arrow on segment IV-VI points to a sensillum on posterior side); D, furcula: manubrium and dens, anterior view; E, ♂ genital plate; F, body sensillar pattern. Abbreviations: see Material and methods. Scale bars: A, B, D, E, 0.02 mm; C, 0.05 mm.
Genus *Uzelia* Absolon, 1901

*Uzelia kuehnelti* Cassagnau, 1954

Material examined. — Spain • 1 juvenile; SSD-3, slide 07; Ortuño *et al.* leg.; MZNA • 1 ♀; SSD-4, slide 03; same data; MZNA.

Remark
Originally described in Cádiz (South of the Iberian Peninsula) (Cassagnau 1954), it had already been cited in the Sierra de Guadarrama by Simón (1971).

Subfamily Proisotominae Stach, 1947
Genus *Folsomides* Stach, 1922

*Folsomides portucalensis* da Gama, 1961

Material examined. — Spain • 2 ♀; SSD-7, slides 07 and 10; Ortuño *et al.* leg.; MZNA.

Remark
Only two specimens have appeared and in a single trap. The species seems to have a European distribution (de Jong *et al.* 2014).

Subfamily Isotominae Schäffer, 1896
Genus *Isotomurus* Börner, 1903

Material examined. — Spain • 2 juveniles; SSD-9, slides 07 and 10; Ortuño *et al.* leg.; SSD-29, slide 08; same data; MZNA • 1 juvenile; SSD-32, slide 03; same data; MZNA.

Remarks
By having only juvenile specimens, which appear to belong to the genus *Isotomurus* (fallen bothriotricha have been seen in two of the specimens), a reliable identification has not been possible.

Genus *Parisotoma* Bagnall, 1940

*Parisotoma notabilis* (Schäffer, 1896)

Material examined. — Spain • 1 specimen; SSD-6, slide 09; Ortuño *et al.* leg.; MZNA.

Remarks
Already cited in the Sierra de Guadarrama by Acón (1980). Originally described in Germany (Schäffer 1896), it is considered a Holarctic species (Potapov 2001). In this study, only one specimen has been collected and it therefore appears to be occasional in the MSS.

Subfamily Pachyotominae Potapov, 2001
Genus *Pachyotoma* Bagnall, 1949, sensu Deharveng 1977

*Pachyotoma penalarenensis* Baquero & Jordana n. sp. (Figs 6A; 7; Table 2)

Type material. — Holotype. Spain • ♀; Segovia, Sierra de Guadarrama, Majada Aranguez (Northwest); 30T 4190-45231; 2071 m a.s.l.; 17.XI.2015; Ortuño *et al.* leg.; pitfall SSD (since 20.V.2015); MZNA SSD-8 (slide 16).

Paratypes. Spain • 2 ♀ and 1 ♂; slide 16; same data as for holotype; MZNA • 1 ♂ (subadult) and 1 ♀; slide 02; same data as for holotype; MZNA • 11 juveniles on slide and approximately 500 in ethyl alcohol.
Fig. 6. — *Pachyotoma penalarensis* Baquero & Jordana n. sp.; **A**, head chaetotaxy; **B**, antenna, with detail of organite (**C**); **D**, maxillary palp; **E**, tibiotarsus, claw and empodium of leg 3; **F**, furcula, left — anterior side, right — posterior side; **G**, tenaculum. Scale bars: **A**, **B**, **E**, **F**, 0.02 mm; **D**, **G**, 0.01 mm.
TABLE 2. — Group of characters traditionally used for the identification of the species of the Proisotominae Stach, 1947 s.l., and to establish some of the proposed subfamilies, for the species that share with Pachytoma penalarensis Baquero & Jordana n. sp. (in combination) the 

| Subfamily | species | EYE | PAO PE | CL | ETF | MA | MP | DA | DP | TT | TC | MT |
|-----------|---------|-----|--------|----|-----|----|----|----|----|----|----|----|----|
| Proisotominae | B. excavata | 6 + 6 | e | 1.2-1.5 | 0 | 1 | 0 | U | 1-5 | 12 | 4+4 | 1 | 2 |
| Proisotominae | Cl. africana | 6 + 6 | o | 1.2 | 1 | 1 | U | 1 | 12 | 3+3 | U | 2 |
| Proisotominae | Cl. fatonei | 6 + 6 | e | 1.5-2 | 1 | 0 | 0 | n | 1 | 13-15 | 4+4 | 1 | 2 |
| Proisotominae | Cl. filifera | 6 + 6 | o | 1.5 | 1 | 2 | 0 | U | 2-3 | 16-17 | 4+4 | 1 | 2 |
| Proisotominae | Cl. laticauda | 6 + 6 | o | 2.5-3 | 1 | 2 | 0 | U | 2-3 | 9-15 | 3+3+4 | 1 | 2 |
| Pachytominae | C. cassagnai | 5 + 5 | 6 + 6 | e | 2.0 | 0 | 0 | 0 | 11-11 | 1 | 4 | 4+4 | 1 | 8 |
| Pachytominae | C. linnanii | 6 + 6 | e | 2.0 | 0 | 0 | 0 | 26-30 | 4 | 6 | 4+4 | 1 | 8 |
| Proisotominae | F. centralis | 6 + 6 | e | 1.0 | 0 | 1 | 0 | 22 | 2-3 | 6-7 | 4+4 | 1 | 2 |
| Proisotominae | F. deflexus | 6 + 6 | o | 3 | 0 | 0 | U | U | U | 4+4 | 1 | 2 |
| Proisotominae | F. delamarei | 6 + 6 | e | 2 | 0 | 2 | 0 | 12 | 1 | 3 | 3+3 | 1 | 2 |
| Proisotominae | F. denisi | 6 + 6 | e | 2-3 | 0 | 0 | 0 | 6+6 | 0 | 3 | 3+3 | 1 | 9 |
| Proisotominae | F. deserticolus | 6 + 6 | e | 4 | 0 | 1 | 0 | 16 | 1 | 6 | 3+3 | 1 | 2 |
| Proisotominae | F. nepalicus | 6 + 6 | b | 2 | 0 | 1 | 0 | 12 | 0 | 2 | 3+3 | 1 | 2 |
| Pachytominae | P. pseudopectra | 6 + 6 | e | 1.7 | 0 | 0 | 4 | U | 40 | 30 | 4+4 | 1 | 0 |
| Pachytominae | P. penalarensis Baquero & Jordana n. sp. | 6 + 6 | q | 2.0 | 0 | 0 | 0 | 30 | 4 | 9 | 4+4 | 0 | 2 |
| Proisotominae | Pr. andina | 6 + 6 | e | 1.1 | 0 | 1 | U | 2 | 64 | 10 | 5 | 4+4 | 5 | 4 |
| Proisotominae | Pr. beta | 6 + 6 | b | 1 | 1 | 0 | 3 | U | 23-26 | 8-9 | 4+4 | 2-3 | 3 |
| Proisotominae | Pr. muscicola | 6 + 6 | e | 4 | 0 | 1 | 0 | 12 | 1 | 5 | 5+4 | 1 | 2 |
| Proisotominae | Pr. santosorum | 6 + 6 | q | 2.5-3.0 | 0 | U | 2 | 24-26 | 6 | 5 | 3+3 | 1 | 3 |
| Proisotominae | W. beckeri | 6 + 6 | i | U | 1 | U | 4 | 18 | 2 | 5 | 4+4 | 1 | 2 |

alcohol; slide 13; same data as for holotype; MZNA • 10 specimens in ethyl alcohol; Segovia, Sierra de Guadarrama, Majada Aranguez (Northwest); 30°41’39.45231; 2071 m a.s.l.; 17.XI.2015; Ortuño et al. leg.; pitfall SSD (since 20.V.2015); MNHN.

TYPE LOCALITY. — Spain, Segovia, Sierra de Guadarrama, Majada Aranguez (Northwest); 30°41’39.45231; 2071 m a.s.l.

ETYMOLOGY. — The specific epithet 'penalarensis' refers to the presence of this species in the Peñalara massif, which boosts the highest peak of the Sierra de Guadarrama.

DIAGNOSIS. — Cylindrical dens, macro present and bidentate. PAO with four lobes. Ant III sensory organ with the central sensilla more or less spherical and number of sensilla on tergites at about 10,10/6,6,6,9,7.

DESCRIPTION

Body

Size 0.72-0.80. Color dark blue. Integument granulated without reticulation. 6 + 6 to 8 + 8 eyes (sometimes eyes G and H disappear, but it is possible to see the refringent structures below). PAO with four lobes, two times eye A (Fig. 6A). Antenna as in Figure 6B, C; Ant III sensory organ with the central sensilla more or less spherical; Ant IV with seven sensilla, six dorsoexternal and one dorsointernal. Maxillary outer lobe bifurcated and four subdigital hairs (Fig. 6D). Labral formula 4/5,5,4 (labral chaetae papillated). Labium with four basomedial, three proximal and five basolateral chaetae and, as common for the family, with 16 guard chaetae.

Legs

Tibiotarsi tenent hairs all pointed. Claw without tooth; empodium short with lamella but without terminal filament (Fig. 6E).

Abdomen

Collophore with 5 + 5 (or 6 + 6) laterodistal, and five posterior chaetae. Furca: manubrium with 28-30 posterior and without anterior chaetae; dens with nine posterior (three groups: three basal, two medial and four distal) and four distal anterior chaetae; micro with two poorly developed teeth, and two lamellae (Fig. 6F). Tenaculum with four teeth and without chaeta on corpus (Fig. 6G).

Chaetotaxy

Body chaetae short and without macrochaetae (see Figure 7 for number of rows and axial chaetae). Thoracic medial s-chaetae in front of p-row; abdominal medial s-chaetae in p-row (Abd IV-V with three and four respectively additional ones before p-row); s-chaetae formula (c. 10,10/6,6,6,9,7 for half tergite). Ms-chaetae formula 1,0/0,0,0 (Fig. 7).

ECOLOGY

So far, this species has only been located in the MSS of the northern slope of the Peñalara massif, in SSD-8, installed in the Canchal de la Majada Aranguez (Figs 1A, C; 3A, B). This site is located at altitudes that exceed 2000 m a.s.l., and is part of the
supraforestal strip of the oro-Mediterranean bioclimatic zone. Extensive slopes dominate the landscape with a moderate slope, where there is very little vegetation, highlighting small stands of Juniperus communis alpina (Suter) Celak. (Fig. 3A). Pachyotoma penalarensis Baquero & Jordana n. sp. share their habitat with at least four other Collembola species, of which three are also new (Figs 1F; 3B). As a whole, the syntopy of the five species at this site has provided an average relative activity that does not reach a thousand specimens (Fig. 1E). This species only represents 2% of the total Entomobryomorpha studied in this paper (Fig. 1D), but accounts for 65% of the total Isotomidae collected (Fig. 2A, C).

**REMARKS**

Considering the group of characters for the family, the $6 + 6$ ocelli and a very specific PAO are enough to establish the specimens found as a new species, assigned to the Pachyotominae subfamily due to the absence of anal spines, the presence of furca, fewer than four chaetae in the anterior part of the manubrium, granulation of the body, abundant sensory chaetotaxy, dens with teeth and absence of Mc. The new species really has an extraordinary shape of PAO compared with congeners and Isotomidae as a whole. The characters that are used for the separation of the different genera of the Proisotominae s.l. seem to have a low diagnostic value. It is probable that all this taxonomy is artificial and it will take further work to update definitions of the genera and probably also the subfamilies of all Isotomidae. The description of the specimens of this sampling into a new species according to the number of eyes, PAO and presence or not of the tenent hair on the tibiotarsus can be seen in Table 2, which includes the eye number, PAO shape, PAO/eye ratio, empodial terminal filament presence and shape, anterior manubrium chaetae number, posterior manubrium chaetae number, anterior dens chaetae number, posterior dens chaetae number, tenaculum teeth number, tenaculum chaetae number and mucro teeth number and shape. This table is an example of the absence of differential generic characters for the subfamily Proisotominae s.l.

**Family ORCHESELLIDAE** Börner, 1906

**Subfamily HETEROMURINAE** Absolon & Kseneman, 1942 *sensu* Zhang & Deharveng 2015

**Genus Heteromurus** Wankel, 1860

*Heteromurus major* (Moniez, 1889)

*Podura teres* Linnæus, 1746: 342.

*Podura plumbea* Linnæus, 1761: 473.

*Podura* (Longe) *plumbea* Geoffroy, 1762: 610.

*Podura* (Longe) *violacea* Geoffroy, 1762: 611.

*Heteromurus major* – Börner 1901: 78.

*Heteromurus caeruleus* Börner, 1903: 156.

*Heteromurus melitensis* Stach, 1924: 115.

*Heteromurus mexicanus* Handschin, 1928: 545.

*Lepidocyrtus lundbladi* Agrell, 1939: 5.


**Material examined.** — Spain • 6 specimens; SSD-1 (0.5 m depth), slides 05-07; Ortuño et al. leg.; MZNA • 13 specimens; SSD-1 (1 m depth), slides 06, 09 and 10; same data; MZNA • 8 specimens on slide and 13 in ethyl alcohol; SSD-2 (0.5 m depth), slides 04 and 09; same data; MZNA • 1 specimen on slide and 70 in ethyl alcohol; SSD-2 (1 m depth), slide 17; same data; MZNA • 2 specimens on slide and 28 in ethyl alcohol; SSD-3 (1 m depth), slides 02 and 11; same data; MZNA • 2 specimens on slide and...
Baquero E. et al.

**Table 3.** — Group of species of *Entomobrya* Rondani, 1861 that share with *E. guadarramensis* Jordana & Baquero n. sp. the dorsal macrochaetae formula for tegidites Abd II-III, 2-5/1-2-1: E. airamii Baquero & Jordana, 2018 (Canary Islands, La Gomera, La Palma, Tenerife), *E. dorsalis* Uzel, 1891 (Central and Eastern Europe, Czech Republic), *E. dorsolineata* Jordana & Baquero, 2018 (Canary Islands, Fuerteventura, Gran Canaria, Lanzarote), *E. longisticta* Baijal, 1958, *E. icoae* Jordana & Baquero, 2018 (Canary Islands, Lanzarote), *E. guadarramensis* Jordana & Baquero, 2018 (Sierra de Guadarrama, Spain).

| species                  | H1  | H2  | H3  | H4  | L1  | T1  | T2  | E1  | A1  | A2  | A3  | A4  | A5  | A6  | A7  | A7' | A8  | A8' | A9  | A9' | A10 | M1  | D  |
|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| *E. airamii*              | 3   | 0   | 0   | 2   | 3   | 2   | 4   | 1   | 2   | 45  | 1   | 2   | 1   | 3   | 0   | 2   | 0   | 3   | 0   | 2   | 2   | 2   | 6   |
| *E. dorsalis*             | 2*  | 1*  | 0   | 3*  | 1*  | 4*  | 4*  | 4*  | 8*  | 1   | 2   | 5   | 1   | 2   | 1   | 4*  | 1*  | 5*  | 0   | 3*  | 0   | 4*  | 4*  | 2   | 15  |
| *E. dorsolineata*         | 4*  | 2*  | 0   | 3*  | 1*  | 4*  | 2*  | 4   | 2   | 2   | 5   | 1   | 2   | 1   | 0*  | 1*  | 7*  | 0   | 0*  | 3*  | 3   | 3*  | 15  |
| *E. icoae*               | 3   | 1*  | 0   | 3*  | 2   | 2*  | 4   | 2*  | 2   | 2   | 46  | 1   | 2   | 2   | 0*  | 0   | 4   | 0   | 4*  | 2   | 2   | 2   | 2   | 7   |
| *E. longisticta*          | 4*  | 1*  | 1*  | 2   | 2   | 3   | U   | U   | 1   | 2   | 5   | 1   | 2   | 1   | 0*  | 0   | 4   | 0*  | 3*  | 0   | 2   | 2   | 2   | 9   |
| *E. guadarramensis*       | 3   | 0   | 4   | 2   | 3   | 4   | 2   | 1   | 2(3)| 0   | 5   | 1   | 2   | 1   | 2(7)| 0   | 4   | 2   | 4   | 1   | 2   | 2   | 2   | 2   |

**Remarks**

Present in the south-west part of the palearctic region. In this study, it is present in almost all samples.

**Family Entomobryidae** Schäffer, 1896

**Subfamily Entomobryinae** Schäffer, 1896

*Entomobrya* Jordana & Baquero, 2018

**Entomobrya albocincta** (Templeton, 1835)

*Podura albocincta* Templeton, 1835: 95.

*Degeeria albocincta* – Nicolet 1847: 370.

*Degeeria cincta* – Lubbock 1862: 594.

*Entomobrya albocincta* – Brook 1884: 279.

**Material Examined.** — Spain: 1 specimen on slide and 6 in ethyl alcohol; SSD-14, slide 02; Ortuño et al. leg.; MZNA • 13 specimens in ethyl alcohol; SSD-15; same data; MZNA • 4 specimens in ethyl alcohol; SSD-09; same data; MZNA.

**Type Material.** — Holotype. Spain: ♀; Segovia, Sierra de Guadarrama, Majada Hambrienta (Northeast), 30 T 4185 45229; 1994 m a.s.l.; 17.XI.2015; Ortuño et al. leg.; pitfall SSD (since 2.VI.2015): MZNA SSD-7 (slide 06).

**Paratypes.** Spain: 19 specimens in ethyl alcohol; same data; MZNA as for holotype; Ortuño et al. leg.; MZNA • 4 specimens on slide and 78 in ethyl alcohol; SSD-6, slides 10 and 11; same data; MZNA • 5 specimens on slide and 24 in ethyl alcohol; SSD-8, slides 01 and 05; same data; MZNA • 4 specimens; SSD-10, slide 02; same data; MZNA • 2 specimens on slide and 10 in ethyl alcohol; SSD-8, slides 14 and 15; same data as for holotype; Ortuño et al. leg.; MNHN.

**Type Locality.** — Spain, Segovia, Sierra de Guadarrama, Majada Hambrienta (Northeast); 30 T 4185 45229; 1994 m a.s.l.

**Etymology.** — The specific epithet refers to the presence of this species in the Sierra de Guadarrama.

**Additional Material.** — Spain: 24 specimens on slide and 212 in ethyl alcohol; SSD-1 (0.5 m depth), slides 03–07; Sierra de Guadarrama.
Entomobryomorpha Collembola from Guadarrama MSS (Spain)

Fig. 8. — Habitus and color patterns of some species: **A**, *Entomobrya guadarramensis* Jordana & Baquero n. sp.; **B**, *Entomobrya ledesmai* Jordana & Baquero n. sp.; **C, D**, *Lepidocyrtus labyrinthi* Baquero & Jordana n. sp.; **E**, *Lepidocyrtus pungatori* Baquero & Jordana n. sp.; **F**, *Lepidocyrtus paralignorum* Baquero & Jordana n. sp.; **G**, *Pseudosinella valverdei* Baquero & Jordana n. sp.; **H**, *Pseudosinella gonzaloi* Baquero & Jordana n. sp. Scale bar: 0.25 mm.
Fig. 9. — Entomobrya guadarramensis Jordana & Baquero n. sp.: A, head chaetotaxy; B, maxillary palp and outer maxillary lobes; C, sensory organ of antennal segment III; D, Th II dorsal macrochaetotaxy; E, Abd I-III dorsal macrochaetotaxy; F, Abd IV-V dorsal macrochaetotaxy; G, chaetae from central area of Abd II; H, trochanteral organ; I, claw and empodium; J, tip of furcula showing the nonringed area of dens, mucro and mucronal spine. Abbreviations: see Material and methods. Symbols: ●: Mc; ○, mes; ▲, sensilla. Scale bars: A, D-F, 0.05 mm; B, H-I, 0.02 mm; C, G, J, 0.01 mm.
Body length (excluding antennae): 2.60 mm (n = 10), up to 2.84 mm (holotype 2.66 mm). Ground color white or very pale yellow, with pigment on lateral body, dorsolateral head and vertex, transversal stripes on some posterior tergites, and pale yellow, with pigment on lateral body, dorsolateral head and vertex, transversal stripes on some posterior tergites, and abundant Mc on Abd IV. The unequivocal identification of the species can only be done using the abbreviated formula that, for this species, is: 3-1-0-3-2/2-4/2-5/1-2-1(2)/7-4-2-4-1-2-2 (following Jordana & Baquero 2005).

DIAGNOSIS. — White species, with lateral pigmentation, 2-4 Mc on areas T1-T2 on Th II, 2-5/1-2-1(2) Mc on areas A1-A5 on Abd II-III, and abundant Mc on Abd IV. The unequivocal identification of the species can only be done using the abbreviated formula that, for this species, is: 3-1-0-3-2/2-4/2-5/1-2-1(2)/7-4-2-4-1-2-2 (following Jordana & Baquero 2005).

DESCRIPTION

Size and color
Body length (excluding antennae): 2.60 mm (n = 10), up to 2.84 mm (holotype 2.66 mm). Ground color white or very pale yellow, with pigment on lateral body, dorsolateral head and vertex, transversal stripes on some posterior tergites, and two patches with more or less development and intensity on Abd II-IV (Fig. 8A).

Head
Eight eyes, GH smaller than EF. Antennae length 1.36 mm, 2.08-2.92 times the length of the head (n = 4; the antennae have suffered the sampling method by the time the specimens have been in the polyethylene glycol); Ant IV with simple apical vesicle and pin chaetae present; sensory organ of Ant III with the special rod-like sensilla, and three additional guard sensilla (Fig. 9C); relative length of Ant I/II/III/IV = 1/2.08/1.95/1.89 (n = 3). Prelabral chaetae ciliated. Labral papillae multipinose. Lateral process of labial papilla E 1/3 shorter than the papilla, sometimes and additional mes or Mc above them), area A2 with five Mc, between three and seven (m 3, m 3ep, m 3e, m 3a, m 3ae; sometimes m 3e, m 3eai2; sometimes m 3e, m 3eai2; Abd III with one Mc on area A3 (a 1) and two Mc on A6 (a 2 and a 2a) and A5 (m 3 always present, m 3, sometimes present as Mc, and m 3 − if present– as mes); Abd IV with up to seven Mc on A6 area (A1, A2, B1, B1, B2, B3 and D1), four Mc on A7 area (A2, B2, B3 and E1), four Mc on A8 (A3, A4, B3 and C2) in addition of two unpaired mes (A3 and A4), two Mc on A9 (A3 and B8) in addition to one unpaired mes (A6) and two on A10 (A6 and B9).

ECOLOGY
Species widely distributed in the three mountain ranges (Fig. 1B, C). It is present in the MSS of the three bioclimatic zones and its overwhelming implantation in the subsoil, and the fact that it has never been registered as epigean, suggests that it is a regular inhabitant of this habitat. It was extraordinarily abundant in SSD-27 of the Canchal de Bailanderos (Figs 1B, C; 3C, D), located in the cryo-Mediterranean zone. At this site 1034 specimens of E. guadarramensis Jordana & Baquero n. sp. were collected; thus, almost all of the Entomobryomorpha (1039 not including Orchesella) found from SSD-27 (Fig. 1E) evidence the dominance of this species over the other three species of sympatric Entomobryomorpha (Figs 1F; 3D).

REMARKS
If we consider the dorsal macrochaetotaxy of the abdominal tergites Abd II-III using the simplified formula, 2-5/1-2-1(2), it differs from all the Entomobrya species described except for E. atraigii Baquero & Jordana, 2018, E. dorsalis Uzel, 1891, E. darsolinae Jordana, Schulz & Baquero, 2009, E. icoae Baquero & Jordana, 2018 and E. longisticta Baijal, 1958 (sensus Baquero et al. 2013). The differences among these species and the new species can be seen in Table 3, showing 6, 15, 15, 7 and 9 different chaetotactic characters. Highly abundant species in the MSS of the Sierra de Guadarrama, accounting for 24% of the total Entomobryomorpha studied in this work (Fig. 1D), and 25% of the Entomobryidae (not including Orchesella) (Fig. 2A, B).
The unequivocal identification of the species can only be done using the abbreviated formula that, for this species, is: 3-1-0-2-2/2-4/2-2/1-0-1/0-3-0-102-2.

### Species

<table>
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<th>Species</th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>L1</th>
<th>T1</th>
<th>T2</th>
<th>E1</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
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### Macrochaetotaxy

| Table 4 — Group of species of Entomobrya Rondani, 1861 that share with E. ledesmai Jordana & Baquero n. sp. the dorsal macrochaetae formula for tergites Abd II-III, 2-2/1-0-1: E. katzi Jordana & Baquero n. sp. (USA), E. lawrencei Baquero & Jordana, 2008 (British Isles), E. luquei Jordana & Baquero, 2006 (Spain), E. nicoleti (Lubbock, 1868) (British Isles, Spain, Switzerland, France, Sweden, Germany, Russia, Egypt), E. rubella Latzel, 1918 (Austria) and E. siciliana Jordana, 1986 (Sicilia, Italia). Legend for the headers of the columns: Head: H1, Mc on series sd'-sd'-sd', (An1-An3), total number; H2, Mc on series sd'-sd'-sd'/3m (An4-A7), total number; H3, Mc on series d'(S'd'), total number; H4, Mc on series d'-sd'-sd', (S1-S4-S5), total-l number; H5, Mc on series v1-v2-v3 (Ps2-Ps3-Ps4), total number; L1, labral papilla presence and shape: 1, without; 2, simple, smooth papilla; 3, multispired; 4, a chaetake-like projection. Th1: T1, Mc on series m3-m4 series, total number; 5 if > 6. E1, empodium, shape of external lamella (pe) of leg3: 1, smooth; 2, serrated; 3, with tooth. Abd II: A1, Mc on series a1-a9, total number; A2, Mc on series m1-m6, total number; A3, Mc on series a1-a9, total number; A4, Mc on series above m0, total number; A5, Mc on series m1-m6 series, total number. Abd IV: A6, Mc on series a1-a9, (An4-An5), total number; 9 if > 10. A7, unpaired Mc on series ma0 (A03), total number; A7', Mc on series ma0, (A05), total number; A8, Mc on series m1-m6 (A7, A8), total number; 6 if > 5. A9', Mc on series m1-m6 (A7, A8), total number; 6 if > 5. A10, Mc on series Ps5-Ps5 (A8, A9, A10), total number; 6 if > 5. M1, macro; sub-apical tooth: 1; without; 2, normal; 3, bigger than apical; 4, smaller than apical. Abbreviations and symbols: *, difference for the character with the new species; D, total number of differences between the species and the new species; U, unknown. |
Fig. 10. — Entomobrya ledesmai Jordana & Baquero n. sp.: A, head chaetotaxy; B, sensory organ of antennal segment III; C, labral papillae; D, ThII dorsal macrochaetotaxy; E, AbdIII dorsal macrochaetotaxy; F, AbdIV dorsal macrochaetotaxy; G, chaetae from central area of AbdII; H, tibiotarsus of leg3; I, trochanteral organ. Abbreviations: see Material and methods. Symbols: ●, Mc; ○, mes; ▲, sensilla. Scale bars: A, D-F, 0.05 mm; H-I, 0.02 mm; B, C, G, 0.01 mm.
EcoLoGy

Unlike what was observed with *E. guadarramanensis* Jordana & Baquero n. sp., the high activity values shown by *E. ledesmai* Jordana & Baquero n. sp., do not correspond to wide distribution. It has been found in the MSS of only three sites, located in two mountain ranges (Fig. 1B, C), in the forest strip of the oro-Mediterranean zone and in the cryo-Mediterranean.

Using reasonable interpolation, it is most likely also found in the supraforestal area of the Mediterranean. Almost all of the specimens (4106 of 4109) come from SSD-29, installed in the supraforestal area of the Mediterranean. Almost all of the specimens, we consider this site to be a new species of *Entomobrya* from the USA, denominated *Entomobrya katzi* Jordana & Baquero n. sp., with an abbreviated formula 3-2-0-1-2/3-5/2-2/1-0-1/0-4-0-2-2.

Table 4 shows that the new species differs by multiple characters from the species with which it shares the simplified formula of *Abd II-III*. *Entomobrya ledesmai* Jordana & Baquero n. sp. represented 18% of the total *Entomobryomorpha* studied in this work, (Fig. 1D), and 19% of *Entomobryidae* (not including *Orchesella*) (Fig. 2A, B), i.e., it is the third species in the dominance rank.

**Entomobrya nicoleti** (Lubbock, 1868)

*Degearia nicoleti* Lubbock, 1868: 299.

*Entomobrya multifasciata var. nicoleti* Brook, 1884: 278.

*Entomobrya nicoleti* – Börner 1901: 68.


**Remarks**


Katz et al. (2015) found an *Entomobrya* captured in Chester (USA) and ascribed the specimen to *E. intermedia*. Some specimens of *E. intermedia* from England were studied for the review of the palearctic *Entomobryinae* (specimens from different parts of the United Kingdom sent to Rafael Jordana by Peter Shaw) (Jordana 2012). The coloration of both populations is similar but the macrochaetotaxy is different: H4 (Jordana & Baquero 2005) has three chaetae in the specimens from England, one (sometimes an additional mes) in the American specimen; A2 has four Mc in the English form (m3, m3ep, m3e and m3ei), two in the American form (m3 and m3e); A7 has more Mc in the English form than in the American form; in addition, the labral papillae are smooth in the English specimens and multispinate in the American specimen. Given these differences and the geographical origin of the specimens, we consider *E. intermedia sensu Katz et al. (2015) to be a new species of *Entomobrya* from the USA, denominated *Entomobrya katzi* Jordana & Baquero n. sp., with an abbreviated formula 3-2-0-1-2/3-5/2-2/1-0-1/0-4-0-2-2.

Table 4 shows that the new species differs by multiple characters from the species with which it shares the simplified formula of Abd II-III.

**Entomobrya ledesmai** Jordana & Baquero n. sp. represented 18% of the total *Entomobryomorpha* studied in this work, (Fig. 1D), and 19% of *Entomobryidae* (not including *Orchesella*) (Fig. 2A, B), i.e., it is the third species in the dominance rank.
Material examined. — Spain • 1 specimen; SSD-22, slide 04; Ortuño et al. leg.; deposited at MZNA.

Remarks
This is the first record for Guadarrama.

Family Lepidocyrtidae Wahlgren, 1906
sensu Zang et al. 2015
Subfamily Lepidocyrtinae Wahlgren E, 1906
Genus Lepidocyrtus Bourlet, 1839

*Lepidocyrtus lusitanicus* nigrus Simón-Benito, 2007


Material examined. — Spain • 6 specimens on slide and 12 in ethyl alcohol; SSD-7, slides 07 and 12; Ortuño et al. leg.; MZNA • 1 specimen; SSD-29, slide 08; same data; MZNA.

Remarks
*L. lusitanicus* is present in Portugal, Spain and France. Different types of coloration that have been elevated to the rank of subspecies by different authors (Simón-Benito 2007; Mateos 2008).

The specimens found in this study, based on their coloration, would belong to the subspecies *L. lusitanicus nigrus*, which is cited in Navarra, Zaragoza, Madrid and Pontevedra (Spain).

*Lepidocyrtus labyrinthi* Baquero & Jordana n. sp.
(Figs 8C, D; 11; 12; 13; Table 5)

Type material. — Holotype. Spain • ♀; Segovia, Sierra de Guadarrama, Montes Carpetanos, Majada Aranjuez (Northwest); 30.4190 45231; 2071 m a.s.l.; 17.XI.2015; Ortuño et al. leg.; pitfall SSD (since 2.VI.2015); MZNA SSD-8 (slide 04).

Paratypes. Spain • 5 specimens on slide and 70 in ethyl alcohol; SSD-6, slides 05 and 11; Ortuño et al. leg.; MZNA • 6 specimens;
SSD-7, slide 09; same data; MZNA • 11 specimens on slide and 20 in ethyl alcohol; SSD-9, slide 06; same data; MZNA • 1 specimen; SSD-29, slide 08; same data; MZNA • 10 specimens in ethyl alcohol; SSD-6; same data; MNHN.

Type Locality. — Spain, Segovia, Sierra de Guadarrama, Montes Carpetanos, Majada Aranjuez (Northwest); 30 T 4190 45231; 2071 m a.s.l.

Etymology. — The specific epithet "labyrinthus" (of the labyrinth) refers to the presence of this species in the underground crack network of the mesovoid shallow substratum.

Additional Material. — Sierra de Guadarrama, Segovia; Ortuño et al. leg.; MZNA • 13 specimens; SSD-1 (0.5 m depth), slides 06, 07; same data; MZNA • 9 specimens; SSD-1 (1 m depth), slides 06, 09 and 10; same data; MZNA • 6 specimens; SSD-2 (0.5 m depth), slides 08, 09; same data; MZNA • 2 specimens on slide and 23 in ethyl alcohol; SSD-2 (1 m depth), slide 16; same data; MZNA • 3 specimens; SSD-3 (1 m depth), slide 01; same data; MZNA • 1 specimen; SSD-16, slide 12; same data; MZNA • 1 specimen; SSD-22, slide 06; Madrid; same data; MZNA • 1 specimen; SSD-12, slide 11; same data; MZNA • 3 specimens; SSD-13, slide 05; same data; MZNA • 1 specimen; SSD-15, slide 07; same data; MZNA • 12 specimens on slide and 30 in ethyl alcohol; SSD-23, slide 04; same data; MZNA • 1 specimen; SSD-24, slide 02; same data; MZNA • 1 specimen; SSD-28, slide 04; same data; MZNA • 3 specimens on slide and 26 in ethyl alcohol; SSD-30, slide 04; same data; MZNA.

Diagnosis. — Body violet more or less pigmented, ocular spot black, and antennae and body violet-blue, with darker pigment dorsally, especially on tergites Th II-Abd III and distal part of the head; antennae with distal area pigmented and Ant IV totally pigmented; some specimens with posterior Th III and Abd I paler (Fig. 8C, D). Head Mc Pa5 present; A0, A2 and A3 as Mc, and A2a as mes; postorbital labial row with M1, M2, R*, E, L1 and L2 ciliated Mc (R half to two thirds of M; sometimes M1 absent and usually asymmetric); Th II a little projected overhead, i.e., not pointed completely downward; Th II-III without Mc; Abd II with chaeta a2p present, a3 forward from 'a' sensilla and only m3 as ciliated Mc; Abd IV with four median ciliated Mc (C1, B4-6), three non-fan-shaped ciliated mic behind anterior bothriotrichum and bothriothrichal complex mic D1p present; claw with four internal teeth: two basal and two unpaired; empodium acuminate; manubrial plate with three internal and 5-8 external chaetae.

Description

Size and color

Body length up to 2.00 mm, including head (mean 1.64 mm, n = 17 adults), excluding antennae (holotype: 1.80 mm). Color variable, from pale to dark violet almost whole body except last two abdominal segments and furcula; all specimens maintain transversal bands on Th II-Abd III; blue pigment on vertex of head and ocular patches Ant IV and tip of Ant II-III pigmented. Scales present on Ant I-II, ventral and dorsal head, thorax and abdomen dorsally, coxae I-III and femora-tibiotarsus I-III, dorsally and ventrally on manubrium and only dorsally on dens; manubrium and dens similar in length (0.37 mm, n = 15); non-annulated part of dens three times the length of mucro.

Head

Antennal head ratio 1.58 (n = 6). Ant IV without apical bulb, apical organite and accessory sensilla as in Figure 11B. Ant III sense organ with two curved and expanded sensilla, one of them bigger than the other (Fig. 11C) three spiny guard sensilla, one of them blunt; on Ant II one distal similar but straight to Ant III expanded sensilla; Head Mc Pa5 present, A0, A2 and A3 as ciliated Mc, A2a as mes; t, s and p chaetae present on ocular well (p as mes, bigger than the other), three scales in the area; head dorsal chaetotaxy (Fig. 11A) with 5-8 antennal (An) ciliated Mc basomedian labial fields chaetae smooth. Four prelabral ciliated chaetae; labrum with three rows, 'a' row with four apically ciliated chaetae, 'm' and 'p' with five smooth chaetae (Fig. 11D). Four labral papillae, conical or with a spinelike chaeta. Maxillary palp bifurcated with three smooth appendages (Fig. 11E). Labial papilla (l.p.) E with finger-shaped process not reaching at base of apical appendage (Fig. 11F). Labial row with M1, M2, R*, E, L1 and L2 ciliated.
Mc (R half to two-thirds of M; M sometimes absent and usually asymmetric) (Fig. 11G). Postlabial chaetotaxy with 3 + 1 ciliated central Mc along the groove. 12 + 12 spinelike chaetae on posterior dorsal head.

Thorax chaetotaxy (Fig. 12)
Th II and Th III without Mc; Th II with ‘s’ and ‘ms’ in posterolateral position at level of m row; Th III with two ‘a’ mic before psp, a2, a5, a6, m2 (above psp), m3, m4, p2-p6, and on lateral tergite a mes with the lateral sensilla (sl) interiorly.

Abdomen chaetotaxy (Figs 12; 13)
Abd I with a1 before psp; m1 beside psp; a3, a6, m3, m4, m6 and p5 (with the ‘ms’ near a3). Abd II, mi and ml chaetae present over bothriotrichum (m2); a2p (p) present as smooth...
this study.
seven other species (Figs 1F; 3H) of the group analyzed in
and p4 (q1 and q2) present as smooth mic; ll present
B4/B4-B6 0.60-0.74, n = 3), and 6 lateral Mc (E2-4, F1-3); T5
♂ only one specimen ( Fig. 1E). At this
Orchesella
zone, and accounts for 32% of the 234 Entomobryomorpha
Pedriza (Fig. 3G, H), located in the oro Mediterranean forest
its greatest activity was recorded in SSD-6 of Canchal La

Species widely distributed in the three mountain ranges,
found in the MSS of more than half of the sampling points
(Fig. 1A-C). Although it is present in the three bioclimatic
zones, given the average catch and its frequent occurrence,
it is more common with increasing altitude. Nevertheless,
its greatest activity was recorded in SSD-6 of Canchal La
Pedriza (Fig. 3G, H), located in the oro Mediterranean forest
zone, and accounts for 32% of the 234 Entomobryomorpha
(not including Orchebella) collected there (Fig. 1E). At this
site, L. labyrinthi Baquero & Jordana n. sp. is syntopic with
seven other species (Figs 1F; 3H) of the group analyzed in
this study.

mic; a2 (a) as smooth mic; m3 (B) present as ciliated Mc; ‘as’
over m1 and a3 upside over a2 (two times its length); mse
and p4 (q1 and q2) present as smooth mic; lm and ll present
as pointed ciliated mic over bothriotrichum (a3); ‘as’ between
a2 and m2; m3 as smooth mic; a3 very up; p3 below m1, and
m4 as smooth mic; lm, li, ll and a5 as ciliated pointed mic
surrounding bothriotrichum (a3); im, em and am5 as small
ciliated mic over m3 bothriotrichum; pm6 and p6 as ciliated
Mc with d3 between them; ‘ms’ near p5 as smooth mic; p8p
as ciliated mes; a7, a8, m7, m8, p7 and p8 as smooth mic.
Abd IV with four median mac (C1, B4,6; ratio between C1-
B4/B3-B6 0.60-0.74, n = 3), and 6 lateral Mc (E2-4, F1,3); T5
as mic, D6, T5 and T7 as mes (D3 as Mc in some specimens);
before T2 bothriotrichum, usually, three pointed ciliated mic
(a, m and D1), with a supplementary ‘s’ chaeta present in
only one specimen (♂) and asymmetric (Fig. 13).

Legs
Scales on legs (including all coxae). Trochanteral organ V-
shaped with about 14-19 spine-like chaeta; a spermathecal
opening in the side of…) of Greek origin. This indirectly conveys the idea that it
is a species close to.

Macrochaetotaxy
Reduced formula (from Gisin 1965, 1967a, b): R6R6R6,001/001/014+3/0, paBq1p2, M1M2R*EL1L2 (* ½
to 2/3 of M).

Ecology
Species widely distributed in the three mountain ranges,
found in the MSS of more than half of the sampling points
(Fig. 1A-C). Although it is present in the three bioclimatic
zones, given the average catch and its frequent occurrence,
it is more common with increasing altitude. Nevertheless,
its greatest activity was recorded in SSD-6 of Canchal La
Pedriza (Fig. 3G, H), located in the oro Mediterranean forest
zone, and accounts for 32% of the 234 Entomobryomorpha
(not including Orchebella) collected there (Fig. 1E). At this
site, L. labyrinthi Baquero & Jordana n. sp. is syntopic with
seven other species (Figs 1F; 3H) of the group analyzed in
this study.

REMARKS
Winkler (2016) and Mateos (2011) defined the L. lignorum
group as the species with the formula R6R6R6,001/001/014+3
(with or without cephalic Mc S6, also called Pa3) and scales
on antennae and legs, which currently includes the species:
L. barbulus Mateos 2011, L. instratus Handschin, 1924, L. juliae
Mateos, 2011, L. lignorum (Fabricius, 1775), L. peisonis
Traser & Christian, 1992, L. ruber Schött, 1902, L. tellecheae
Arbea & Jordana, 1990, L. traseri Winkler, 2016, L. uzeli
According to this definition, this new species belongs to this

Lepidocyrtus barbulus is differentiated by the labial formula;
also has a pale color. Lepidocyrtus tellecheae has scales in the
antennal segments I-III, claw with three teeth and row ‘a’ of the
labral series with pointed chaetae. Lepidocyrtus juliae, L. lignorum
and L. violaceus have labial papillae multispinate; L. juliae
also has a characteristic coloration, with only four spots and L. lignorum has no pigments. Lepidocyrtus peisonis has smooth
labial papillae and row ‘a’ of labral chaetae pointed. Lepidocyrtus
traseri has three teeth on the claw and outer lamella of the
empodium smooth. Lepidocyrtus traseri also has the outer
lamella of the empodium smooth, in addition labral chaetae of row ‘a’ are bifurcated. Lepidocyrtus uzeli has the claw with only
two teeth. Lepidocyrtus juliae, L. lignorum, L. traseri and L. violaceus have the row ‘a’ of labral chaetae bifurcated (Table 5).
The wide distribution of L. labrinthus Baquero & Jordana
n. sp. does not correspond to the activity records, since it
represents only 1% of the Entomobryomorpha and Entomo-
byridae, studied in this work, (Figs 1D; 2A, B).

Lepidocyrtus paralignorum
Baquero & Jordana n. sp.
(Figs 8F; 14A-F; 15A-E; 16; Table 5)

urn:lsid:zoobank.org:act:C3480E16-3903-4E20-83C6-807916103607

TYPE MATERIAL. — Holotype. Spain • 9; Madrid, Sierra de Guadarrama, Cuerna Larga and associated mountainous complex, Collado de Peña Vaqueros (Loma de Pandasco); 30°42.27 45170; 2233 m
a.s.l.; 6.XI.2015; Ortuño et al. leg.; pitfall SSD (since 3.VI.2015); MZNA SSD-30 (slide 06).

Paratypes. Spain • 4 specimens on slide and 10 in ethyl alcohol; SSD-12, slide 10; Ortuño et al. leg.; MZNA • 1 ♀ and 2 juveniles on slide and 44 in ethyl alcohol; SSD-28, slide 05; same data; MZNA • 1 ♀ on slide and 50 in ethyl alcohol; SSD-29, slide 07; same data; MZNA • 10 specimens in ethyl alcohol; SSD-29; same data; MHNH.

TYPE LOCALITY. — Spain, Madrid, Sierra de Guadarrama, Cuerna Larga and associated mountainous complex, Collado de Peña Vaqueros (Loma de Pandasco); 30°42.27 45170; 2233 m a.s.l.

ETYMOLOGY. — The specific epithet contains the prefix “para” (outside of…) of Greek origin. This indirectly conveys the idea that it is a species close to L. lignorum.
ADDITIONAL MATERIAL. — Spain • 3 specimens; SSD-1 (0.5 m depth), slide 05; Sierra de Guadarrama, Segovia; Ortuño et al. leg.; MZNA • 3 specimens on slide and 210 in ethyl alcohol; SSD-2 (0.5 m depth), slides 09 and 10; same data; MZNA • 8 ♀ , 5 ♂ and 6 juveniles on slide and 22 in ethyl alcohol; SSD-2 (1 m depth), slides 04, 13 and 22; same data; MZNA • 2 ♀ , 1 ♂ and 5 juveniles; SSD-3 (1 m depth), slides 11 and 13; same data; MZNA • 3 specimens on slide and 29 in ethyl alcohol; SSD-4; 1 m depth; slide 06; same data; MZNA • 1 ♂ subadult and 1 juvenile on slide; SSD-5, slide 07; same data; MZNA • 13 specimens; SSD-6, slides 11 and 12; same data; MZNA • 4 specimens; SSD-7, slide 09; same data; MZNA • 19 ♀ and 3 juveniles on slide and 16 in ethyl alcohol; SSD-8, slide 09; same data; MZNA • 19 ♀ and 5 juveniles on slide and 68 in ethyl alcohol; SSD-11, slide 07; same data; MZNA • 19 ♀ and 3 juveniles on slide and 32 in ethyl alcohol; SSD-17, slide 06; same data; MZNA • 5 ♂ and 2 juveniles on slide and 60 in ethyl alcohol; SSD-18, slides 09 and 10; same data; MZNA • 4 juveniles; SSD-20, slide 06; same data; MZNA • 19 ♀ and 11 juveniles on slide and approximately 1800 in ethyl alcohol; SSD-22, slides 05 and 07; same data; MZNA • 4 specimens on slide and 150 in ethyl alcohol; SSD-25, slide 12; same data; MZNA • 19 ♀ and 3 juveniles on slide and 26 in ethyl alcohol; SSD-26, slide 05; Madrid; same data; MZNA • 3 specimens; SSD-27, slide 05; same data; MZNA • 2♀ and 1 ♂ on slide and 71 in ethyl alcohol; SSD-31, slide 10; same data; MZNA.

DIAGNOSIS. — Body without pigment, except for head vertex, ocular spot and antennae (final part of Ant II, whole Ant II-IV); Ant I-II and legs I-II scaled (except coxa I). Head Mc Pa5 present; A0, A2 and A3 as Mc, A2a as ciliated mes; posterior labial row with M1, M2, R*, E, L1 and L2 ciliated Mc. Th II projecting over head, i.e., pointed downward; Th II-III without Mc; Abd II with chaeta a3p present, a3 very forward from ‘as’ sensilla and only m3 as ciliated Mc; Abd IV with four median mac (C1, B1a), three or four non-fan-shaped ciliated mic behind anterior bothriotrichium and bothriotrichal complex mic D1a present; claw with four internal teeth: two basal and two unpaired; empodium acuminate; manubrial plate with 3 internal and 5-8 external chaetae.

DESCRIPTION

Size and color
Body length up to 2.40 mm including head (mean 1.57 mm, n = 27 adults), excluding antennae (holotype: 2.10 mm). Color white with blue pigment on Ant III-IV and tip of Ant II; blue pigment on vertex of head and ocular patch (Fig. 8F). Scales present on Ant I-II, ventral and dorsal head, thorax and abdomen dorsally, coxae II-III and femora-tibiotarsus I-III, and furcula dorsally and ventrally.

Head
Antennal head ratio 1.5 (n = 4). Ant IV without apical bulb, four types of sensilla (Fig. 14A), and apical organite and accessory sensilla as in Figure 14B; Ant III sense organ with two expanded sensilla, three spiny guard sensilla, s-blunt sens, ciliated and weakly ciliated chaetae (Fig. 14C); on Ant II two distal similar to Ant III expanded sensilla. Head Mc Pa5 present; A0, A2 and A3 as Mc, A2a as ciliated mes; 5-8 antennal (An) ciliated Mc; s, t and p chaetae present on ocular well (p as mes) (Fig. 14D); basomedian labial fields chaetae smooth. Four prelabral ciliated chaetae (only one
Fig. 15. — Lepidocyrtus paralignorum Baquero & Jordana n. sp.: A, Th II dorsal chaetotaxy with detail of the area with the lateral sensilla and microsensilla (B); C, Th III-Abd I dorsal chaetotaxy; D, Abd II-Abd III dorsal chaetotaxy; E, Abd V dorsal chaetotaxy. Abbreviations: see Material and methods. Symbols: ●, Mc; ○, mes; ◇, pseudopores; ◼, bothriotricha. Scale bar: 0.02 mm.
Fig. 16. — Lepidocyrtus paralignorum Baquero & Jordana n. sp., Abd IV dorsal chaetotaxy. Symbols: ●, ciliated Mc, size proportional to reality; ○, mes; □, pseudopores; ▲, bothriotricha; ▲, accessory chaetae. Abbreviations: see Material and methods. Scale bar: 0.05 mm.
species among 42 observed has smooth prelabral chaetae); labrum with three rows, ‘a’ row with four bifurcate chaetae, ‘m’ and ‘p’ with five smooth chaetae. Four labral papillae, mono to three spinulated (small projection, not a relatively large chaeta-like projection). Maxillary palp bifurcated with three smooth appendages. Labial papilla (l.p.) E with finger-shaped process not reaching base of apical appendage. Labial row with M1, M2, R+, E, L1 and L2 ciliated Mc (R half to two thirds of M; sometimes M1a or M1p present and usually asymmetric). Postlabial chaetaotaxy with 3 + 1 ciliated central Mc along the groove.

Thorax chaetaotaxy (Fig. 15A, B)
Th II and Th III without Mc; Th II with s and m5 in postero-lateral position at level of m row; Th III with a1 before psp, a3, a4, a5, m2, m4, m5 and m6; p2, p3, p4, p5 and p6, two lateral mes with the lateral sensilla (s) between them, and four Mc in front of the sensilla.

Abdomen chaetaotaxy (Figs 15C-E; 16)
Abd I with a1 before psp, and a2; a5 as m2, m3, m4, m5 and m6; p5 and p6, a sensilla in front of p5 and m6, and three lateral mes. Abd II, mi and ml chaetae present over bothriotrichum (m2); a2p (p) present as smooth mic; a3 (a) as smooth mic; m1 (B) present as Mc; ‘as’ over m1 and a3 very up; m3, and p4 (q1 and q2) present as slightly ciliated mic; li, lm and ll present as pointed ciliated mic over bothriotrichum (a2); a6, m6 and p6, as smooth mic; m4 as slightly ciliated mic; m2 as Mc. Abd III, mi, ml and a2 as pointed ciliated mic over bothriotrichum (m2); m1 and m4 as slightly ciliated pointed mic; ‘as’ before m3; a3 very up; p3 below m3 as smooth mic; lm, li, ll and a6 as ciliated pointed mic surrounded bothriotrichum (a3); im and em as small ciliated mic under a5 bothriotrichum; am6 as ciliated pointed mic over bothriotrichum (m2); pm6, and p6 as ciliated Mc with d1 between them; ‘ms’ near p3 smooth mic; m7, and psp as ciliated mes; m8, p7 and p8 as smooth Mc. Abd IV with four median mac (C1, B4-6; ratio between C1-B4/B4-over bothriotrichum (m5); four median mac (C1, B4-6; ratio between C1-B4/B4-over bothriotrichum (m5); four median mac (C1, B4-6; ratio between C1-B4/B4-reciprocally). Abd V as two thirds of M; sometimes M1a or M1p present and usually asymmetric. Tepigynium, Abd III, m6, im and ‘as’ before m3; a3 very up; p3 below m3 as smooth Mc; pm6 and p6 as ciliated pointed mic over bothriotrichum. Furcula: manubrium and dens with scales dorsally and ventrally; manubrial plate (dorsally) with seven external (between 5 and 12, n = 36), three (exceptionally two) internal ciliate Mc, and 2 psp. Non-ringed part of dens two times the length of micro, with subapical tooth a little smaller than the apical tooth. (Fig. 14F).

ECOLOGY
Species widely distributed in the three mountain ranges (Fig. 1A-C), and present in the three bioclimatic zones. Only surpassed in distribution by E. guadarramensis Jordana & Baquero n. sp., and almost at the same time as H. major. From an altitudinal perspective, the average of collections per bioclimatic zone shows that the activity of L. paralignorum Baquero & Jordana n. sp. increases with altitude. However, this is due to the bias provided by two sampling points: 1812 specimens (SSD-22) and 3708 specimens (SSD-30), respectively, for this new species. La Loma de Pandasco (SSD-30), in the cryo-Mediterranean zone, is one of the places with the most extreme environmental conditions (Fig. 4A, B). At this site L. paralignorum Baquero & Jordana n. sp. represents 99% of the total collected specimens (Fig. 1E), being syntopic with other four Entomobryomorpha species (excluding Orchesella) (Fig. 1F; 4B) that were poorly represented.

REMARKS
Lepidocyrtus paralignorum belongs to the L. lignorum group as the previous species. With regard to the shape of the labral papillae, it is separated from L. poenonis and L. ruber by smooth papillae, and from L. traseri, L. tellecheae and L. uzelli because they have a chaeta-like projection. Lepidocyrtus barbulus is separated from the remaining species by having the labral chaetae of row ‘a’ pointed instead of bifurcated, and, in addition to the chaetae, M1, M2 and R are duplicated or triplicated, something not found in any other species of the group. Lepidocyrtus instratus and L. violaceus have only three teeth on the inner border of the claw (the last unpaired tooth missing). Lepidocyrtus juliae has a particular color pattern, with four dorsal spots on Abd II and Abd IV; it also has intraocular ‘q’ chaeta, and four scales in the area: Lepidocyrtus juliae does not have the chaeta d4 in Abd III, and does not have ml in Abd II. Lepidocyrtus lignorum has all chaetae or bothriotricha fan-shaped and external lamella of empodium smooth. See Table 5.

It is the most abundant species, with capture records that account for 29% of the Entomobryomorpha studied here (Fig. 1D), and 30% of the Entomobryidae (not including Orchesella) (Fig. 2A, B).
**Lepidocyrtus purgatori** Baquero & Jordana n. sp.  
(Figs 8E; 17; 18; 19)

**Type Material.** — **Holotype.** Spain • 9; Madrid, Sierra de Guadarrama, Cuerda Larga and associated mountainous complex, El Purgatorio; 30T 4274 45224; 1406 m a.s.l.; 5.X.2015; Ortuño et al. leg.; pitfall SSD (since 18.VI.2015); MZNA SSD-14 (slide 04).  
**Paratypes.** Spain • 5 specimens on slide and 11 in ethyl alcohol; same data as for holotype, slide 08; Ortuño et al. leg.; MZNA • 5 specimens in ethyl alcohol; SSD-29; same data as for holotype; MNHN.

**Type Locality.** — Spain, Madrid, Sierra de Guadarrama, Cuerda Larga and associated mountainous complex, El Purgatorio; 30T 4274 45224; 1406 m a.s.l.

**Etymology.** — The specific epithet “purgatorium” (purgatory), refers to the presence of this species in a beautiful place from the Sierra de Guadarrama, known as ‘Cascada de El Purgatorio’.

**Diagnosis.** — Body pale violet-blue, ocular spot black, antennae partially bluish from distal part of Ant I to tip, dorsal head slightly pigmented, Th II-Abd III with bluish bands (darker on Abd II-III), and an oval spot with a pale interior area on lateral Abd IV. Head: A₀, A₂, A₃, M₁, S₃ and Pa₃ as Mc; A₁₈ as mes; basomedian labial
Baquero E. et al.

fields chaetae smooth; posterior labial row with M2, R*, E, L1 and L2 ciliated Mc (*R half to two thirds of M); one ciliated and two smooth postlabial Mc. Th II a little projected over head, i.e., not pointed completely downward, and with one Mc; Th III without Mc; Abd II without chaeta a2p, a2 and m3 as ciliated Mc; Abd IV with four median Mc (C1, B4-6), three non-fan-shaped ciliated mic behind anterior bothriotrichum and bothriothrichal complex mic D1 present; claw with four internal teeth: two basal and two unpaired; empodium acuminate; manubrial plate with 2 internal and 0-3 external chaetae.

**Description**

**Body**

Body length up to 1.25 mm (holotype), head included (mean 1.05 mm, n = 6 adults), excluding antennae. Body pale violet blue, ocular spot black, antennae partially bluish from distal part of Ant I to tip, dorsal head slightly pigmented, Th II-Abd III with bluish bands (darker on Abd II-III), and an oval spot with a pale interior area on lateral Abd V (Fig. 8E). Scales absent on antennae, present on coxa, ventral and lateral manubrium, ventral dens, thorax, and abdomen; manubrium and dens similar in length (0.27 mm, n = 5); not annulated part of dens 4-5 times the length of mucro. Microchaetae on body with a particular aspect (Fig. 17).

**Head**

Antennal head ratio 2.40 (n = 5). Ant IV with simple apical bulb, apical organite not capitate and accessory sensilla as in Figure 17A; Ant III sense organ with two curved and expanded sensilla (Fig. 17B) three spiny guard sensilla, one of them blunt. Four prelabral chaetae, lateral ciliated and central bifurcated and ciliated; labrum with three rows, ‘a’ row with four apically bifurcated chaetae, ‘m’ and ‘p’ with five smooth chaetae (Fig. 17C). Four labral papillae not visible or absent. Maxillary palp bifurcate with three smooth appendages. Labial papilla (l.p.) E as in Figure 17D with finger-shaped process reaching toward base of apical appendage. Labial row with M2, R*, E, L1 and L2 ciliated Mc (R half to two thirds of M). Postlabial chaetotaxy with one ciliated and two smooth central Mc along the groove (Fig. 17F). Head dorsal chaetotaxy with four antennal (An) ciliated Mc. A0, A2, A3, S3 and Pa5 as Mc; R1s (A2a) as mes; 4-5 Mc on series An (Fig. 17E); interocular chaetotaxy not seen.

**Thorax chaetotaxy** (Fig. 18)

Th II with one Mc (p3), with ‘s’ and ‘ms’ in posterolateral position at level of m row; a2, a3, m1, m2-m6, p3-p1 (Mc), p2-p6 (p6 more spiniform); Th III without Mc, with two mic before psp (a2 and p1), and a3-a4, m2 (near psp), m2-m6, p2-p6 an ‘al’ sensilla near a mes up to m6 (Fig. 18).

**Abdomen chaetotaxy** (Figs 18, 19)

Abd I with a1 before psp; a2-a3, a5-a6 (‘ms’ near and external to a2); m1 (next to psp), m2-m6; p5-p6. Abd II, mi and ml chaetae present over bothriotrichum (m3); a3p (p) absent; a2 (a) and m1 (B) present as ciliated Mc; ‘as’ over m1 and a3 upside over a2 (1.5 times the length of as); m3e and p4 (q1 and q2) present as smooth mic; lm ii present as pointed ciliated chaetae.
mic over bothriotrichium (a₂); a₆, m₄, m₆ and p₅ as smooth mic; m₄ as a very big ciliated Mc. Abd III, mi, ml and a₂ as pointed ciliated mic over bothriotrichium (m₂); 'as' between a₂ and m₃, next to m₃; m₃ as ciliated mic; a₃, m₃ and p₃ equi-
distant; p₃ below m₃ and m₄ as mes; lm, ll and a₆ apparently as ciliated mic surrounding bothriotrichium (a₆); im, em and am₆ as small ciliated mic over m₅ bothriotrichium; pm₆ and p₆ as very long and pointed ciliated Mc; d₃ absent; 'ms' near p₅ as smooth mic; m₈ as ciliated mes; m₇ and p₇ as smooth mic. Abd IV with four median mac (C₁, B₄-₆; ratio between C₁-B₄/B₄-B₆ 0.46, n = 5), and 7 lateral mac (D₃, E₁-₄, F₂-₃; E₂ missing in a ♂); T₅ as mic, T₆ and T₇ as mes; before T₂ bothriotrichum, usually, there are three pointed ciliated mic (a, m and D₁) (Fig. 19).

Fig. 19. — Lepidocyrtus purgatori Baquero & Jordana n. sp., A, Abd IV dorsal chaetotaxy; B-E, detail of some chaetae of Abd III and IV: B, bothriotrichum lateral of Abd III; C, T₆ chaeta of Abd IV, D, M₃ chaeta, lateral, of Abd III; E, B₄ chaeta of Abd IV. Abbreviations: see Material and methods. Symbols: ●, Mc; ○, mes; ⊗, pseudopores; ⦰, bothriotricha; ▲, special chaetae. Scale bars: 0.05 mm for tergite, 0.02 mm for chaetae.
Log
Scales only on coxae, not on rest of appendage. Trochan-teral organ V-shaped with about 7 spine-like chaetae (n = 5) (Fig. 17G). Claw with four teeth on inner edge: basal pair at 50%, a unpaired median at 65% (highly developed), and one minute unpaired subapical; two big lateral teeth intermedial to base and paired, and dorsal at level of lateral. Empodium acuminate, 0.66 times the length of claw, with pe lamella serrated and other lamellae smooth (ae, ai, pi). Tibiotarsus III distally with one inner smooth chaeta reaching the tip of empodium and same size than claw; tenent hair spatulated, smooth, similar in size than claw (Fig. 17H).

Furcula
Manubrium with scales dorsally and laterally; dens with scales only dorsally; manubrium and dens similar in length; manubrial plate (dorsally) with between 1-2 (n = 3) internal chaetae, 0-3 external ciliate Mc, and 2 psp. Non-ringed area of dens 4-5 times the length of micro (0.015 mm) (Fig. 17I).

Macrochaetotaxy
Reduced formula (from Gisin 1965, 1967a, b); Rq1Rq2Rq3110/10201+3/0, ABq1q2, M2R*EL1L2 (* ½ to 2/3 of M).  

Ecology
Species only found in the MSS of the site of El Purgatorio (Fig. 1A, C). The sampling point (SSD-14) is at the lower limit of the supra-Mediterranean bioclimatic zone and is located in the ‘Garganta del Arroyo Aguillón’ near large rocky walls (Fig. 4C, D). In these escarpments, the pine forest (Pinus sylvestris) loses distribution and gives way to Pinus sylvestris, Quercus pyrenaica, Acer monspessulanus, Sorbus aucuparia and Rhamnus frangula. Lepidocyrtus purgatori Baquero & Jordana n. sp. is syntopic with five other species (Figs 1F; 4D), three of which outnumber its activity (L. guadarramensis Jordana & Baquero n. sp., 180 specimens; H. major, 93 specimens; and L. tellecheae, 183 specimens).

Remarks
This species does not share the reduced formula of Gisin (1965, 1967a, b) with any other species (R1111/10201+3/0, ABq1q2). The closest species belong to the L. lusitanicus group with a characteristic three Mc on Abd II, but are different in many other characters: prelabral chaetae, absence of labral papillae, length of the antennae and, in the case of L. lusitanicus, the color pattern.
**Genus** *Pseudosinella* Schäffer, 1897

*Pseudosinella valverdei* Baquero & Jordana n. sp.  
(Figs 8G; 20; 21; 22; Table 6)

**Type Material.** — **Holotype.** Spain • 9; Madrid, Sierra de Guadarrama, Montes Carpetanos, Hoya de la Laguna Grande (east); 30T 4191 45213; 2049 m a.s.l.; 5.X.2015; Ortuño et al. leg.; pitfall SSD (since 3.VI.2015); MZNA SSD-10 (slide 06).

**Paratypes.** Spain • 10 specimens on slide and 15 in ethyl alcohol; same data as for holotype, slides 06 and 07; Ortuño et al. leg.; MZNA • 5 specimens on slide and 40 in ethyl alcohol; SSD-6, slides 03 and 11; same data; MZNA • 5 specimens in ethyl alcohol; SSD-6; same data; MNHN.

**Type Locality.** — Spain, Madrid, Sierra de Guadarrama, Montes Carpetanos, Hoya de la Laguna Grande (east); 30T 4191 45213; 2049 m a.s.l.

**Diagnosis.** — Body with blue pigment, including antennae and first leg segments. Head with 5 + 5 eyes (A-E); A3, A7 and A9 as Mc, A2 absent; basomedian labial fields chaetate smooth; posterior labial row with M1, M2, M2*, e, l1 and l2 Mc (R half to two-thirds of M; sometimes M1 and l2 ciliated, and usually asymmetric); three plus one anterior postlabial chaetae as ciliate Mc. Th II-III without Mc; Abd II with chaeta a3p present, a3 forward from ‘as’ sensilla; a2 as mes.

**Etymology.** — This species is dedicated to the biologist Alberto Jiménez-Valverde, member of the research team of this project and active participant in the sampling of the mesovoid shallow substratum.

**Additional Material.** — Spain • 2 juveniles; SSD-1 (0.5 m depth), slides 05 and 06; Sierra de Guadarrama, Segovia; Ortuño et al. leg.; MZNA • 2 specimens; SSD-2 (0.5 m depth), slide 09; same data; MZNA • 8 specimens on slide and 393 in ethyl alcohol; SSD-2 (1 m depth), slides 05, 06 and 08; same data; MZNA • 2 juveniles on slide and 56 in ethyl alcohol; SSD-16, slide 07; same data; MZNA • 1 juvenile; SSD-18, slide 07; same data; MZNA • 1 juvenile; SSD-25, slide 06; Madrid; same data; MZNA • 10 specimens on slide and 389 in ethyl alcohol; SSD-21, slides 03 and 05; same data; MZNA • 7 juveniles on slide and 389 in ethyl alcohol; SSD-21, slides 03 and 05; same data; MZNA.

**Fig. 20.** — *Pseudosinella valverdei* Baquero & Jordana n. sp.: A, organite and accessory sensillum on Ant IV; B, head chaetotaxy; C, hind part of labium and postlabial area; D, manubrial plate chaetae and pseudopores; E, claw and empodium of leg 3; F, tip of dens, mucro and mucronal spine. Abbreviations: see Material and methods. Symbols: ●, Mc; ○, mes or small/doubtful Mc; ⦰, pseudopores. Scale bars: A, D, 0.01 mm; C, E, F, 0.02 mm; B, 0.05 mm.
or short Mc, and m3 as ciliated Mc; Abd IV with three median mac (C1, B5-6), four ciliated mic behind anterior bothriotrichum and bothriothrichal complex mic D1p present; claw with four internal teeth: two basal and two unpaired (the last one sometimes almost imperceptible); empodium acuminate; manubrial plate with three internal and 10-13 external chaetae.

**Description**

**Body**

Body length up to 2.40 mm, head included (mean 2.05 mm, n = 11 adults), excluding antennae (holotype: 2.05 mm). Color blue dark, especially on Ant I-IV (except tip of IV), anterior part of the head, and posterior area of the tergites Th II-Abd VI), coxae, and basal manubrium; Th II darker in front area (Fig. 8G). Scales absent on antennae and legs, present on ventral and dorsal head, thorax and abdomen dorsally, and furcula only ventrally.

**Head**

Antennal head ratio 1.65 (n = 6). Ant III sense organ with two rod-shaped sensilla (individually encased in a pit), three spiny guard sensilla, s-blunt sens, ciliated and weakly ciliated chaetae; on Ant II 2-3 distal similar to Ant III sensilla; Ant IV without apical bulb, apical organite and accessory sensilla as in Figure 20A.

**Thorax chaetotaxy (Fig. 21)**

Th II and Th III without Mc; Th II with s and ms in anterolateral position; Th III with a1 before psp, a3, a4, a6, m2, m4, m6, and m7; p2, P3, P4, P5, and P6, two lateral mes with the lateral sensilla (s) between them, and four Mc in front of the sensilla.

**Abdomen chaetotaxy (Figs 21; 22)**

Abd I with a1, a3 and p1 before psp; a3, a4, a6, m2, m4-m6; p1-p6, a sensilla in front of m6, and some lateral mes. Abd II, mi and ml chaetae present over bothriotrichum (m3) (sometimes an additional mic between ml and a3); a3p (p) present as slightly ciliated mic; a2 (A) as small Mc or mes, but not mic; m1 (B) present as Mc; ‘as’ over m3 and a2. Abd III, m1, m2 and m3 as slightly broadened at tip ciliated mic over bothriotrichum (a3); m4 as slightly ciliated chaeta; m3 as mes; a6 (smooth), a7, a8, m6, p5-p8 (slightly ciliated) as mic; Abd IV, mi, ml and a2 as slightly broadened ciliated mic over bothriotrichum (m3); ‘as’ before m3 that is apparently smooth; a3, m4 and p3 as slightly ciliated pointed mic; a3 very up; im, li, lm and a6 as ciliated pointed mic surrounding bothriotrichum (a3); em, am6, and a3 as small ciliated mic under a3 bothriotrichum (sometimes an additional mic near a3); pm6 and p5 as Mc with d1 between them (d3 not always present, and duplicated in one specimen); ‘ms’ (d4) near p5 as smooth mic; m3g and p9 as mes; m4-m9, p7 and p8 smooth mic. Abd IV with three median mac (C1, B5-6; ratio between C1-B5/B5-6 1.00, n = 9), and 7 lateral mac (D3, E2-4, F1-3; T5 as mic, D2, D3, E4, F5, T6 and T7 as mes; before T2 bothriotrichum four ciliated mic (a, m, s and D1) as in Figure 22; p1 and pe as ciliated fan-shape mic.

**Legs**

Legs without scales. Trochanteral organ with near 40 spine-like chaetae. Claw with four teeth on inner edge: basal pair at 40% and 50% with respect to the internal claw edge length, respectively, first unpaired median at 70%, and one minute (sometimes imperceptible) unpaired subapical at 90%; two lateral teeth at 20%, and one more basal dorsal tooth. Empodium acuminate, all with non-serrated pe lamella (but with a small tooth on first third of all legs, and a minute serration.
Fig. 22. — *Pseudosinella valverdei* Baquero & Jordana n. sp., AbdIV dorsal macrochaetotaxy and detail of chaetotaxy lateral to anterior mac C1. Abbreviations: see Material and methods. Symbols: ●, Mc; ○, mes; ◆, pseudopores; ▲, bothriotricha; ▲, special chaetae. Scale bars: 0.05 mm for whole tergite, 0.025 mm for detail.
on legs 1 and 2), other lamellae smooth (ae, ai, pi); claw: empodium ratio = 1:0.65. Tibiotarsus III distally with one inner smooth chaeta 0.50 longer than claw; tent hair capitate, smooth, and 0.90 shorter than claw (Fig. 20E).

**Furcula**

Manubrium and dens with scales only ventrally, and with the same length; manubrial plate (dorsally) with three internal, approximately thirteen external ciliated Mc, and 2 psp (Fig. 20D). Non-ringed area of dens 2-3.5 times the length of micro, with subapical tooth a little smaller than apical tooth (Fig. 20F).

**Macrochaetotaxy**

Reduced formula (from Gisin 1965, 1967a, b): R2R1R3000/00/0201+2/s, pABq1q2, M1M2R*el1l2 (*1/2 to 3/5 of M; sometimes M3 and L2 ciliated, and usually asymmetric).

**Ecology**

Species widely distributed in MSS of Montes Carpetanos and Siete Picos-La Mujer Muerta, not detected in Cuerda Larga (Fig. 1A-C). According to the available data (presence and activity), it appears to show a preference for the subsoil of the oro-Mediterranean zone, with dominance in the forest strip. Its presence in the cryo-Mediterranean zone has not been verified and the upper level of this species is 2049 m a.s.l., which corresponds to SSD-10 installed in the Canchal Hoya de la Laguna Grande (supraforestal strip of the oro-Mediterranean zone). Its greatest activity was recorded in SSD-11 in the Canchal Cerro Ventoso (Fig. 4E, F), exceeding 1000 specimens, with subapical tooth a thousand specimens (more than half of the Entomobryomorpha (excluding Pinus sylvestris) and SSD-16, slide 08; Sierra de Guadarrama, Segovia; Ortúñ o et al. leg.; MZNA • 4 fig. 1, 6 and 19 in ethyl alcohol; SSD-25, slides 05, 06; same data; MZNA • 2 juveniles; SSD-26, slide 09; same data; MZNA.

**Diagnosis.** — Body with blue pigment, including antennae and first leg segments, as in Figure 8H. Head with 6+6 eyes (A-F); Mc A0, A1, and A2 present, A1 present; t and p chaetae present (p as Mc); basomedian labial fields chaetae smooth; posterior labial row with M1, M2, R+, E, L1 and L2 Mc (R half to two thirds of M); two or three anterior postlabial chaetae as ciliated Mc. Th II-III without Mc; Abd II with chaeta a2p present, a3 forward from 'a's' sensilla; a2 as mes or short Mc, and m3 as ciliated Mc; Abd IV with three median mac (C1, B3, 3). Four ciliated (some fan-shaped) mic behind anterior bothriotrichum and bothriotrichal complex mic D1 present; claw with four internal teeth; two basal and two unpaired; empodium acuminate; manubrial plate with 3 internal and 6-9 external chaetae.

**Description**

**Body**

Body length up to 1.80 mm, head included (mean 1.55 mm, n = 8 adults), excluding antennae (holotype: 1.40 mm). Color blue dark, especially on Ant I-IV, head vertex, and posterior area of the tergites Abd I-Abd VI, coxae, dorsal and basal manubrium; Th II darker at front area. Scales absent on antennae and legs, present on ventral and dorsal head, thorax and abdomen dorsally, and furcula only ventrally.

**Head**

Antennal head ratio 1.60 (n = 2). Ant IV without apical bulb, apical organite and accessory sensilla present (Fig. 23A); three types of sensilla on Ant IV-II (Fig. 23B). Ant III sense organ with two rod-shaped sensilla, three spiny guard sensilla, s-blunt sens, ciliated and weakly ciliated chaetae; 6 + 6 eyes (A-F). Head dorsal chaetotaxy with 10-12 antennal (An) ciliated Mc (Fig. 23D). 4/554 prelabral and labral chaetae: prelabral ciliated, labral row ‘a’ ciliated only on the final part, and rows ‘m’ and ‘p’ smooth. Labral papillae absent. Maxillary palp bifurcated with three smooth sublobal chaetae. Labial papilla (l.p.) E with finger-shaped process not reaching the base of apical appendage. Labial row with M1, M2, R+, E, L1 and L2 Mc (R half to two thirds of M). Postlabial chaetotaxy with 2-3 ciliated central Mc along the groove (Fig. 23C).

**Type material.** — **Holotype.** Spain • ♀; Segovia, Sierra de Guadarrama, Siete Picos-La Mujer Muerta, Umbria de la Mujer Muerta (North); 30T 4068 45192; 1622 m a.s.l.; 17.XI. 2015; Ortúñ o et al. leg.; pitfall SSD (since 21.V.2015); MZNA SSD-3 (slide 01).

**Paratypes.** Spain • 1 ♀; same data as for holotype, slide 01; Ortúñ o et al. leg.; MZNA • 6 juveniles; SSD-2, slide 04; same data; MZNA • 1 ♀ on slide and 257 in ethyl alcohol; SSD-11, slide 05; same data; MZNA • 10 specimens in ethyl alcohol; SSD-11; same data; MNHN.

**Type locality.** — Spain, Segovia, Sierra de Guadarrama, Siete Picos-La Mujer Muerta, Umbria de la Mujer Muerta (North); 30T 4068 45192; 1622 m a.s.l.

**Etymology.** — This species is dedicated to the biologist Gonzalo Pérez-Suárez, member of the research team for this project and active participant in the sampling of the mesovoid shallow substratum.

**Additional material.** — Spain • 4 juveniles and 600 (approximately) in ethyl alcohol; SSD-16, slide 08; Sierra de Guadarrama, Segovia; Ortúñ o et al. leg.; MZNA • 4 fig. 1, 6 and 19 in ethyl alcohol; SSD-25, slides 05, 06; same data; MZNA • 2 juveniles; SSD-26, slide 09; same data; MZNA.
Thorax chaetotaxy
Th II and Th III without Mc.

Abdomen chaetotaxy (Figs 24; 25)
Abd II, mi and ml chaetae present over bothriotrichum (m$_3$) (sometimes an additional mic externally to mi); a$_{3p}$ (p) present as slightly ciliated mic; a$_2$ (a) as small Mc or mes, but not mic; m$_3$ (B) present as Mc; ‘as’ over m$_1$, and a$_1$ above a$_2$ and m$_2$; m$_{2s}$ and p$_4$ (q$_1$ and q$_2$) present as slightly ciliated mic; lm and ll present as slightly broadened at tip ciliated mic over bothriotrichum (a$_5$) (additional mic interior to a$_5$ bothriotrichum; m$_4$ as slightly ciliated chaeta; m$_5$ as mes; a$_6$ (smooth), a$_7$-a$_9$, m$_6$, p$_5$-p$_8$ (slightly ciliated) as mic; Abd III, mi, ml and a$_3$ as slightly broadened ciliated over bothriotrichum (m$_3$); a$_3$, m$_1$, m$_4$ and p$_3$ as smooth mic; li, lm and a$_6$ as ciliated mic above bothriotrichum (a$_5$); im and am$_6$ as small ciliated mic under a$_5$ bothriotrichum; pm$_5$ and p$_6$ as Mc with d$_3$ as slightly ciliated mic between them; ‘ms’ (d$_3$) near p$_5$ as smooth mic; m$_{7s}$ and p$_{8p}$, as mes; p$_8$ as small ciliated mic;

Legs
Legs without scales. Trochanteral organ with about 15-20 spine-like chaetae (Fig. 23E). Claw with four teeth on inner edge: basal pair at 60% with respect to the internal claw edge length, respectively, first unpaired median at 75%, and one minute unpaired subapical at 85% and two lateral teeth at 20%, and one more basal dorsal tooth. Empodium acuminate, all with pe lamella serrated, other lamellae smooth (ae, ai, pi); claw : empodium ratio = 1 : 0.65. Tibiotarsus III distally with one inner smooth chaeta 0.50 longer than claw; tenent hairs capitate, smooth, and 0.90 shorter than claw (Fig. 23F).
Furcula
Manubrium and dens with scales only ventrally, and with the same length; manubrial plate (dorsally) with three internal, approximately eight external ciliated Mc, and 2 psp (Fig. 23G). Non-ringed area of dens 3.4 times the length of mucro (2.5-5.33, n = 8), with subapical tooth a little smaller than apical tooth. (Fig. 23H).

Macrochaetotaxy
Reduced formula (from Gisin 1965, 1967a, b): R₀R₁R₀000/00/0201+2/s, pABq₁q₂, M₁M₂R*EL₁L₂ (* ½ to 2/3 of M).

Ecology
Species present in the MSS of the three mountainous ranges (Fig. 1A-C) but only verified from the supra-Mediterranean and oro-Mediterranean bioclimatic zones (in the forest strip), in the latter with records that suggest a more stable population. The largest number of specimens was collected with SSD-16, installed in the Canchal Las Revueltas-Los Horcos (Fig. 4G-H), site with strong influence of the pine forest (Pinus sylvestris), and where P. gonzaloi Baquero & Jordana n. sp. accounted for 67% of the 895 Entomobryomorpha (excluding Orchesella) collected there (Fig. 1E). At this site, where this species is dominant, it is syntopic with four other Entomobryomorpha species (Figs 1F; 4H).

Remarks
The species that share the traditional formula of Gisin (1965, 1967a, b) with this species are, in addition to P. valverdei Baquero & Jordana n. sp., P. styriaca Neuherz & Nosek, 1975 and P. subcentralis. Table 6 shows the differences between these four species.

Of the 22 species of Entomobryomorpha (Orchesella excluded), P. gonzaloi Baquero & Jordana n. sp. is the sixth most abundant, accounting for 4% of the specimens collected (Fig. 1D).
DISCUSSION

Of the eight new species described, seven are among the nine most abundant of a total of 22 species analyzed in this work (Figs 1D; 2). Four of them have been collected in thousands of specimens (L. paradigorum Baquero & Jordana n. sp., E. guadarramensis Jordana & Baquero n. sp., E. ledesmai Jordana & Baquero n. sp., P. valverdei Baquero & Jordana n. sp.), and another three collected in hundreds of specimens (P. gonzaloi Baquero & Jordana n. sp., P. penalarensis Baquero & Jordana n. sp., L. labyrinthi Baquero & Jordana n. sp.). The taxonomic analysis of the captures recorded in the different SSDs reveals that five new species are among the nine most widespread species (Fig. 1B, C). Therefore, if we combine activity and distribution, the result may be surprising, as new species are not rare in the prospected territory. This diversity pattern has already been observed with the new species of Orchesella collected in the MSS of the Sierra de Guadarrama (Baquero et al. 2017). Moreover, the Sierra de Guadarrama is a mountainous area that has long been studied by eminent collembologists (for example, F. Bonet, D. Selga, W. Steiner, J. C. Simon and M. J. Luciáñez) (Luciáñez & Simón 1989). Regarding Orchesella, Baquero et al. (2017) concluded “that this environment has its own assemblage of characteristic species”. All the data indicate that the MSS in the Sierra de Guadarrama contains a wide range of species (of various genera) of Collembola, which are specific or nearly specific to these singular habitats.

Predatory species, particularly of Carabidae, have been found with Collembola regularly and abundantly. Four species stand out for their constancy, activity and distribution in the MSS of the Sierra de Guadarrama (Ortuño et al. 2019): Leistus (Leistus) constrictus Schaufuss, 1862, Nebria (Nebria) vailllefroyi Chaudoir, 1866, Trechus (Trechus) schaufussi pandelinei Putzeys, 1870, and Laemostenus (Eucryptotrichus) pinicola (Graells, 1851). In particular, specialization in hunting both the imago and larva of Collembola has been recognized in L. (L.) constrictus, as well as in other species of the genus. The presence of this species in the MSS, where its larvae are particularly abundant (Ortuño et al. 2019), should be taken into account as a regulator of the Collembola populations in these underground spaces.

The results of this study indicate that the MSS is remarkably heterogeneous in terms of the activity, richness and composition of Entomobryomorpha species (Fig. 1C, E, F). The same is likely to be true of other MSS on the Iberian Peninsula. In the future, new studies to characterize this type of Collembola communities will require the development of extensive sampling protocols.

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