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A new species of the genus *Typhlocharis* Dieck, 1869 (Coleoptera, Carabidae) from Portugal

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Abstract: A new endogean carabid species of the genus *Typhlocharis* Dieck, 1869 from Portugal is described and illustrated: *Typhlocharis mendesi* **sp. n.** The work provides diagnostic characters, the structure of male and female genitalia, discussions on affinities to related taxa, as well as some remarks on its ecology.

Keywords: Taxonomy - species Groups - Iberian Peninsula - Portugal.

INTRODUCTION

Within the Anillini, the genus *Typhlocharis* Dieck, 1869 (Coleoptera: Carabidae: Trechinae) is the most speciose in the Iberian Peninsula, with 63 known species (Serrano & Aguiar, 2014; Zaballos *et al.*, 2016). Ortuño & Gilgado (2011) provided a historical review of the genus. A synthesis on the current knowledge (e.g. updated descriptions, systematics reorganization, antennal morphology and chaetotaxy) and a review of the presence/absence of the last abdominal sternum 'belt', including remarks on its external microsculpture was provided by Serrano & Aguiar (2014).

The aim of this work is to describe a new species of the genus *Typhlocharis* from Portugal and to discuss its taxonomic position within the traditional species groups.

MATERIAL AND METHODS

Fieldwork was conducted in Bucelas region located in the outskirts of Lisbon (Province of Ribatejo), resulting in the collection of specimens of an endogean beetle species of the subtribe Anillina. The specimens were collected by hand under embedded stones. Additional specimens were obtained from samples of soil taken under the embedded stones using Berlese apparatus. After careful study, we concluded that the specimens represent a new species of the genus *Typhlocharis*. Habitat description (soil and vegetation) can be accessed in Serrano & Aguiar (2012).

The morphological study of dried and gold coated adult specimens was conducted using a scanning electron microscope (SEM) JEOL JSM-5200 LV (JEOL Ltd Tokyo, Japan). The chaetotaxy of labrum, clypeus, anterior and posterior margins of pronotum, and posterior margin of last ventrite, follows the nomenclature proposed by Pérez-González & Zaballos (2012). However, we do not follow this nomenclature for the anterior margin of the prosternum due to its constancy and lack of relevance in terms of sexual dimorphism. Nomenclature of antennal features follows Pérez-González & Zaballos (2013a). Measurements were done with a Wild M5 stereoscopic microscope equipped with a dissecting microscope ocular micrometre. The male genitalia was mounted on 100% glycerol, and imaged on a Leica SPE confocal microscope, using a 40x 1.15NA oil-immersion objective. Optical slices were acquired every 0.5 µm. The z-stack was processed and 3D reconstructed using the Amira v5.3 software. The last female ventrite, the spermatheca, and the spermathecal gland were mounted on 100% glycerol and examined with a Zeiss Stereo Lumar V12 stereomicroscope.

Coordinates of localities where specimens were found are indicated in U.T.M. (1 km x 1 km).

Material examined is deposited in the collections with acronyms listed below:

cAS	Coll. Artur Serrano, Faculty of Sciences, Lisboa, Portugal
MHNG	Muséum d'histoire naturelle, Genève, Switzerland

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DOI:

TAXONOMY

Typhlocharis mendesi sp. n.

Figs 1-17

Holotype: cAS; 1 ♂; Portugal, Bucelas (Estremadura Prov.) (UTM: 29SMD9305), 3.III.2011, Serrano & Aguiar leg.

Paratypes: cAS; 3 ♂♂ and 2 ♀♀; same locality and date as holotype. – MHNG; 2 ♂♂ and 2 ♀♀; same locality and date as holotype. – cAS; 4 ♂♂ and 2 ♀♀; Bucelas (Estremadura Prov.) (UTM: 29SMD9305), 22.III.2011. – cAS; 3 ♂♂ and 4 ♀♀; Arruda dos Vinhos (Estremadura Prov.) (UTM: 29SMD9012), 3.III.2011. – cAS; 1 ♂; A. do Mourão (Estremadura Prov.) (UTM: 29SMD9209), 3.III.2011. – cAS; 1 ♀; Bucelas (Estremadura Prov.) (UTM: 29SMD9205), 23.X.2012. – cAS; 5 ♂♂ and 5 ♀♀ (2 ♂♂ and 2 ♀♀ gold coated); Bucelas (Estremadura Prov.) (UTM: 29SMD9305), 7.XII.2012. – MHNG; 1 ♂ and 1 ♀; same locality and date as previous lot. – cAS; 7 ♂♂; 7 ♀♀; Bucelas (Estremadura Prov.) (UTM: 29SMD9305. 1.XI.2013. All Serrano & Aguiar leg.

Diagnosis: Anophthalmous. Body parallel, depressed, brown or brownish-yellow with integument micro-reticulate and scattered pubescence. Antennae moniliforme. Semilunar notch present. Vertex with *pars stridens*. Pronotum rectangular (1.2 times longer than wide). Apical edge of elytra slightly sinuate, without teeth; discal setae arranged in 4 or 5 rows slightly bent anteriad; umbilicate series with six (4+2) marginal setae; abdominal female sternum II and III with lateral fovea; anterior region of the last abdominal sternum in both sexes showing a smooth or scaly and serrate microsculpture ('belt') (Figs 13, 14). Hind trochanters inerm in both sexes (Figs 7-8). Aedeagus (Figs 15, 16) sickle-shaped, basal lamina markedly arcuate, the apex slightly eagle's beak shaped (lateral view); parameres bisetulose. Female genitalia (Fig. 12) with long tubular gonocoxites, each one with a double apical seta and without a lateral seta.

Etymology: This new species is dedicated to our colleague Luís Mendes, eminent Portuguese entomologist, who has been greatly contributing to the taxonomic and faunistic knowledge of the world Zygentoma, Microcoryphia, and Afrotropical Lepidoptera.

Description:

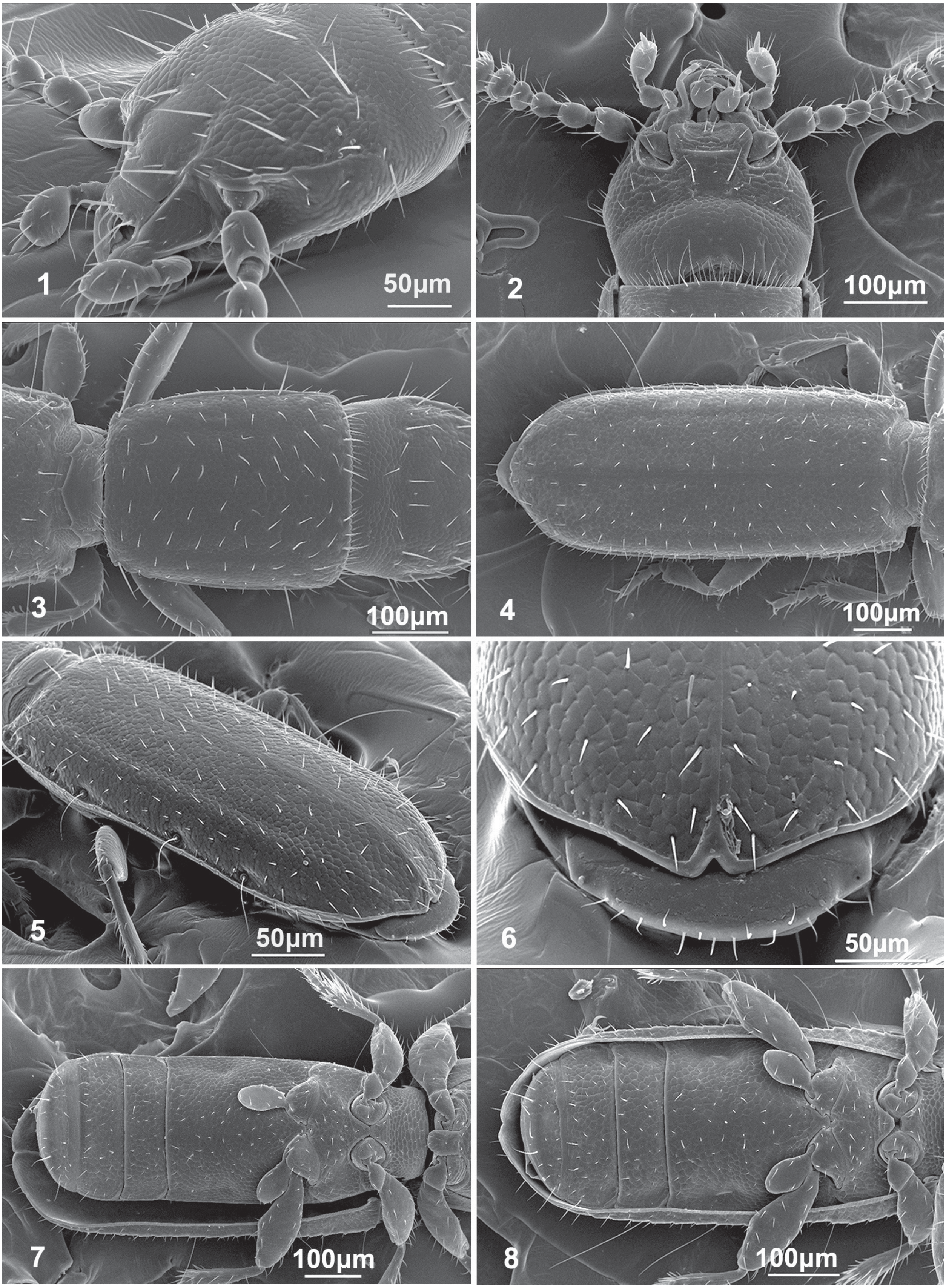
Length of holotype: 1.14 mm.

Length of paratypes: 1.12-1.23 mm (males) and 1.15-1.27 mm (females).

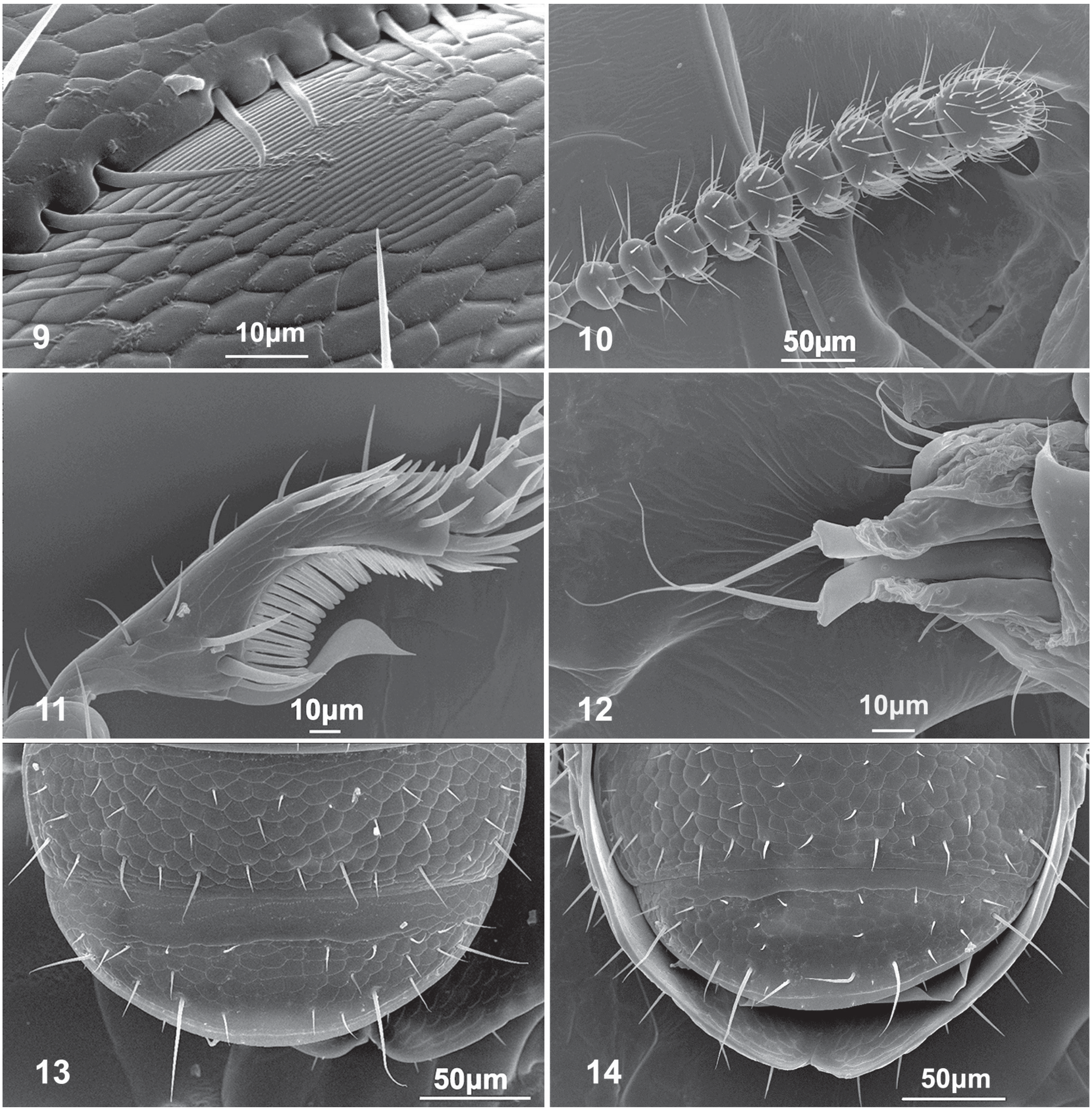
Head (Figs 1, 2, 9, 10): Almost as long as wide [length: 0.21-0.24 mm (males) and 0.22-0.26 mm (females), width: 0.24-0.26 mm (males) and 0.24-0.27 mm females)] with hexagonal microsculpture; vertex with transverse microsculpture which, in the middle area bellow the anterior margin of the pronotum, is arranged in parallel ridges forming a stridulatory organ (*pars stridens*) (Fig. 9); posterolateral region of the head with a semilunar notch (Fig. 1); labrum sub-rectangular, anterior margin almost straight; anterior margin of clypeus almost straight; moniliform antennae with 11 rounded antennomeres progressively more quadrate (morph 1, subquadrate, as defined in Pérez-González & Zaballos, 2013a), except last one, pyriform (Fig. 10). The last antennomere has a pattern of three anterodorsal and one posterodorsal sensilla coeloconica (type A). Ventral sensilla coeloconica in antennomeres 5° and 6°. Stem of third antennomere short (average proportion of stem length/antennomere body length=0.38). Labium with epilobes and middle tooth slightly sharp. Ligula with convex middle lobe and paraglossae not long. Gula wide with sutures visible through light microscopy. Cephalic chaetotaxy: two pairs of submarginal labral setae (l-s/s-l) and two pairs of marginal labral setae (m-m/m-m), two pairs of clypeal setae (l-s/s-l), one pair close to frontal sulcus; two pairs of supraocular setae (anterior and posterior) and 1-2 pairs of setae on the posterior region between vertex and lateral carinae.

Pronotum (Fig. 3): Rectangular, slightly longer than wide [length: 0.3-0.33 mm (males) and 0.31-0.34 mm (females); width: 0.26-0.28 mm (males) and 0.27-0.29 mm (females)], with hexagonal microsculpture, lateral margins slightly arcuate, slightly narrowed posteriorly, with 3-4 small crenulations before the posterior angles, which are marked with one small tooth; disk flattened, anterior margin almost straight and posterior margin slightly arcuate outwards in median region, anterior margin with medial hiatus. Pronotal chaetotaxy: four longitudinal series of erect setae between midline and lateral margins, directed inwards and slightly anteriad; lateral groove of each side with one long seta in the anterior quarter and one long seta on hind angle; a row of five pairs of setae (l-l-l-l-l/l-l-l-l-l) parallel to the anterior margin, two pairs of setae near the posterior margin (l-l/l-l); a row of regularly placed setae in anterior, posterior and lateral margins, more spaced in the later.

Elytra (Figs 4, 5, 6): 2.1 times longer than wide [length: 0.58-0.65 mm (males) and 0.59-0.66 mm (females); width: 0.22-0.30 mm (males) and 0.29-0.30 mm (females)], parallel and oval posteriorly, dorso-ventrally flattened on the disk; transverse scutelar organ present; disk with hexagonal and pentagonal micro-sculpture, almost scaly in the lateral regions; scutelar region not punctured; humeral angles rounded; lateral margins serrate, the teeth decreasing in size posteriorly; apical margin without teeth. Elytral chaetotaxy: Part of the pubescence of the disk is arranged since the sutural region in four or five rows of short setae slightly directed anteriad; a very irregular series of minute setae between the outer row and the lateral margins directed outward; umbilicated series aggregated with four seta in the anterior group and two in the posterior group (4+2) (Figs 4, 5).



Figs 1-8. *Typhlocharis mendesi* sp. nov. (1) Head in dorso-lateral view. (2) Head in ventral view). (3) Pronotum in dorsal view. (4) Eytra in dorsal view. (5) Elytra in dorso-lateral view. (6) Elytra in apical view. (7) Male abdomen in ventral view. (8) Female abdomen in ventral view.

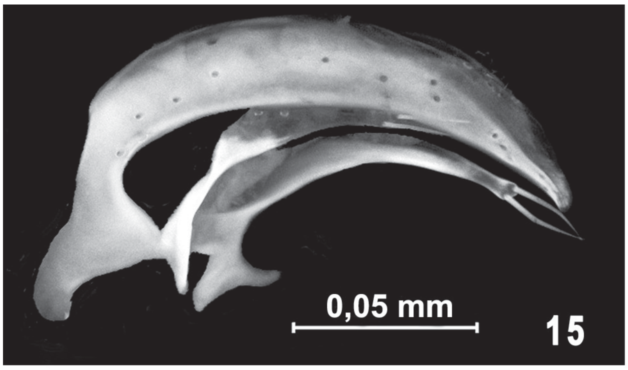


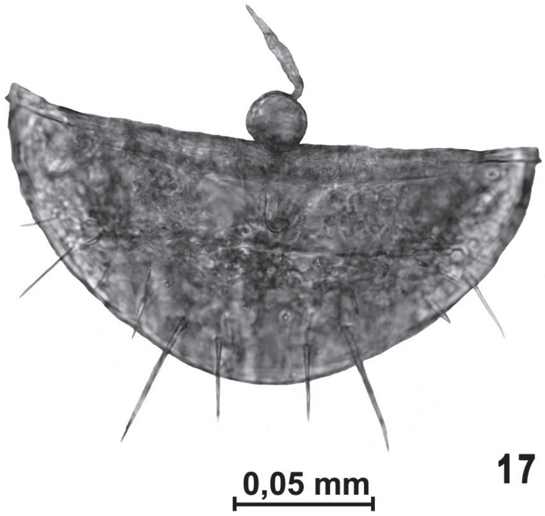
Figs 9-14. *Typhlocharis mendesi* sp. nov. (9) Stridulatory organ (*pars stridens*) in dorso-lateral view. (10) Antenna in dorsal view. (11) Male protibia cleaning organ in ventral view. (12) Female genitalia gonocoxites with apical setae in ventral view. (13) Male abdominal 'belt' in ventral view. (14) Female abdominal 'belt' in ventral view.

Legs: Femora robust, inner margin of pro- and mesofemora inerm, slightly dentate in metafemora; metatrochanters similar in both sexes and without any special features (Figs 7, 8); meso- and metatibiae without apical teeth (Figs 7, 8); apex of fore tibia with a comb of setae (cleaning organ) similar in both sexes (Fig. 11); male protarsus without dilated segments.

Abdomen (Figs 7, 8): Sterna II and III with lateral fovea, deeper in females than in males; last abdominal sternite (both sexes) presents in its anterior region a more or less invaginated area of smooth and scaly zone of microtrichia (abdominal 'belt') (Figs 13, 14); last sternite chaetotaxy with sexual dimorphism: male (s-l-s-s-l-(s)s/s(s)-l-s-s-l-s), female (s-l-s-s-l-(m)m/m-l-s-s-l-s) (Figs 13, 14).

Male genitalia (Figs 15, 16): in lateral aspect with median lobe sickle-shaped, basal lamina markedly arcuate, the apex slightly shaped like an eagle's beak; in dorsal aspect with apex broadly rounded, slightly bent to left; internal sac with several tangled membranes, in central area with one twisted sclerite in continuous by





Figs 15-17. *Typhlocharis mendesi* sp. nov. (15) Aedeagus in external and lateral view. (16) Internal sac of median lobe in lateral view. (17) Spermatheca, spermathecal gland and last ventrite in ventral view.

one fusiform membrane (Fig. 16); parameres bisetulose apically; external tegument of median lobe with several presumably chemo- or chemo-mechano sensilla sunken in pits (Fig. 15). Ring sclerite (IX abdominal sternum) subtriangular-arcuate, the apical margin is slightly projected in a triangular blunt extension, gently tilted.

Female genitalia (Fig. 12): Tubular ovipositor gonocoxites weakly sclerotized, each one in ventral aspect without a lateral seta and with a double apical one (Fig. 12); internal genital tract with spermathecal duct short, spermatheca spherical (Fig. 17) and short (length: 0.022 mm); conical spermathecal gland (length: 0.047 mm) sclerotized in distal region (Fig. 17).

Variability: There is a certain degree of intraspecific variation affecting some characters, such as the chaetotaxy of the labrum, the number and marking of posterolateral denticles in the pronotum (from faintly marked to almost absent), or the chaetotaxy of the last ventrite, showing some variability of the number and length of marginal seta. It is also common that some individuals show short and long setae irregularly mixed in the anterior row of setae in pronotum.

DISCUSSION

The following traits and others more have been used to discuss affinities among *Typhlocharis* species or to justify their close geographical proximity or even syntopy (Ortuño & Gilgado, 2011; see also Andújar *et al*., 2010): conformation of clypeus, presence or absence of *pars stridens*, type of gula, discal setae on the elytron, elytral pores, tarsal formula, hind trochanter shape, sexual dimorphism [e.g. presence or not of: 1) a median tubercle or carina in the sternum II (males), 2) a more or less deep foveae in the sterna II, III or even IV (predominantly in females) and, 3) thorn-shaped hind trochanter (males); different chaetotaxy of the last abdominal segment].

Being useful for practical purposes, the morphological species groups proposed by Zaballos & Ruíz-Tapiador (1997), Zaballos & Wrase (1998), and more recently by Pérez-González & Zaballos (2013b), are not always coherent, sometimes even for the geographic distribution of the species within each group (e.g. Zaballos & Pérez-González, 2011). This is evident, for instance, for the *diecki*- and *outereloi*-groups, whose diagnoses are based almost exclusively on the presence of a maximum number of two teeth in the apical margin of each elytron and on the pattern of the umbilicate series (4+3 – *diecki*-group, 4+2 or 4+1 – *outereloi*-group) (Zaballos & Wrase, 1998; Serrano & Aguiar, 2008). The latter character presents a degree of variability (4+2, 4+3 or 4+1, 4+2, 4+3) within several other *Typhlocharis* groups also (e.g. Zaballos & Pérez-González, 2011; Pérez-González *et al*., 2013; see also Pérez-González & Zaballos, 2012: table 1).

At a first sight, the absence of a median tooth in clypeus and teeth in the apical margin of elytra allows the inclusion of *T. mendesi* sp. nov. in the *silvanoides*- or *diecki*-group. The former group includes six species (see Serrano & Aguiar, 2014: table 1) and is known for the stability of the 4+4 umbilicate series pattern and the absence of teeth in the apical margin of elytra (see Pérez-González & Zaballos, 2012: table 1). Thus, *T. mendesi* sp. nov. shares with all species of the *silvanoides*-group the absence of teeth in the apical margin of the elytra, but it is well differentiated by the 4+2 umbilicate series pattern. The *diecki*-group includes eleven species (see Serrano & Aguiar, 2014: table 1), all with 4+3 umbilicate series pattern and of which only *T. armata* Coiffait, 1969 and *T. deferreri* Zaballos & Pérez-González, 2011 present an apical margin of elytra without teeth also (see Pérez-Gonzalez & Zaballos, 2012: table 1). So, for both the *silvanoides*-and *diecki*-group the 4+2 umbilicate series pattern of the new species is apparently incompatible. This could be solved redefining both groups by encompassing species with 4+2 umbilicate series pattern, which would allow the inclusion of *T. mendesi* sp. nov. in one of them. Taking into account only this pattern of umbilicate series, the new species could be included in some of the remaining groups too.

Thus, apart the difficulty into which species group the new species should be included, it is easily differentiated from all species of the *silvanoides*- or *diecki*-group by the 4+2 umbilicate series pattern and from part of the species of these two groups by the presence of abdominal 'belt' in males and females also (see Serrano & Aguiar, 2014: table 1). On the other hand, it is easily differentiated from all species of the *monastica*-group by the female genitalia model (tubular gonocoxite *vs*. unguiform gonocoxite shapes), from the *quadridentata*- group [all species except *T. quadridentata* (Coiffait, 1969)] by the tarsal formula (5+5+5 *vs*. 4+4+4) and the absence of elytral teeth in the apex and from the *gomezi*-, *carpetana*-, *outereloi*- and *baetica*-group – among other traits – by the absence of elytral teeth in the apex (see Pérez-González & Zaballos, 2012: table 1; 2013b: table 1).

However, by the female tubular genitalia model (submodel with long tubular gonocoxites without lateral setae and two apical nematiform setae) (Pérez-González & Zaballos, 2012), the tarsal formula (5+5+5), the absence of a median clypeal tooth and of meso- and metatibial apical teeth, it seems closer to the *outereloi*-group. This group is characterized by the presence of at least one sutural tooth or yet additional one at the end of the 7th elytral striae. Taking into account the above set of characters, we propose that *Typhlocharis mendesi* sp. nov. must be incorporated in *outereloi*-group. This implies also that the characterization of the group needs to be redefined by the inclusion of 'absence of teeth in the apical margin of elytra'. This redefinition avoids the creation of a new species group, which would greatly complicate the artificial systematics of the genus.

The *outereloi*-group contains a variety of morphologically diverse species (e.g. Serrano & Aguiar, 2008: table 2; Pérez-González & Zaballos 2012: table 1). Within the group, the new species differs from *T. elenae* Serrano & Aguiar, 2002 and *T. gomesalvesi* Serrano & Aguiar, 2002 by the umbilicate series pattern (4+2 *vs.* 4+1), but shares with 5 species (*T. outereloi* Novoa, 1979, *T. bazi* Ortuño, 2000, *T. laurentii* Magrini, 2000, *T. singularis* Serrano & Aguiar, 2000 and *T. gomesalvesi*) the presence of a *pars stridens* as well as with 3 species (*T. laurentii*, *T. singularis* and *T. gomesalvesi*) the presence of a medial hiatus in the pronotum. Another feature shared by the new species and both sexes of 8 species of the group (*T. outereloi*, *T. bazi*, *T. belenae* Zaballos, 1983, *T. intermedia* Zaballos, 1986, *T. navarica* Zaballos & Wrase, 1998, *T. laurentii*, *T. singularis* and *T. gomesalvesi*) are the ovoid-elongate hind trochanters versus the thorn-shaped (at least in males) in the remaining species. Additionally, the presence of a fovea in the female abdominal sternum II or sterna II and III is shared by 6 species (*T. bazi*, *T. navarica*, *T. atienzai* Zaballos & Ruiz-Tapiador, 1997, *T. estrellae* Zaballos & Ruiz-Tapiador, 1997, *T. bullaquensis* Zaballos & Ruiz-Tapiador, 1997 and *T. elenae*). It seems that morphologically the new species is more akin to *T. singularis*, *T. gomesalvesi,* and *T. laurentii*. Interestingly, the two former species occur geographically closer to Portugal (Serrano & Aguiar, 2000, 2002), and the latter farther away (Almeria, Spain) (Magrini, 2000). Morever, *T. mendesi* sp. nov. is also similar to *T. laurentii* concerning the number of setae of the female gonocoxite (apical and lateral: 2, 0). However, the new species is easily separated from all species of the *outereloi*-group, including the closely resembling ones, by the absence of teeth in apical margin of elytra and the presence of a slight fovea in the male abdominal sternum II (Figs 6, 7). There are three *Typhlocharis* species belonging to other species groups with a known geographical distribution in Portugal which is closer to the new species than the other two mentioned above (*T. singularis* and *T. gomesalvesi*). They are *Typhlocharis rochapitei* Serrano & Aguiar, 2008, *T. passosi* Serrano & Aguiar, 2005, and *T. bivari* Serrano & Aguiar, 2006, belonging to the *diecki* and *gomezi* species groups, respectively. *Typhlocharis rochapitei* was found in the same region of the new species (see also the ‘Ecological remarks’) and *T. passosi* and *T. bivari* were located more northerly and far away (60 km) in the region of Serra d’Aire e Candeeiros (Serrano *et al.,* 2005; Serrano & Aguiar, 2006). These observations reinforce the idea that the existing species groups, eventually with the exception of the *baetica*-group (Pérez-González *et al*., 2013; Pérez-González & Zaballos, 2013c), have no biogeographical or phylogenetic meaning and that obviously many traits that define them are probably convergences (e.g. see Ortuño & Gilgado, 2011).

Despite the above comments, the inclusion of *T. mendesi* sp. nov. based on external morphologic characters in one of the already established species groups nevertheless challenges the relationships of the species so far included in each group.

ECOLOGICAL REMARKS

The new species of *Typhlocharis* inhabit the endogean environment in the same way as other congeneric taxa. They live in the soil, usually at different depths of the B-horizon, but are found also under sunken stones lying at different depths, even from superficial (epigean) to well-buried (edaphic or endogean) environments. Individuals of endogean carabids are more easily found close to the superficial horizon layers after heavy rains because then the soil reaches higher percentage of humidity (saturation or close to saturation), pushing the beetles upwards (e.g. Serrano & Aguiar, 2011; Zaballos & Pérez-González, 2011).

Typhlocharis mendesi sp. nov. was found in three geographically close localities (see description) with calcareous rocky substrate and clayey brown- or brown-reddish colour soils. The habitats in the Bucelas and Arruda dos Vinhos region are dominated by dense herbaceous vegetation, typical of grassland (e.g. gramineous, liliaceous, leguminous, orchidaceous, asteraceous plants) with holm-oaks (*Quercus ilex* Linnaeus), pine trees (*Pinus pinaster* Aiton), daphnes (*Daphne gnidium* Linnaeus), hawthorns (*Crataegus monogyna* Jacquin), and other woody plants, while in A. do Mourão the vegetation is only grassland. The new species is syntopic with other endogean carabid species in the localities of Bucelas and Arruda dos Vinhos such as *Typhlocharis rochapitei*, *Geocharis olisipensis* (Schatzmayr, 1937), and *Geocharis capelai* Serrano & Aguiar, 2012 and also with other soil endogean arthropods like pseudoscorpionids, zopherid beetles (*Doderonymus lusitanicus* Binaghi, 1937), curculionid beetles, and hymenopteran formicids [*Ponera coarctata* (Latreille, 1802) and *Solenopsis* sp.]. The great concentration of endogean carabid beetles (at least four species) in Bucelas, among other endogean species, confers to this region a statute of a biodiversity ‘hot-spot’. Unfortunately, the region suffers from strong human influence and threats, like quarry industries, off-road racings, and other activities.

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