

A small carabid for a great entomologist: *Typhlocharis amara*, a new species dedicated to Dr. FRITZ HIEKE (Coleoptera, Carabidae, Anillini)

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Abstract

A new species of the genus *Typhlocharis* DIECK, 1869 is described from the Iberian Peninsula: *Typhlocharis amara* n. sp. The status as new species is supported by the presence of a unique configuration of the abdominal ventral foveae in the female. The distribution of the ventral foveae through the entire genus *Typhlocharis* is discussed, providing a classification of this character into five categories and the character state for each species.

Zusammenfassung

Ein kleiner Carabide für einen großen Entomologen: *Typhlocharis amara*, eine neue Art dediziert für Dr. FRITZ HIEKE (Coleoptera, Carabidae, Anillini). Eine neue Art der Gattung *Typhlocharis* DIECK, 1869 von der Iberischen Halbinsel wird beschrieben: *Typhlocharis amara* n. sp. Ihr Status als neue Art wird unterstützt durch das einzigartige Muster der abdominalen Ventralgruben beim Weibchen. Die Anordnung der Ventralgruben innerhalb der Gattung *Typhlocharis* wird diskutiert. Dieses Merkmal kann in fünf Kategorien klassifiziert werden, wobei der Zustand für jede Art hier angegeben wird.

Key words: Iberian Peninsula, taxonomy, ventral foveae, sexual dimorphism, endogean

Introduction

The genus *Typhlocharis* DIECK, 1869 is the most diverse endogean genus within the family Carabidae, with more than 60 described species (SERRANO & AGUIAR 2014) all of them endemic to the Iberian Peninsula and the north of Africa (Morocco and Tunisia). All *Typhlocharis* species inhabit the soil horizons A and B (ORTUÑO, 2000) and share a lack of eyes and a body shape unique within Carabidae, with depressed rectangular bodies and subrectangular or square shaped pronotum. The majority of *Typhlocharis* species have been discovered and described within the last 30 years (ZABALLOS & PÉREZ-GONZÁLEZ 2010), with an important number of contributions recently published by different research teams (SERRANO & AGUIAR 2014, PÉREZ-GONZÁLEZ & ZABALLOS 2013a, 2013c, PÉREZ-GONZÁLEZ et al 2013, ORTUÑO & GILGADO 2011, ANDÚJAR et al 2010).

The sampling of new localities within the distribution area of the genus has frequently led to the discovery of new populations. Recent samplings in a natural area near Badajoz, Spain, resulted in the discovery of a new population that was unambiguously identified as a new species thanks to the presence of a unique configuration of the ventral foveae. The ventral fovea is a paired concavity found in the first ventrite of the abdomen

(ZABALLOS 1991, ZABALLOS & RUIZ-TAPIADOR 1996), generally present in the females of many species of the genus but absent or only shallowly marked in the males, with the only exception of *T. matiasi* ZABALLOS & BANDA, 2001. In this work we present the description of the new species and discuss the characteristics and distribution of the ventral foveae through the genus, providing a classification of this character into five categories and the character state for each species.

Material and methods

The material was collected during a field campaign in March, 2014, three kilometers northwest of the city of Badajoz. A soil sample was taken from a low slope and floated according to an optimized version of the method of soil washing (NORMAND 1911). The resulting residue was processed with a Berlese apparatus (BERLESE 1905) and the collected material was examined through a stereomicroscope. Overall, six *Typhlocharis* specimens were collected and stored in absolute ethanol. Of these, four were processed into a proteinase k buffer overnight for extracting the DNA prior to their morphological study,

and a voucher number has been assigned to them (referred in the type series). Subsequently, all specimens were treated with lactic acid to clear the cuticle, separating the body parts and extracting the male genitalia for a detailed morphological study; female genitalia was studied *in situ*, by transparency, to avoid damage of delicate structures. Finally, the specimens were mounted on entomological cards using dimethyl hydantoin formaldehyde resin (BAMEUL 1990). The type series is deposited in Coll. J.P. ZABALLOS, Universidad Complutense de Madrid (UCM). All the observations were made using light microscopy. Measurements were made with a Wild Heerbrugg M8 stereomicroscope (Switzerland). Drawings were made from photographs obtained using a Zeiss 474620-9900 microscope (Germany), processed and outlined with Adobe Photoshop CS6 13.0. SEM images were obtained with a LEO 1455 VP (Variable Pressure) SEM in the Imaging Service of the NHM London.

Nomenclature of cephalic chaetotaxy follows ZABALLOS (2005). Nomenclature of the rows of setae follows PÉREZ-GONZÁLEZ & ZABALLOS (2012) and PÉREZ-GONZÁLEZ & ZABALLOS (2013c). Nomenclature of antennal features follows PÉREZ-GONZÁLEZ & ZABALLOS (2013b). Terminology for the IX sclerite of males follows SOKOLOV & KAVANAUGH (2014).

Results

Typhlocharis amara n. sp.

Figs. 1-4

Type series. Holotype: 1 male (voucher n° BMNH1424387), Badajoz, 3km NW (38° 54' N, 06° 59' O), Badajoz, SPAIN, 25.III.2014, J.P. Zaballos & S. Pérez-González leg. (Coll. J.P. ZABALLOS, UCM).

Paratypes: 5 females (voucher n° BMNH1424384, BMNH1424385, BMNH1424386 + 2 females without assigned voucher), same data as the holotype (Coll. J.P. Zaballos, UCM). DNA aliquots are deposited in the Natural History Museum of London (voucher n° BMNH1424387, BMNH1424384, BMNH1424385 and BMNH1424386).

Diagnosis. Small, eyeless, endogean beetle with narrow subrectangular body covered with microreticulation and scattered pubescence (Fig. 1). Vertex without stridulatory organ.

Sexual dimorphism in head proportions, head larger in males. Robust mandibles, angular in males, smoothly curved in females. Clypeus strongly curved outwards. Narrow gula. Elytra with two pairs of denticles in the apical margin (a pair associated to the seventh stria and a sutural pair, the latter with sexual dimorphism). Umbilicate series with six setae (4+2). Metatrochanters with sexual dimorphism, much more angular in males. Males with a large metatibial seta associated to a spur. Females with a pair of deep, double foveae in the first

ventrite, with the anterior margin projected back and covered by scaly microsculpture. Sickle-shaped, curved aedeagus, with subtriangular, narrow apex. "Bicycle seat-shaped" endophallic sclerites, with an anterior projection (Fig. 3A). Female genitalia with tubular gonocoxites, with lateral setae. Spermathecal duct very long, subcylindrical-reniform spermatheca (Fig. 3B).

Description. Length 1.50 mm (male), 1.28-1.31 mm (females). Anophthalmous insect, depigmented, colouration from dark yellow to brown. Integument microreticulated, covered with scattered pubescence (Fig. 1).

Head (Fig. 1A, 1B): slightly longer (0.27-0.33 mm) than wide (0.28-0.30 mm), covered by subhexagonal microreticulation. Sexual dimorphism in head proportions: the cephalic capsule is larger in males than in females. Vertex region without stridulatory organ. Semilunar notch in posterolateral region of cephalic capsule almost faded. Slightly notched labrum, with a middle triangular area and small button of thicker cuticle. Clypeus with the anterior margin strongly curved outwards, more subtle in females. Moniliform antennae with 11 reniform antennomeres (morph 2), the last one is pyriform. Stem of third antennomere not elongated. Last antennomere with a pattern of one antero-dorsal and one postero-dorsal sensilla coeloconica (sc). One ventral sc in antennomeres 5th and 6th. Sexually dimorphic mandibles: more robust and angular in males; less robust, not angular but smoothly curved in females. External angles of the mandibles with cuticular bumps. Right mandible with one terebral tooth and a sharp, slightly projected edge (smoother in females). Left mandible with slightly projected edge. Labium without special characteristics, with pointed epilobes and a medial tooth, blunt and rounded. Ligula with triangular middle lobe and long paraglossae. Narrow gula, approximately four times longer than wide.

Cephalic chaetotaxy: six pairs of labral setae (s-s-l-m-s-m/m-s-m-l-s-s), two pairs of clypeal setae (l-s/l), one pair of frontal setae, two pairs of supra-ocular setae (anterior and posterior), one pair of supra-antennal setae, one pair of vertical setae, one pair of temporal setae, two pairs of occipital setae and one pair of genal setae, as well as scattered pubescence. Labium with a pair of setae near the base of middle tooth, a pair of long setae near the base of epilobes, a pair of very short setae near the apex of epilobes and one or two pairs of very short setae near posterior suture (irregularly distributed among different individuals). Prebasilar with two pairs of setae near anterior margin (lateral pair much longer, sometimes there are irregular supernumerary small setae), a pair of very small setae in the middle region and two pairs of setae (lateral pair much longer) in posterior region, with some degree of individual variation over this pattern.

Thorax (Fig. 1A, 1B): pronotum subtrapezoidal to subrectangular, longer (0.33-0.47 mm) than wide (0.30-0.31 mm), narrowed in posterior region. Anterior margin straight, barely crenulated, without medial

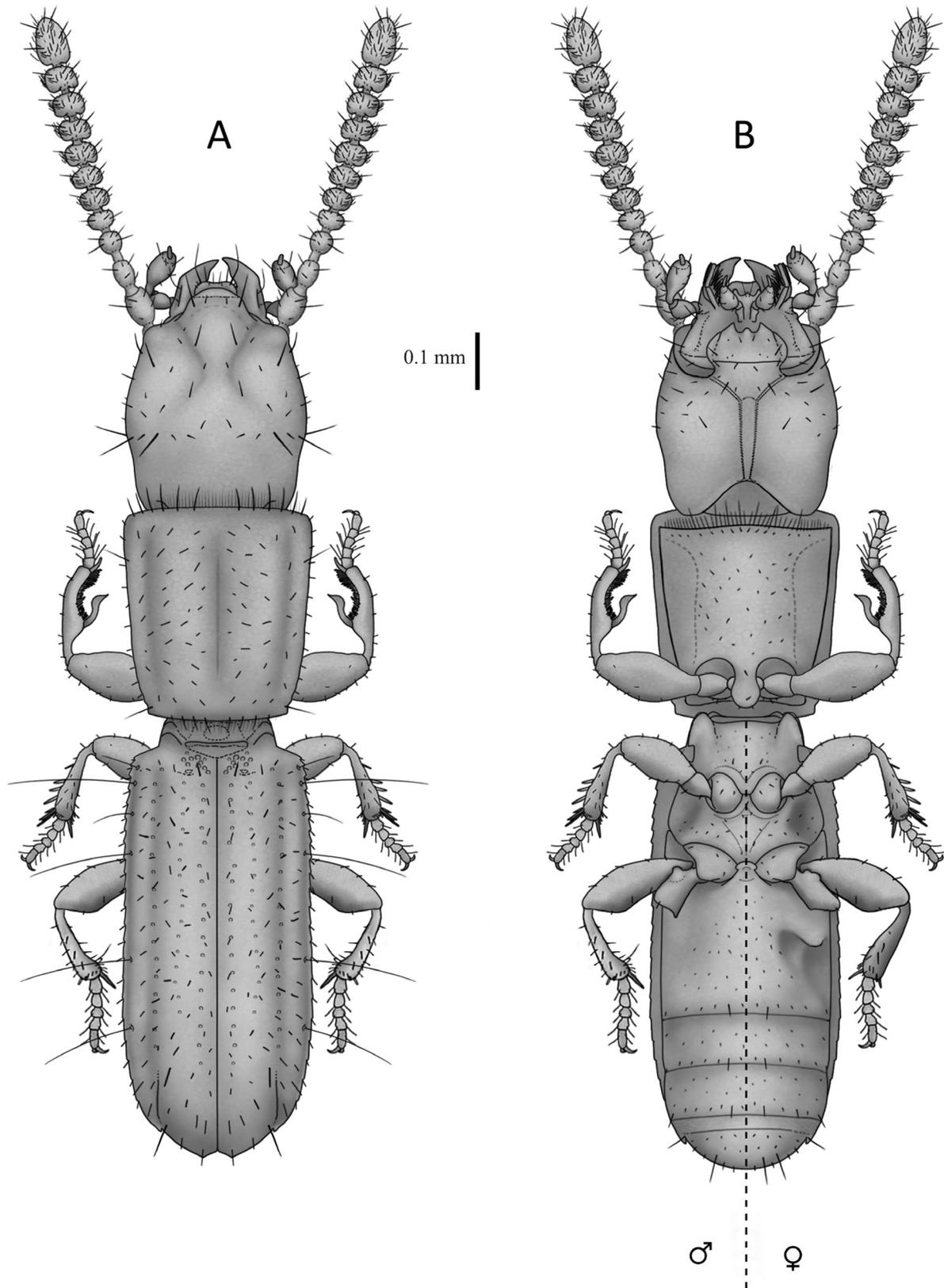


Fig. 1. *Typhlocharis amara* n. sp. **A** – Habitus, dorsal (male). **B** – Habitus, ventral (left half: male, right half: female). Scale: 0.1 mm.

hiatus; posterior margin smoothly curved outwards. Lateral margins with three posterolateral denticles, barely noticeable. Surface covered by subhexagonal microreticulation. Disc flattened, with a medial line and a pair of faint lateral sulci.

Thoracal chaetotaxy: one pair of long setae in the first third of lateral margins, one pair of long setae near posterior angles, a row of five or six pairs of setae [l-(l)-l-l-l-l-l-l-(l)-l] parallel to anterior margin, four pairs of setae parallel to posterior margin [l-l-l-s/s-l-l-l], a row of small, filiform setae in the anterior and posterior margins, a row of short setae in lateral margins and four pairs of irregular longitudinal rows of short pubescence in disc. Proepisternal suture marked. Prosternal apophysis rounded. Anterior margin of prosternum with a row of long, thin setae and six to eight pairs of short setae parallel to it. Prosternum covered in scattered pubescence, absent in proepisternum. Mesoepisternum with a pair of foveae, deeply marked in females. Metaepisternum depressed near the articulation of the rear legs, forming a pair of smooth foveae in both sexes.

Elytra (Fig. 1A): aprox. 2.2 times longer (0.66-0.70 mm) than wide (0.30-0.32 mm), subparallel. Lateral margins with 19-22 well defined denticles, progressively less marked towards the posterior region. Apical margin with two pairs of denticles: one pair associated to the end of seventh stria, and one sutural pair, apparently affected by sexual dimorphism: broad triangular denticles in males (more like a strong angle than a true denticle), pointed spiniform denticles in females (Fig. 2). Humeral angle well defined. Disc flattened, with a longitudinal lateral carinae associated to the seventh stria, reaching the apical margin where they draw a defined line. Surface covered by irregular subhexagonal microreticulation. Large and well-marked elytral pits, present in scutellar region, parallel to the suture, in disc and along seventh stria. Transverse scutellar organ with straight margin. A pair of small, atrophied “buttonholes” present near the base of elytra.

Elytral chaetotaxy: umbilicate series with an anterior group of four setae and a posterior group of two setae (4+2). One pair of scutellar setae. No discal setae. Discal pubescence arranged in five or six pairs of longitudinal rows of pubescence of irregular length, the third row with longer and shorted setae interspersed. A pair of long apical setae and two pairs of subapical setae, the inner

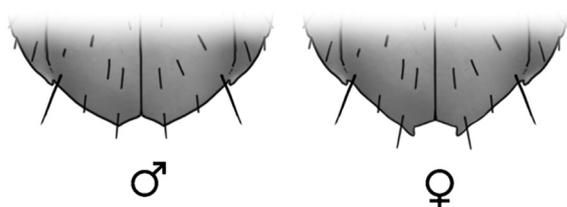


Fig. 2. Apical margin of the elytra in male and female of *Typhlocharis amara* n. sp. showing the sexual dimorphism of the sutural denticles.

pair mid-sized and the outer pair much longer. Lateral margins with a short seta for every denticle.

Legs (Fig. 1B): with sexual dimorphism. Profemora, protibiae, mesofemora and mesotibiae without special characters. Intermetacoxal space not widened. Metacoxal flap smoothly rounded. Males with very angular metatrochanters, with a pointed inner angle, those of females show similar features but softly marked. Metafemora slightly angular, metatibiae with distal region subtly dilated. Males have a mid-sized perpendicular metatibial long-seta associated with a short, very robust seta (“spur”) in the distal inner edge. A perpendicular metatibial seta also appears in females, but is very short. Smooth inner margin of femora. Clearly pentamerous tarsi in all the legs (tarsal formula: 5-5-5). Tarsal claws smooth and curved.

Abdomen (Fig. 1B): covered by irregular microreticulation. Females with a pair of deep double foveae in the first ventrite, with the anterior margin projected back and covered by scaly microsculpture (Fig. 1B, Fig. 5E). Males with very faint or absent foveae (Fig. 1B). Last ventrite with a belt of scaly microsculpture (the edge of each scale is fine and irregularly serrated in both sexes), the posterior margin with a pair of lateral notches and six to eight pairs of setae: l-(s)-s-s-l-s-s/l-s-l-s-s-(s)-l, showing sexual dimorphism. Male genitalia (Fig. 3A): Aedeagus with robust, sickle-shaped median lobe (length: 0.20 mm), strongly curved; straight in dorsal view (Fig. 3A-2). Subtriangular apex, narrow and blunt. Endophallus with sclerites arranged in a characteristic “bicycle seat” shape (in lateral view), with a gently curved anterior projection (Fig. 3A-3). Subtriangular parameres, with two medium-sized, slightly unequal, apical setae (Fig. 3A-4, 3A-5). Ring sclerite (IX abdominal sternum) subtriangular, the apical margin is projected in a handle-like extension, gently tilted (Fig. 3A-1).

Female genitalia (Fig. 3B): adjusts to the model described by VIGNA-TAGLIANTI (1972). Tubular, robust gonocoxites, with double apical setae. One lateral setae in the middle part of each gonocoxite, as well as scattered pores. Narrow and very pointed gonosubcoxites. Very long spermathecal duct, divided in two regions: a thinner proximal section (diameter 0.004 mm) and a thicker distal section (diameter 0.010 mm). Spermatheca subcylindrical-reniform (length: 0.027 mm). Conical spermathecal gland (length: 0.017 mm), distally sclerotized. Tergite VIII with posterior margin smoothly curved or slightly triangular, covered by a row of thin setae. Mid-sized lateral projections, gently dilated distally.

Derivatio nominis. This species is dedicated *in memoriam* of the distinguished German entomologist Dr. FRITZ HIEKE (1930-2015). The specific name “*amara*” comes from the latin *amarus*, “bitter”, in a double reference to the bitter feeling of his loss and as tribute to him as the leading specialist of the carabid genus *Amara* BONELLI, 1810. It should be treated as a noun in apposition.

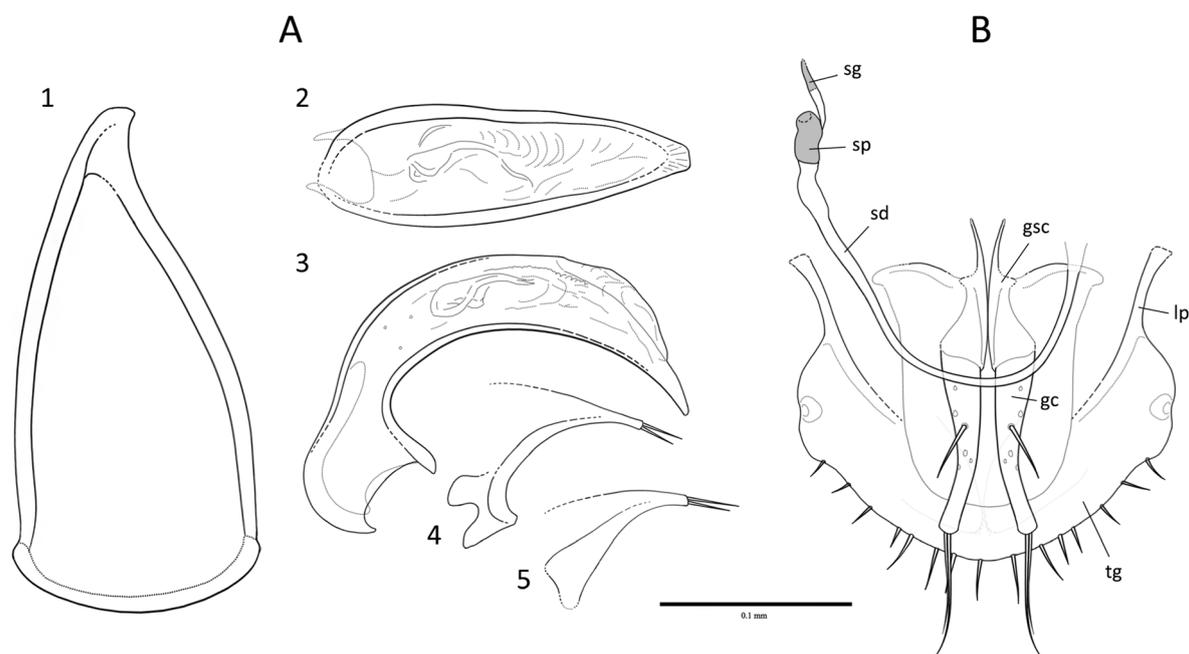


Fig. 3. *Typhlocharis amara* n. sp. **A** – Male genitalia: 1 – ring sclerite, 2 – aedeagus (dorsal view), 3 – aedeagus (lateral view), 4 – right paramere, 5 – left paramere. **B** – Female genitalia. Abbreviations: gc – gonocoxite, gsc – gonosubcoxite, lp – lateral projection, sd – spermathecal duct, sg – spermathecal gland, sp – spermatheca, tg – tergite VIII. Scale: 0.1 mm.

Habitat. *T. amara* n. sp. is known from a single locality in the surroundings of the city of Badajoz. It inhabits an open prairie-like pasture environment (Fig. 4), with abundance of herbaceous plants, thistles, mirror orchids (*Ophrys speculum* LINK), asphodels (*Asphodelus* sp.) and some scarce brooms (*Retama* sp.). Reddish soil, relatively dry at the time of sampling, with abundant boulders and stones of different sizes. The sampling was taken near an old open-pit mining development. Some boulders had a porous, cement-like texture and are probably debris from the mine.

Affinities. The sexual dimorphism affecting to the metatrochanters and the umbilicate series of 4+2 relate *T. amara* n. sp. with *T. belenae* ZABALLOS, 1983, *T. intermedia* ZABALLOS, 1986, *T. toribioi* ORTUÑO, 1988, *T. jeannei* ZABALLOS, 1989, *T. bullaquensis* ZABALLOS & RUIZ-TAPIADOR, 1997, *T. atienzai* ZABALLOS & RUIZ-



Fig. 4. Habitat of *Typhlocharis amara* n. sp

TAPIADOR, 1997 and *T. estrellae* ZABALLOS & RUIZ-TAPIADOR, 1997. However, *T. belenae*, *T. toribioi*, *T. jeannei*, and *T. estrellae* share deep ventral foveae in females with a single concavity, whereas in *T. intermedia*, *T. atienzai* and *T. bullaquensis*, the ventral foveae have a double concavity, akin to that of *T. amara* n. sp., but clearly differentiated by the anterior margin projected backwards seen in the new species.

Females of the new species can be easily identified by the structure of the ventral foveae, but males can be more difficult to identify. The markedly curved shape of the clypeus in *T. amara* n. sp. (Fig. 1A) is only shared by *T. belenae* and *T. jeannei*, but the new species can be distinguished from them by the configuration of the endophallic sclerites. These are particularly similar to the sclerites of *T. bullaquensis* and *T. estrellae*, as they share the “bicycle seat shape” (in lateral view) with an elongated and curved anterior projection. In the other mentioned species this projection is either very short (*T. belenae*, *T. intermedia*, *T. toribioi* and *T. jeannei*) or very long (*T. atienzai*).

Finally, the shape of the sutural pair of denticles in the apical margin of the elytra is known to vary from complete absence to presence of angular shapes or well developed denticles in species with sexual dimorphism affecting to the metatrochanters and ventral foveae. It is interesting to note that a sexually dimorphic intraspecific variation of this feature (i.e. angular shapes in one sex, well developed denticles in the other, as in Fig. 2) is also known in *T. portilloi* and *T. elenae*.

Table 1. Development and sexual dimorphism of abdominal ventral foveae in the genus *Typhlocharis*, compared to sexual dimorphism in the metatrochanters. Species highlighted in bold type give names to the groups defined by ZABALLOS & RUIZ-TAPIADOR (1997), ZABALLOS & WRASE (1998) and PÉREZ-GONZÁLEZ & ZABALLOS (2013C). The types of ventral foveae are illustrated in Fig. 5.

Species	Type of ventral foveae (male/female)	Sexual dimorphism in metatrochanters
<i>T. monastica</i>	absent / deep, single concavity	no
<i>T. peregrina</i>	absent / deep, single concavity	no
<i>T. toletana</i>	absent / absent	no
<i>T. josabelae</i>	absent / very faint or absent	no
<i>T. gomezi</i>	absent / absent	no
<i>T. hiekei</i>	very faint or absent / shallow	yes
<i>T. wrasei</i>	shallow / deep, single concavity	yes
<i>T. passosi</i>	shallow / deep, single concavity	no
<i>T. fozcoaensis</i>	very faint or absent / deep, single concavity	no
<i>T. bivari</i>	absent / deep, single concavity	no
<i>T. zaballosi</i>	absent / shallow	no
<i>T. carpetana</i>	absent / deep, single concavity	yes
<i>T. portilloi</i>	absent / deep, double concavity	yes
<i>T. silvanoides</i>	very faint or absent / deep, single concavity	no
<i>T. algarvensis</i>	very faint or absent / very faint or absent	no
<i>T. fancelloi</i>	absent / absent	no
<i>T. sarria</i>	absent / ?	?
<i>T. carinata</i>	absent / shallow	no
<i>T. paulinoi</i>	absent / absent	no
<i>T. baetica</i>	absent / absent	no
<i>T. pacensis</i>	absent / absent	no
<i>T. aguirrei</i>	absent / shallow	no
<i>T. millenaria</i>	absent / absent	no
<i>T. furnayulensis</i>	absent / absent	no
<i>T. matiasi</i>	deep, single concavity / deep, single concavity	no
<i>T. prima</i>	absent / absent	no
<i>T. secunda</i>	absent / absent	no
<i>T. tertia</i>	absent / shallow	no
<i>T. quarta</i>	absent / very faint or absent	no
<i>T. acutangula</i>	absent / absent	no
<i>T. mixta</i>	absent / deep, single concavity	no
<i>T. diecki</i>	very faint or absent / very faint or absent	no
<i>T. santschii</i>	shallow / shallow	no
<i>T. armata</i>	very faint or absent / shallow	no
<i>T. besucheti</i>	very faint or absent / very faint or absent	no
<i>T. carmenae</i>	absent / deep, double concavity	yes
<i>T. farinosae</i>	absent / deep, double concavity	yes
<i>T. gonzaloi</i>	? / deep, single concavity	?
<i>T. lunai</i>	absent / deep, single concavity	no
<i>T. rochapitei</i>	shallow or very faint / shallow	no
<i>T. martini</i>	absent / absent	no
<i>T. deferreri</i>	absent / deep, single concavity	no

Species	Type of ventral foveae (male/female)	Sexual dimorphism in metatrochanters
<i>T. quadridentata</i>	shallow / shallow	no
<i>T. crespoid</i>	absent / absent	no
<i>T. baeturica</i>	absent / shallow	no
<i>T. scrofa</i>	absent / absent	no
<i>T. tetramera</i>	absent / shallow	no
<i>T. outerelei</i>	absent / shallow	no
<i>T. belenae</i>	absent / deep, single concavity	yes
<i>T. intermedia</i>	absent / deep, double concavity	yes
<i>T. toribioi</i>	absent / shallow	yes
<i>T. jeannei</i>	absent / deep, single concavity	yes
<i>T. bullaquensis</i>	shallow / deep, double concavity	yes
<i>T. atienzai</i>	shallow or very faint / deep, double concavity	yes
<i>T. estrellae</i>	absent / deep, single concavity	yes
<i>T. navarica</i>	shallow / deep, single concavity	no
<i>T. laurentii</i>	absent / absent	no
<i>T. bazi</i>	absent / deep, single concavity	no
<i>T. singularis</i>	absent / absent	no
<i>T. gomesalvesi</i>	absent / absent	no
<i>T. elenae</i>	absent / deep, single concavity	yes
<i>T. amara</i> sp. n.	very faint or absent / deep, double concavity with anterior margin projected backwards	yes

Discussion

The most outstanding feature of the new species is the unusual configuration of the abdominal ventral foveae in females. Ventral foveae are common within the genus (see Table 1), but no other species sports a projected anterior margin over the fovea such as is here described for *T. amara* n. sp. (Fig. 5). The ventral foveae are generally much more developed in females and just a few species show equally developed foveae in both sexes (Table 1) with only *T. matiasi* ZABALLOS & BANDA, 2001 showing deep foveae in males and females (PÉREZ-GONZÁLEZ & ZABALLOS 2013a).

The structure of the foveae varies within the genus and can be separated into five categories of development (Fig. 5):

- 1) Absent foveae (Fig. 5A).
- 2) Shallow, slightly developed foveae (Fig. 5B).
- 3) Deep, well developed foveae, composed of a single concavity (Fig. 5C).
- 4) Deep, well developed foveae, composed of a double concavity (Fig. 5D).
- 5) Deep, well developed foveae, composed of a double concavity with the anterior margin projected back, over the concavity (Fig. 5E).

It is noteworthy that the most exaggerated features of the fovea appear in species that show the strongest sexual dimorphism within the genus, affecting additional characters, such as head proportions, mandibles and metatrochanters. The latter are very angular, with pointed projected edges (as seen in Fig. 1B and 5C) in these species, as opposed to the rounded, non dimorphic metatrochanters more common in the genus (as in Fig. 5A). Indeed, the presence of deep, well developed foveae in females has been proposed to correlate with this unusual configuration of the metatrochanters (ZABALLOS 1983, 1986, 1989, 1991, ORTUÑO 1988, ZABALLOS & FARINÓS 1995, ZABALLOS & RUIZ-TAPIADOR 1995, 1997, SERRANO & AGUIAR 2002), as a mechanism to achieve a better grip during copulation (ZABALLOS 1991). The character states for both ventral foveae and metatrochanters with sexual dimorphism are summarized in Table 1. Females of all 15 species with sexual dimorphism in metatrochanters show ventral foveae and for 13 of them it is deeply marked. This effectively points to the correlation of the two characters related with sexual dimorphism, but fails to explain all the situations. Some species have well developed foveae but rounded non dimorphic metatrochanters (12 species

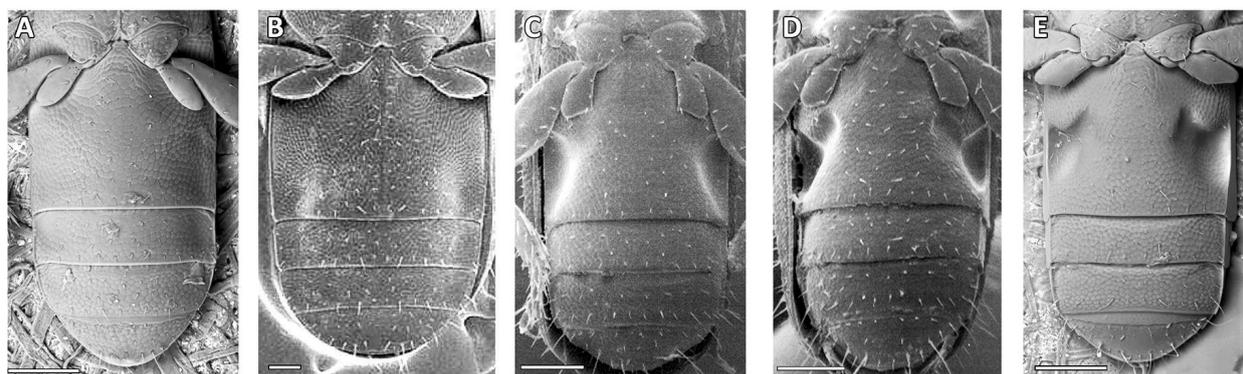


Fig. 5. SEM photographs of different categories of development affecting abdominal ventral foveae in *Typhlocharis*: **A** – absent foveae (represented by *Typhlocharis* sp., undescribed species, voucher n° BMNH104185). **B** – shallow, slightly developed foveae (represented by *Typhlocharis carinata*, modified from SERRANO & AGUIAR, 2006). **C** – deep, well developed foveae, composed by a single concavity (represented by *T. estrellae*, modified from ZABALLOS & RUIZ-TAPIADOR, 1997). **D** – deep, well developed foveae, composed by a double concavity (represented by *T. atienzae*, modified from ZABALLOS & RUIZ-TAPIADOR, 1997). **E** – deep, well developed foveae, composed by a double concavity with the anterior margin projected back over the concavity (*Typhlocharis amara* n. sp., voucher n° BMNH1424385). Scale bars = 0.1 mm.

in Table 1). The true function of this singular structure and how it works still remains unknown.

Acknowledgments

We would like to thank MICHAEL GEISER (NHM London) for helping with the German version of the abstract and TOMASZ GORAL (NHM London) for his support with the SEM photographs.

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