Zootaxa 5264 (4): 505–525
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5264.4.3
http://zoobank.org/urn:lsid:zoobank.org:pub:9C61EF9D-1085-4EC6-B8A1-DCA65F768D76

Trechus (s. str.) "subnotatus" species group (Coleoptera: Carabidae) in Bulgaria

RUMYANA KOSTOVA[1] & ROSTISLAV BEKCHIEV[2]
Department of Zoology and Anthropology, Faculty of Biology, Sofia University, 8 Dragan Tsankov Bvld., 1000 Sofia, Bulgaria.
rkostova@biofac.uni-sofia.bg; https://orcid.org/0000-0002-8119-3275
National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria.
bekchiev@nmnhs.com; https://orcid.org/0000-0001-6143-0184

Abstract

The presented study is the first attempt to clarify the taxonomic composition of the *Trechus "subnotatus"* species group sensu Jeannel (1927) in Bulgaria. The study is based on the material collected during field expeditions in Bulgaria from 2009 to 2021 and collections of some European museums and institutions. As a result, based on the morphology of the male aedeagi, five taxa (species and subspecies) of the *T. "subnotatus"* group were confirmed in the territory of Bulgaria, one of which is a new species to science and is described here: *T. asiaticus* Jeannel, 1927; *T. cardioderus irenis* Csiki, 1912 (**stat. nov.**); *T. cardioderus athonis* Schatzmayr, 1909; *T. cardioderus balcanicus* Jeannel, 1927 (**stat. res.**), recognized as a valid subspecies in the present study and *T. strandzhensis*, **sp. n.** *T. cardioderus irenis* remained as a valid name since we found consistent differences between its syntype, the Bulgarian material of the species and *T. cardioderus cardioderus*. Previously reported *T. subnotatus subnotatus* Dejean, 1831 and *T. cardioderus golesnicensis* Apfelbeck, 1918 were not proved to be present in Bulgaria. A stepwise discriminant analysis was conducted to reveal the most significant morphometric characters for species identification. It showed grouping to some extent, although the groups overlapped and formed a gradient.

Key words: Balkans, ground beetles, revision, Trechini, *Trechus strandzhensis*

Introduction

The genus *Trechus* Clairville, 1806 includes more than 800 species, most of which are distributed in the Palearctic region (Faille *et al.* 2011). This genus contains many wingless, short-range, endemic species and is considered polyphyletic. (Faille *et al.* 2011; Donabauer 2019). Based on molecular phylogeny analyses, Donabauer (2019) recently reorganised the European *Trechus* into hypothetical monophyletic groups—genera, subgenera, and species groups, a classification that is not yet generally accepted.

Until now, 27 taxa of *Trechus* (at the species and subspecies level) were known in Bulgaria (Pawlovski 1973; Hieke & Wrase 1988; Guéorguiev & Guéorguiev 1995; Moravec & Lompe 2003; Belousov 2017); 12 of them are Bulgarian and four are Balkan endemics. The *Trechus (s.str.) "subnotatus"* group sensu Jeannel (1927: 437), recently designated as subgenus *Latotrechus by* Donabauer (2019), is particularly problematic from a taxonomic point of view. The difficulty comes from the very similar morphology, variable and overlapping body measures. Reliable identification is possible only through examination of the male genitalia (Jeannel 1927). These facts cause significant taxonomic and systematic problems within this group and justify a taxonomic revision with emphasis on the Balkan region.

Until the present study, the following four taxa of the *Trechus "subnotatus"* species group were recorded from Bulgaria: *T. subnotatus subnotatus* Dejean, 1831 (Netolitzky 1912; Jeannel 1921, 1927; Beron 1972; Pawlowski 1973; Hieke & Wrase 1988; Hurka 1990; Guéorguiev & Guéorguiev 1995; Guéorguiev 1999; Guéorguiev 2004; Bekchiev & Guéorguiev 2014; Moravec & Lompe 2003; Belousov 2017; Teofilova 2017; Teofilova 2020; Teofilova & Kodzhabashev 2020a; Donabauer 2020); *T. irenis* Csiki, 1912 (Yoakimov 1904 as *T. palpalis*; Rambousek 1912 as *T. subnotatus* var. *cardioderus*; Drenovski 1942 as *T. subnotatus cardioderus*; Hieke & Wrase 1988 as *T. cardioderus*; Guéorguiev & Guéorguiev 1995 as *T. cardioderus balcanicus*; Moravec & Lompe 2003; Guéorguiev

Accepted by A. Faille: 3 Mar. 2023; published: 17 Apr. 2023

2004; Guéorguiev & Lobo 2006; Kostova 2009; Langourov *et al.* 2014; Kostova & Guéorguiev 2016; Teofilova 2016; Belousov 2017; Teofilova & Kodzhabashev 2020b); *T. cardioderus golesnicensis* Apfelbeck, 1918 (Mařan 1933, 1939; Nonveiller *et al.* 1994; Guéorguiev & Guéorguiev 1995; Belousov 2017); and *T. asiaticus* Jeannel, 1927 (Mařan 1933; Pawlowski 1973; Hieke & Wrase 1988; Wrase 1991; Guéorguiev & Guéorguiev 1995; Kostova & Guéorguiev 2016; Moravec & Lompe 2003; Belousov 2017; Teofilova 2017).

Yet Pawlowski (1973) highlighted the need for revision of the *T. "subnotatus"* representatives with unicolorous elytra in Bulgaria and the Balkans. He believed that at least four to six taxa from the group exist in Bulgaria. (Pawlowski 1973). Donabauer (2020) reported *Trechus subnotatus subnotatus* in the Rila Mts., suggesting that the Bulgarian population of the subspecies probably has varying colouration, as the specimens collected by him were unicolourous. The colour variation in representatives of the group is not exceptionally rare. Pawlowski (1973) reported unicoloured *T. asiaticus* specimens, although usually members of the species are with elytra spots, Degiovanni and Magrini (2016) also demonstrated varying colouration in *T. binotatus* Putzeys, 1870 from Italy.

Here, we present an attempt to clarify the taxonomic composition of the *Trechus "subnotatus*" species group sensu Jeannel (1927) in Bulgaria.

Material and methods

The study was based on some museum and institutional collections and material collected during field expeditions around the country, conducted from 2009 to 2021. The collected material includes 109 exemplars from the territory of Bulgaria and 13 exemplars from the Turkish part of the Strandzha Mts. (Fig. 1). The collecting methods were hand collecting under stones and substrate sifting (soil, leaf litter, etc.) in different types of deciduous forests. The sifted material was either checked for *Trechus* specimens in the field or placed in Winkler–Mokzarski extractors for further analysis. Collected exemplars were preserved in 95% C_2H_5OH, then pinned using the standard methodology. The male genitalia of all male exemplars were dissected. Dissections were made using standard techniques (Besuchet 1957). The genitalia are preserved in Euparal on acetate cards that were placed on the same pin as the specimen. The material was deposited at the Zoological Collection of Sofia University, Faculty of Biology and National Museum of Natural History, Sofia–BAS.

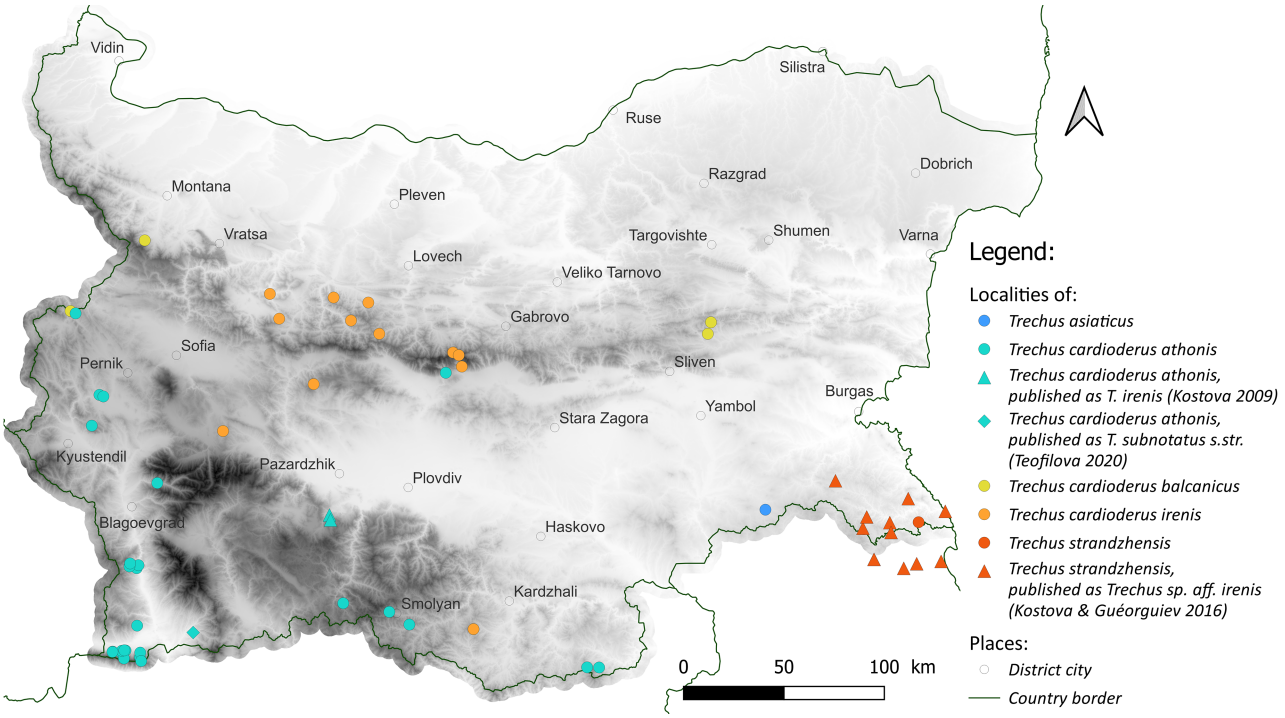

FIGURE 1. Map of the localities of the studied material (only males with dissected genitalia) from the *Trechus "subnotatus"* species group in Bulgaria by taxa. All records are new, except those designated by different symbol than a circle.

Determination of the species was performed using a Zeiss-Stemi 2000 stereomicroscope. The images of the male genitalia were taken by a Canon 700Ds camera mounted on a Zeiss Axioscope 5 microscope. The habitus image was taken using a Canon 700D camera with a Canon MP-E 65 mm f/2.8 1-5X Macro Lens, and a Canon MT-24EX Macro Twin Lite Flash as the light source. The taxonomy of taxa follows Jeannel (1927), with some exceptions discussed later. The determination was conducted using only the morphology of the median lobe of the aedeagus as the most reliable trait. The main morphological characteristics for taxa determination were the shape of the aedeagus in lateral view, the shape of its apical part in dorsal view, and the shape of the copulatory piece. Female genitalia were not examined.

Abbreviations. BFUS—Sofia University, Faculty of Biology; NMNHS—National Museum of Natural History, Sofia, Bulgarian Academy of Sciences; IBER–TT—Collection of Teodora Teofilova, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences; MNHN—Muséum National d'Histoire Naturelle, Paris; SDEI—Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany; HNHMB—Hungarian Natural History Museum, Budapest, Hungary; NBCNBC—Naturalis Biodiversity Centre, Leiden, Netherland; MNP—National Museum–Praha, Czech Republic.

Morphometric measures. AL—Length of aedeagal median lobe; EL—Length of elytra from the basal border to the apex; EW—maximum width of elytra; HW—maximum width of head including eyes; PBW—Width of pronotum base; PW—maximum width of pronotum; PAW—Width of pronotum anterior margin; PL—Length of pronotum; L—Body length from clypeus to the elytra apex; AHD—Distance from anterior discal pore to the base of elytra; PHD—Distance from posterior discal pore to the base of elytra; Indices: L/HW; L/PW; L/PL; L/EL; L/EW; EL/EW; PW/PL; PWB/PL; PW/HW; PW/PBW; PW/PWA; PAW/PBW; EW/PW; EL/AHD; EL/APD.

Statistical analyses. Only male exemplars with dissected copulatory organs (n=111) were used in the analysis to achieve reliable identification of the taxa, including 1 male of *T. irenis* from the type locality: Romania, antr. Godinest cave (coll. R. Jeannel, MNHN); 4 males of *T. cardioderus athonis* from the type locality: Greece, Athos Mt. (coll. O. Leonard, SDEI) and 2 males of *T. asiaticus* from Greece, Chios Isl. (coll. J. Fodor, HNHMB).

A stepwise discriminant analysis was conducted using all measurements and indices organised in a matrix to build a predictive model for the differentiation of Bulgarian taxa. At each step, the variable that minimises the overall Wilks' lambda (the proportion of the total variance in the discriminant scores not explained by differences among the groups) was entered. The maximum significance of F (a measure of the extent to which a variable makes a unique contribution to the prediction of group membership) a variable to enter was 0.05. The minimum significance of F to remove was 0.10. ANOVA or the Kruskal–Wallis test (ANOVA on Ranks) were used when the data were not normally distributed or homoscedastic, and consequent Tukey's or Dunn's *post hoc* tests were used to test the differences between the morphometric characteristics of the species left in the stepwise procedure.

The software used for the statistical analyses was SigmaPlot 12 (Systat Software 2011) and SPSS 17 (IBM 2007).

Results

Based on the morphology of the male copulatory organs, five taxa (species and subspecies) of the *Trechus "subnotatus"* species group were identified in the territory of Bulgaria. One of them is new to science and described in the present paper.

1. *Trechus asiaticus* Jeannel, 1927

Material examined: Bulgaria: 1♂, Yambol, Bolyarovo Vill., Samar daalu cave I, 05.06.2005, P. Stoev leg. (NMNHS)

Additional comparative material examined: **Greece:** 1♀, 2♂♂, Chios Isl., Ayio Georgios [St. George], 25–26.06.1935, (coll. J. Fodor, HNHMB); 1♂, Kephallinia, A. Winkler (coll. R. Jeannel, MNHN); **Turkey**: 1♂, Lycie: Taurus (Hauser) (coll. Jeannel, MNHN); 1♂, Asia minor, Alem Daghi, von Bodemeyer; 1♂, Constantinople (coll. Jeannel, MNHN)

Notes: Relatively large: the body length of males is 4.44–4.84 mm (Pawlowski 1973); in our sample, it was

3.9–4.6 mm. The body's dorsal surface is dark brown, usually with easily visible prolonged humeral and oval spots before the apex on the elytra. In some specimens, the elytra are unicolourous. Wings well developed, partly or fully reduced. Usually, the pronotum base is wide, the basal margin is longer than the length of the pronotum (index PWB/PL ≥ 1.2), but in some cases, the index is lower. The aedeagus does not differ from those illustrated and described by Jeannel (1927: 444) and Pawlowski (1973: 242). Its apex is strongly curved downward in lateral view. The copulatory piece is slightly concave in the middle.

2. *Trechus cardioderus athonis* Schatzmayr, 1909

Type material: syntypes: 4♂♂, 1♀, Macedonie (Greece), Athos, A. Schatzmayr, coll. O. Leonard (SDEI)

Other material examined: Bulgaria: Belasitsa Mts: 1♂, Klyuch Vill., along Klyuchka river, N41.359083 E23.016500, 20.5.2008, B. Guéorguiev leg. (NMNHS); 1♂, same data as above but Klyuchka river valley, N41.358084 E23.015716, 14.09.2009 (NMNHS); 2♂♂, "Kongura" Nature Reserve, N41.3400833, E23.1799167, 04.09.2008, B. Guéorguiev leg. (NMNHS); 1♂, "Varshiloto" Place, N41.323117 E23.188700, 09.07.2008, R. Bekchiev leg. (NMNHS); 1♂, Samuilovo Vill., N41.366897 E23.092969, 05.07.2008, B. Guéorguiev leg. (NMNHS); 1♂, same data as above but 07.04.2019, R. Kostova leg. (BFUS); 1♂, same data as above but 07.04.2021 (BFUS); 1♂, Samuilovo Vill. Kamenishki waterfall, N41.352525 E23.073882, 10.09.2010, R. Kostova leg. (BFUS); 1♂, Demir-Kapiya Pass, N41.330829 E23.085775, 07.08.2008, B. Guéorguiev leg. (NMNHS); 4♂♂, "Vodopada" Place, near Belasitsa hut, N41.360361 E23.180833, 02.09.2008, B. Guéorguiev leg. (NMNHS); 1♂, same data as above but 13.9.2009 (NMNHS); 2♂♂, same data as above but 08.10.2008, R. Bekchiev leg. (BFUS); **Ograzhden Mts**: 1♂, Gyurgevo Vill., N41.48040 E23.15527, 06.04.2010, R. Bekchiev leg. (BFUS); **Maleshevska Mts**: 1♂, West of Gorna Breznitsa Vill., N41.743712 E23.093544, 16.07–14.08.2003, B. Guéorguiev leg. (NMNHS); **Pirin Mts:** 1♂, Kalimantsi Vill., near Kalimanska River, N41.4602, E23.4908, 11.01.2004, M. Langurov, N. Simov, S. Lazarov leg. (IBER-TT); **Rila Mts**: 1♂, Pastra Vill., along the river, N42.12234 E23.23835, 16.07.2018, R. Kostova leg. (BFUS); **Rhodope Mts**: 1♂, "Dyavolsko garlo" Cave, N41.615288 E24.379501, 16.06.2005, P. Stoev leg. (NMNHS); 1♂, "Kupena" Nature Reserve, Novomahlenska River, N42.008347 E24.280907, 25.05.2008, R. Kostova leg. (BFUS); 1♂, same data as above but "Mezar dere" Place, N41.986400 E24.288150, 04.07.2008 (BFSU); 4♂♂, Smolyan Distr., "The canyon of waterfalls" Place, N41.58249 E24.65640, 07.07.2019, R. Kostova leg. (BFUS); Strazhets Vill., 15.05.2018, R. Bekchiev (BFUS); **Konyavska Mts**: 6♂♂, Tsarvendol Vill. N42.36499 E22.82754, 26.07.2019, R. Bekchiev leg. (BFUS); 1♂, Potsarnentsi Vill., N42.496591 E22.894066, 24.05.2018, R. Bekchiev leg. (BFUS); 1♂, same data as above but "Chiflika" Place, N42.50443 E22.86463, 30.06.2020 (BFUS); **Greben Mt:** 1♂, Tran Distr., Vrabcha Vill., 12.8.2020, R. Bekchiev leg. (BFUS); **Stara planina Mts.:** 1♂, Kalofer, ecopath "Byala reka", N42.65990 E24.95974, 06.08.2019, R. Bekchiev leg. (BFUS)

Additional comparative material examined: *dissected median lobe of aedeagi (on microscope slides)*: *T. subnotatus*—**Montenegro**: 1♂, Dalmatia Zelenika (coll. R. Jeannel, MNHN); **Greece**: 1♂, Iles Ioniennes, Céphalonia (coll. R. Jeannel, MNHN); *T. pallidipennis* Schaum, 1857—**Greece**: 1♂, mont Pentelicon, Athènes (coll. R. Jeannel, MNHN); *pinned specimens*: determined as *T. subnotatus* by R. Jeannel—**Bulgaria**: 1♂, 1♀, Trjevna, Netolitzky (coll. R. Jeannel, MNHN); **Montenegro**: 1♀, Dalmatia, Castelnuovo (coll. R. Jeannel, MNHN); 1♂, Iles Ioniennes, Céphalonia; 1♂, Charakti (coll. R. Jeannel, MNHN); 1♂, Grotta du Dragon, près du lac Avythos, 1908, M. Hilf (coll. R. Jeannel, MNHN); *T. pallidipennis*—**Albania**: 1♂, Kruja Mader (coll. R. Jeannel, MNHN); determined as *T. cardioderus golesnicensis* Apfelbeck, 1918 by R. Jeannel—**Montenegro:** 1♂, Zljeb planina, Bielasica (coll. R. Jeannel, MNHN); 1♂, Besina gora (coll. R. Jeannel, MNHN); *T. byzantinus* Apfelbeck, 1901—**Syntypes: Turkey,** 2♂♂, Constantinopol, Belgrader Wald, v. Bodemeyer (coll. O. Leonard, SDEI)

Notes: Relatively large: the body length of males is 4.2–4.8 mm. The body's dorsal surface is brown or dark brown. The colouration of the elytra varies even among the specimens from the same locality: there are specimens with one elongated subhumeral spot and one round spot before the apex of each elytron; specimens with a small, elongated spot in the humeral area of each elytron; specimens with a prolonged spot in the middle of each elytron; or have iridescent, dark, unicoloured elytra. The elytra are long and oval. Reduced wings. Median lobe of the aedeagus (Fig. 2): the apex is prolonged and pointed downward in the lateral view, while the apical lamella is wide and straight (not narrowing) in the dorsal view; the copulatory piece is strongly curved upward in the distal part, a characteristic typical of the species *T. cardioderus*. The habitus and male genitalia of the studied Bulgarian specimens

FIGURE 2. Variability in the median lobe of the aedeagus of *Trechus cardioderus athonis* Schatz. in lateral and dorsal view (a,b—Rila Mts., Pastra Vill.; c,d—West Rhodope Mts., Smolyan, "The canyon of waterfalls" Place; e,f—Konyavska Mts., Tsarvendol Vill.; g,h—Belasitsa Mts., Klyuch Vill.; I,j—Belasitsa Mts., "Kongura" Nature Reserve; k,l—Ograzhden Mts., Gyurgevo Vill.; m,n—Potsarnentsi Vill.; o,p—East Rhodope Mts., Strazhets Vill.; q,r—Belasitsa Mts., "Vodopada" Place). Scale: 0.2 mm.

are identical to those of the type series of *T. cardioderus athonis*. They clearly differ from those of *T. subnotatus subnotatus* in the shape of the copulatory piece, which is almost straight in the lateral view in *T. subnotatus subnotatus* (Jeannel 1927: 443) and strongly curved upward in the distal part in *T. cardioderus athonis* (Fig. 2; Jeannel 1927: 455—Fig. 1079).

3. *Trechus cardioderus balcanicus* Jeannel, 1927 (stat. res.), revived from synonymy with *T. irenis*

The name *Trechus cardioderus balcanicus* is not supposed to be in use anymore since the established by Moravec & Lompe (2003) homonymy of *T. cardioderus balcanicus* with *T. (Anophthalmus) balcanicus* Frivaldszky, 1879 = *Duvalius* (*Paraduvalius*) *balcanicus* (Frivaldszky, 1879). In accordance with the International Code of Zoological Nomenclature Art. 23.9.5. (ICZN 1999), as the taxa *T. cardioderus balcanicus* and *D. balcanicus* were not considered congeneric after 1899, we must not automatically replace the junior homonym, and the case should be referred to the International Commission on Zoological Nomenclature. Until its decision, the prevailing usage of the name will remain.

Type material: Type: **Bosnia and Herzegovina**: 1♂, Žepče, Apfelbeck, 1903 (coll. Jeannel, MNHN); **Paratypes: Bosnia and Herzegovina:** 1♂, *Srnetica* planina, V. Apfelbeck (coll. Jeannel, MNHN); 1♂, Kamenica, Apfelbeck (coll. Jeannel, MNHN); 1♂ H. Koprivnica, près de Kupres, Apfelbeck (coll. Jeannel, MNHN); **Serbia**: 1♂, Stopica pecina, à Rojantsvo (coll. Jeannel, MNHN).

Other material examined: Bulgaria: Stara planina Mts.: 1♂, Kotel, "Lednitsata" Cave, "Zlosten" Place, 11.03.2011, B. Petrov leg. (NMNHS); 2♂, Berkovitsa–Kom, 07.08.2016, R. Bekchiev leg. (BFUS); 1 ♂, Medven Vill., the river, N42.85172 E26.55142, 08.08.2019, R. Kostova leg. (BFUS); **Ruy Mt.:** 2♂, 1♀, 2 km N from Lomnitsa Vill., "Transko zhdrelo" Place, 9–10.07.2007, B. Guéorguiev leg. (NMNHS)

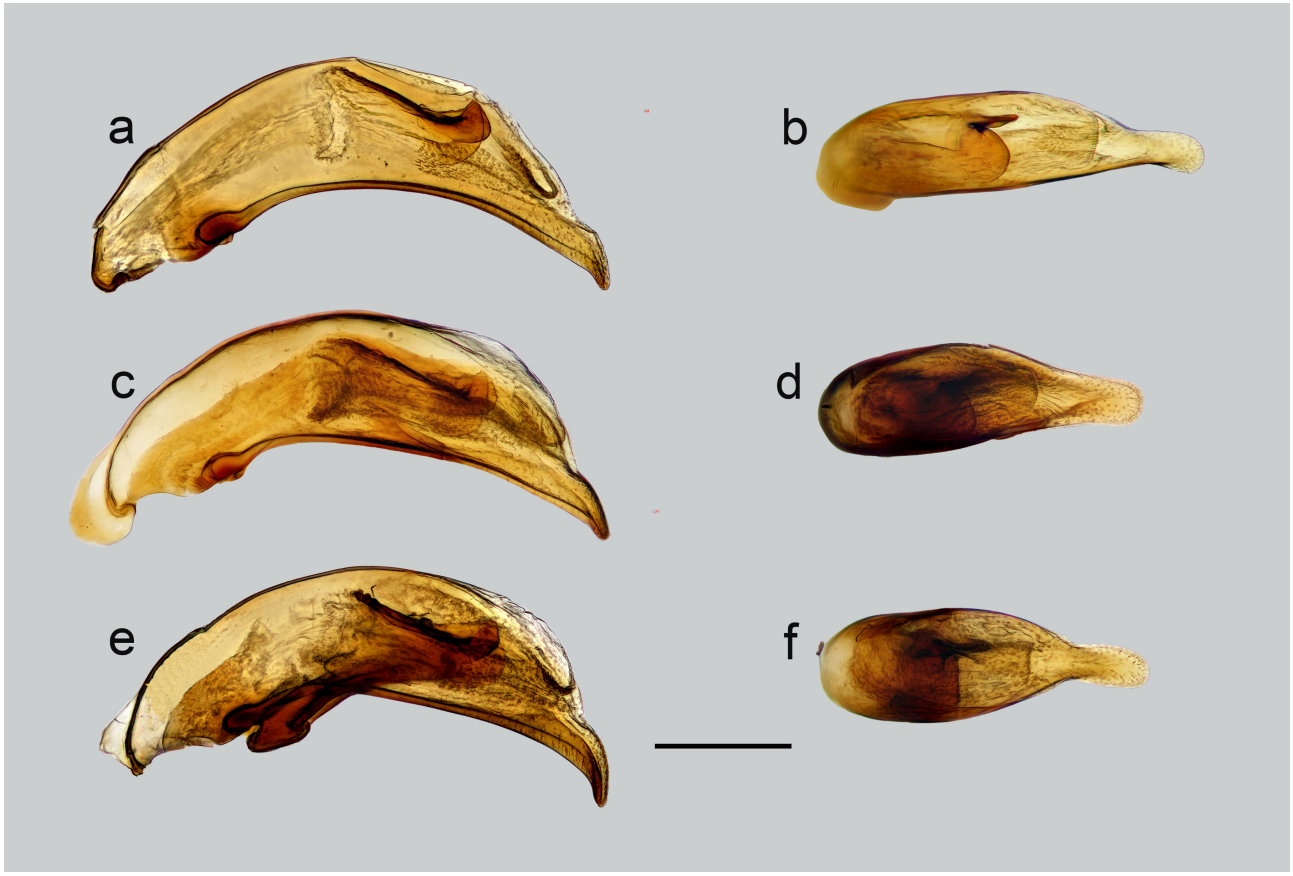

FIGURE 3. Variability in the median lobe of the aedeagus of *Trechus cardioderus balcanicus* Jeann. in lateral and dorsal view (a,b—East Stara Planina Mts, Medven Vill.; c,d—West Stara Planina Mts, Berkovitsa–Kom; e,f—Ruy Mt., Lomnitsa Vill., "Transko zhdrelo" Place). Scale: 0.2 mm.

Notes: Relatively small: the body length of males is 3.95–4.76 mm. The body's dorsal surface is brown or dark brown and unicolourous. Reduced wings. Median lobe of the aedeagus: the apex in the lateral view is strongly elongated and curved downwards; the elongation is also visible dorsally, with the apical lamella separated from the main part of the median lobe by constriction, occasionally rather deep (Fig. 3). The studied material from Bulgaria fully corresponds to the description and male genitalia drawing of Jeannel (1927: 455) and to the drawing of Nonveiller *et al.* (1994: 14), as well as to the material of the *T. cardioderus balcanicus* type series in the collection of R. Jeannel at MNHN.

4. *Trechus cardioderus irenis* Csiki, 1912 (status novus)

Type material: Syntype: **Romania**: 1♂, Antr. Godinest, Hunyad, Mihôk leg. (coll. Jeannel, MNHN)

Other material examined: Bulgaria: Stara planina Mts: 1♂, west of Krachela peak, N42.740061 E25.036336, 25.07.1996, B. Guéorguiev leg. (NMNHS); 1♂, below Tazha chalet, N42.751484 E25.001135, 27.07.1996, B. Guéorguiev leg. (NMNHS); 1♂, Toplya Vill, "Golyama Zhelezna" cave, vault of cave, 28.09.1997, P. Mitov & B. Guéorguiev leg. (NMNHS); 1♂ Rusalka hut, N42.689396 E25.056614, 12.10.1997, P. Stoev leg. (NMNHS); 3♂♂, Divchovoto Vill., Gradeshnitsa cave, N42.982760 E24.263574, 03.07.1999, B. Petrov leg. (NMNHS); 1♂, Vasilyovo Vill., N42.88206 E24.37411, 27.07.2012, R. Bekchiev leg. (BFUS); 1♂, Vasilyovo Vill, "Kozev dol" place, N41.51438 E25.16167, 07.05.2015, R. Bekchiev leg. (BFUS); 4♂♂, Chiflik Vill., N42.82665 E24.54894, 24–27.04.2017, R. Bekchiev leg. (BFUS); 1♂, Pravets, path to "Kamicheto" place, N42.87944 E23.93628, 04.08.2020, R. Bekchiev leg. (BFUS); 1♂, Kalugerovo Vill., Chekotinski Monastery, N42.98888 E23.87380, 07.08.2020, R. Kostova leg. (BFUS); 1♂, Kalugerovo Vill., road to Chekotinski Monastery, N42.98888 E23.87380, 07.08.2020, R. Bekchiev leg. (BFUS); **Sredna gora Mts**: 1♂, Bratiya Vill., 12.08.2018, R. Bekchiev leg. (BFUS); **Rila Mts**: 3♂♂, Shipochane Vill., N42.36716 E23.62139, 17.06.2019, R. Bekchiev leg. (BFUS); **Rhodope Mts:** 2 ♂♂, Temenuga Vill., N41.51438 E25.16167, 26.06.2019, R. Bekchiev leg. (BFUS)

Additional comparative material examined: *dissected aedeagi (on microscope slides)*: *T. cardioderus* s.str.—**Romania:** 1♂, Ponorici, Hunedoarâ (coll. Jeannel, MNHN); *T. cardioderus pilisensis*—**Austria:** 1♂, Graz (coll. Jeannel, MNHN); 1♂, Reichenburg (coll. Jeannel, MNHN); *pinned specimens*: *T. cardioderus* s.str.—**Hungary:** 4♂♂, Montes Mecsek, grotte Abaliget, Dr. Gebhardt leg. (coll. Jeannel, MNHN); **Romania:** 2♀♀, Băile Herculane, Banat (coll. Jeannel, MNHN); 1♂, Ponorici, Hunedoarâ (coll. Jeannel, MNHN); 1♂, Negoi, Carpathes, 1500m (coll. Jeannel, MNHN)

Notes: Relatively small: the body length of males is 3.8–4.7 mm. The body's dorsal surface is reddish-brown and unicoloured. Fully reduced wings. The legs, antennae, and palpi are lighter—yellowish brown. Median lobe of the aedeagus: in lateral view, it is strongly arched at the dorsal side and almost straight in the distal two-thirds at the ventral side. The apex is short and curved abruptly downward. In dorsal view, the apex is slightly narrowed distally, and the apical lamella has a straight tip (Fig. 4). The copulatory piece is strongly curved upward at the apical part. The subspecies first was discribed as a separate species by Csiki, 1912, after in 1927, Jeannel synonymised it with *T. cardioderus cardioderus.* We designated it as a subspecies of *T. cardioderus* after comparing the syntype of *T. irenis* and *T. cardioderus cardioderus* in the collection of Jeannel (MNHN), as well as with the Bulgarian material of the subspecies. The male genitalia of the studied Bulgarian material are very similar in lateral view to those of the syntype in Jeannel's collection (MNHN) and slightly differ in the shape of the apex from those of *T. cardioderus cardioderus* examined at MNHN. In *T. cardioderus cardioderus* specimens from the collection of Jeannel (MNHN), the apex in lateral view is curved more abruptly straight downward, quite similarly to his illustration (Jeannel, 1927: 455). In the *T. irenis* syntype from the collection of Jeannel (MNHN), the apex in lateral view is also curved abruptly downward but much shorter and under a very obtuse angle, as in Fig. 4. As the differences between both groups are clear but only in the median lobe apex, we assigned *T. irenis* the status of subspecies of *T. cardioderus*.

FIGURE 4. Variability in the median lobe of the aedeagus of *Trechus cardioderus irenis* Csiki in lateral and dorsal view (a,b—Rila Mts., Shipochane Vill.; c,d—Rila Mts., Shipochane Vill.; e,f—Central Stara Planina Mts., below Tazha chalet; g,h—Central Stara Planina Mts., West of Krachela Peak; I,j—West Stara Planina Mts. Kalugerovo Vill., Chekotinski Monastery; k,l—Central Stara Planina Mts., Vasilyovo Vill.; m,n—Central Stara Planina Mts., Chiflik Vill.; o,p—Sredna gora Mts., Bratiya Vill.). Scale: 0.2 mm.

5. *Trechus strandzhensis* sp. n.

Type locality: Bulgaria, Strandzha Mts., Slivarovo Vill., along Rezovska River, "Shafariitsa" Place, N41.960506 E27.659671.

Holotype: 1♂, Bulgaria, Strandzha Mts., Slivarovo Vill., along Rezovska River, "Shafariitsa" Place, N41.960506 E27.659671, 08.05–09.06.2009, R. Kostova leg. (NMNHS), median lobe of the aedeagus dissected and mounted on a separate plate, pinned with the specimen.

Paratypes: Bulgaria, Strandzha Mts.: 4♀♀, 2♂♂, same data as holotype but 15.04–02.07.2009 (NMNHS); 1♀, same data as holotype but, 25.09.2009, R. Bekchiev leg. (NMNHS); 1♂, Bliznak Vill., Protected Area "Bataka", N42.193694 E27.326611, 05.05.2009, R. Bekchiev leg. (NMNHS); 1♂, Balgari Vill., Protected Area "Marina reka", N42.111583 E27.764722, 11.06.2009, R. Bekchiev leg. (NMNHS); 1 ♂ Kosti Vill. Cave "Maharata", N42.005505 E27.825647, 25.09.2006, B. Petrov leg. (NMNHS); 3♂♂, 1♀, same data as above but, 01.07.2007, leg. B. Petrov (NMNHS); 1♂, 2♀♀, Malko Tarnovo, "Indipasqua" Place, N42.004694 E27.652556, 25.05.2009, R. Bekchiev leg. (NMNHS); 1♂, Malko Tarnovo, "Propada" Place, N41.980445 E27.490472, 26.07.2009, R. Bekchiev leg. (NMNHS); 1♂, Sinemorets Vill., "Butamyata" Place, N42.052861 E27.987056, 15.04-08.05.2009, R. Kostova leg. (NMNHS); 1♀, 1♂, Stoilovo Vill., "Sredoka" Natural Reserve, along Mechi dol River, N42.030861 E27.513917, 23.08.2009, R. Bekchiev leg. (NMNHS); 1♀ Gradishte Vill. 18.04.2010, leg. R. Bekchiev (NMNHS); **Turkey, Strandzha Mts.(=Yıldız Mts.):** 2♂, 2♀♀, Demirköy, Dökümhanesı, N41.81933 E27.81200, 30.05.2009, R. Kostova & R. Bekchiev leg. (NMNHS); 2♂, 3♀♀, Demirköy surroundings, N41.79936 E27.73400, 06.07.2009, R. Bekchiev leg. (NMNHS); 1♀, Sarpdere Vill., Dupnisa Cave, N41.840472 E27.556083, 29.09.2009, R. Bekchiev leg. (NMNHS); 1♂ Sarpdere Vill., Dupnisa Cave surroundings, N41.840556 E27.556222, 01.10.2009, leg. R. Bekchiev (NMNHS); 1♂ same data as above but, 26.05.2011 (NMNHS); 1♀, Igneada, Hamam Gölü, N41.828667 E27.958639, 02.10.2009, R. Bekchiev leg. (NMNHS)

Diagnosis: Relatively small: the body length of males is 3.5–4.5 mm, and that of females is 3.7–4.3 mm. The habitus is typical for the *T. "subnotatus"* species group, the species is wingless. The body's dorsal surface is unicoloured brown, shiny, and slightly iridescent; the antennae, palpi, and legs are light brown. A reliable distinction from the other members of the species group could be made only by using the male genitalia. The median lobe of the aedeagus in lateral view is gradually and markedly curved, with a prolongated, well-differentiated apex. In dorsal view, the apex narrows. The apical lamella is elongated and slightly twisted to the right, separated from the remaining part by a distinct constriction. The copulatory piece is humpbacked in the proximal part and slightly concave in the distal part. The metric characteristics of the specimens from the type series are shown in Table 1.

Description of the holotype: The habitus is typical for the *T. "subnotatus"* species group, as shown in Fig. 5. The body length from the clypeus to the apex of the elytra is 4.2 mm.

Colour: The dorsal surface is unicoloured brown, shiny, and slightly iridescent; the antennae, palpi, and legs are paler light brown. The microsculpture consists of fine polygonal meshes that are clearly visible on the head at a magnification of 80x and reduced on the pronotun and elytra.

Head: The maximum width is at the eyes level (0.9 mm). The eyes are well developed, 1.5 times longer than the temples, head with deep frontal furrows. The antennae are moderately long and do not proceed half the length of the elytra.

Pronotum: Transverse (PW/PL=1.44), strongly heart-shaped, with the maximum width in the front one-third and lateral margins gradually narrowing to sharply protruding outward posterior angles, forming a right angle (PW/PBW=1.35). Basal margin slightly concave laterally and slightly protruding medially. There are two marginal setae at the first anterior third and at the posterior angles.

Elytra: Oval, with slightly curved margins, wider at the last third (EL/EW=1.35). Inner striae 1–5 are clearly visible, shallow, and finely dotted, with the rest striae fading towards the margins. There are three discal setae (including the preapical one) on the third interval closer to the third stria. The umbilicate series consists of 8 setiferous pores located along the lateral margin as follows: four humeral setae at equal distances from each other, two medial setae, and two preapical setae, with a large distance between medial and preapical groups. On the apical slope there are two apical setae. The reverse apical stria is clearly visible and deep. The hind wings are fully reduced.

Male genitalia: The median lobe of aedeagus is 0.8 mm long. In lateral view, it is strongly arched. The apex is well differentiated, elongated, and directed slightly downward. In the dorsal view, the apical lamella is elongated, clearly separated by narrowing, slightly twisted to the right, and rounded at the tip. Endophallus with a clearly visible dihedral sclerotised plate—the copulatory piece—is slightly concave and saddle-shaped in the distal half; the proximal half is straight to slightly convex (Fig. 6).

TABLE 1. Descriptives of the body measuerments and indexes of *Trechus strandzhensis*.

	Females n=17						Males n=19					
	Mean (mm)	**Std. Dev**	**Std. Error**	**Median (mm)**	**Min (mm)**	**Max (mm)**	**Mean (mm)**	**Std. Dev**	**Std. Error**	**Median (mm)**	**Min (mm)**	**Max (mm)**
Metrics:												
L	4.00	0.22	0.05	4.03	3.66	4.27	4.13	0.22	0.05	4.15	3.48	4.45
HW	0.89	0.05	0.01	0.90	0.78	0.975	0.89	0.07	0.02	0.90	0.74	1.09
PL	0.83	0.06	0.01	0.82	0.74	0.936	0.84	0.06	0.01	0.86	0.66	0.94
PW	1.17	0.07	0.02	1.17	1.05	1.248	1.18	0.08	0.02	1.17	0.94	1.33
PBW	0.86	0.05	0.01	0.86	0.78	0.936	0.87	0.05	0.01	0.86	0.74	0.98
PAW	0.78	0.04	0.01	0.78	0.70	0.858	0.78	0.05	0.01	0.78	0.66	0.86
EL	2.50	0.15	0.04	2.46	2.26	2.808	2.62	0.16	0.04	2.61	2.11	2.89
EW	1.82	0.11	0.03	1.79	1.60	1.95	1.84	0.11	0.02	1.83	1.60	2.03
AHD	0.48	0.05	0.01	0.47	0.39	0.546	0.48	0.05	0.01	0.47	0.39	0.59
PHD	1.36	0.12	0.03	1.37	1.07	1.56	1.38	0.09	0.02	1.37	1.17	1.52
Indices:												
L/HW	4.52	0.16	0.04	4.55	4.19	4.76	4.64	0.23	0.05	4.69	3.80	4.96
L/PW	3.43	0.10	0.02	3.42	3.28	3.63	3.51	0.09	0.02	3.55	3.36	3.72
L/PL	4.84	0.19	0.05	4.83	4.43	5.14	4.90	0.16	0.04	4.91	4.56	5.24
L/EL	1.60	0.04	0.01	1.59	1.52	1.69	1.58	0.04	0.01	1.56	1.54	1.66
L/EW	2.21	0.09	0.02	2.20	1.94	2.31	2.25	0.08	0.02	2.24	2.12	2.42
EL/EW	1.38	0.06	0.02	1.39	1.20	1.50	1.42	0.06	0.01	1.42	1.32	1.57
PW/PL	1.41	0.05	0.01	1.42	1.29	1.48	1.40	0.04	0.01	1.40	1.30	1.46
PW/HW	1.32	0.04	0.01	1.33	1.25	1.40	1.32	0.07	0.02	1.33	1.07	1.41
PW/PBW	1.36	0.04	0.01	1.35	1.27	1.45	1.36	0.03	0.01	1.36	1.26	1.41
PW/PAW	1.50	0.05	0.01	1.48	1.42	1.60	1.51	0.05	0.01	1.52	1.41	1.58
PAW/PBW	0.91	0.03	0.01	0.91	0.86	0.96	0.90	0.03	0.01	0.91	0.86	0.96
EW/PW	1.56	0.07	0.02	1.56	1.45	1.72	1.56	0.06	0.01	1.57	1.42	1.71
EL/AHD	5.27	0.36	0.09	5.42	4.44	5.80	5.47	0.60	0.14	5.58	4.33	6.50
EL/PHD	1.84	0.14	0.03	1.80	1.71	2.29	1.91	0.12	0.03	1.88	1.71	2.13

TABLE 2. Body measures and indices entered in the discriminant model using stepwise procedure:

Measures	PBW	EL	EW/PW	PW	PW/PBW	EW
Wilks' Lambda	0.185	0.164	0.135	0.139	0.19	0.134

Etymology: The name of the species is taken from the mountain chain Strandzha, type locality and only locality known so far.

Affinities: Morphologically, the species is close to the subspecies of *T. cardioderus*, based on the apex of the median lobe of the aedeagus and the coloration of the body. But it clearly differs in the shape of the copulatory piece, which is slightly concave distally in *T. strandzhensis* and strongly curved upward in *T. cardioderus*.

The species is found only in the inner part of the Strandzha Mountains. Other species of the "*subnotatus*" group with the nearest known localities are *T. asiaticus* (Black Sea Coast, Cape Maslen nos, Kiten and Bolyarovo Vill.) and *T. byzantinus* (Istanbul Distr.). *T. strandzhensis* is easily distinguishable from *T. asiaticus* by the median lobe of the aedeagus more arched in the lateral view, with the apex pointed smoothly downward versus median lobe less arched and the apex sharply curved downward in the latter species. Additionally, *T. strandzhensis* is smaller and has the pronotum more narrowed to the base. *T. strandzhensis* differs clearly from *T. byzantinus* in the median lobe of the aedeagus which has a distinct constriction before the apex and a rounded tip in dorsal view. Meanwhile, in *T. byzantinus*, the apex is slightly and gradually narrowed to the tip, which is broad and straight. In addition, the copulatory piece in the lateral view is slightly concave distally in *T. strandzhensis* and strongly curved upward in *T. byzantinus*.

FIGURE 5. *Trechus strandzhensis* **sp.n.**: a—habitus of male paratype from "Indipasqua" Place, Strandzha Mts. Scale: 2 mm.

Distribution and habitat: Bulgarian and Turkish part of the Strandzha Mts in leaf litter of deciduous forests, often near rivers and streams: **riparian forest** of *Alnus glutinosa* Gartn., *Quercus cerris* L. with undergrowth of *Lusula* sp., *Festuca* sp., *Geranium* sp., and others; **old-growth forest** of *Quercus hartwissiana* Stev. and *Q. cerris* with undergrowth of *Carpinus orientalis* Mill., *Cornus mas* L., *Cornus sanguinea, Fraxinus ornis* L., *Acer campestre* L., *Fritillaria pontica* Wahlenb., *Geranium* sp., and others; **old-growth forest** of *Fagus orientalis* Lipsky, single trees of *Carpinus betulus* L. with scarce undergrowth of *Daphne pontica* L., *Cyclamen coum* Mill., *Asperula odorata* L., cereals and others; **old-growth forest** of *F. orientalis*, *Q. polycarpa* Schur. with thick undergrowth of *Rhododendron ponticum* L., single shrubs of *Daphne pontica* L., *Ruscus hypoglossum* L., *Cyclamen coum*, *Lusula* sp. and others, **wind-blown coastal forests** of *Quercus frainetto* Ten., *Q. cerris* with undergrowth of *Ruscus aculeatus* L., *Asparagus acutifolius* L., *Symphhytum taurium* Willd., *Fritillaria pontica* Wahlenb., *Primula acaulis ssp. rubra* (L.) and others; **caves** surrounded by old-growth *Quercus* forest.

FIGURE 6. Variability in the median lobe of the aedeagus of *Trechus strandzhensis* **sp.n** in lateral and dorsal view (a,b—paratype: Strandzha Mts., Slivarovo Vill., along Rezovska River, "Shafariitsa" Place; c,d—holotype: Strandzha Mts., Slivarovo Vill., along Rezovska River, "Shafariitsa" Place; e,f— paratype: Strandzha Mts., Malko Tarnovo, "Indipasqua" Place; g,h—paratype: Strandzha Mts., Demirköy surroundings). Scale: 0.2 mm.

Statistical analyses

After the stepwise procedure, six morphological characters were entered into the predictive discriminant model: the width of the pronotum (PW), the width of the pronotum base (PBW), the elytra length (EL), the elytra width (EW), the index EW/PW, and the index PW/PBW. Overall, 80.2% of the cross-validated *T. "subnotatus"* species group males were correctly classified according to the original groups (Table 3). The males of *T. cardioderus balcanicus* were not classified properly at all—three of them (50%) were classified as *T. cardioderus athonis* and the other three (50%) as *T. cardioderus irenis.* The graph of the first two canonical discriminant functions showed a gradient arrangement without a clear distance between the specimens from the different taxa (Fig. 7). Only the centroid of *T. strandzhensis* was at a relatively great distance from all the others, and the group is clearly distinguishable. Two groups of *T. cardioderus athonis* with the syntypes from Athos and *T. cardioderus irenis* with the syntype from

Romania, were also well differentiated despite some overlapping. The sample of *T. asiaticus* was extremely small; nevertheless, the specimens were well grouped and closely situated to the group of *T. cardioderus athonis*. The *T. cardioderus balcanicus* specimens did not form a group of their own, being randomly disseminated across the groups of *T. cardioderus irenis* and *T. cardioderus athonis*.

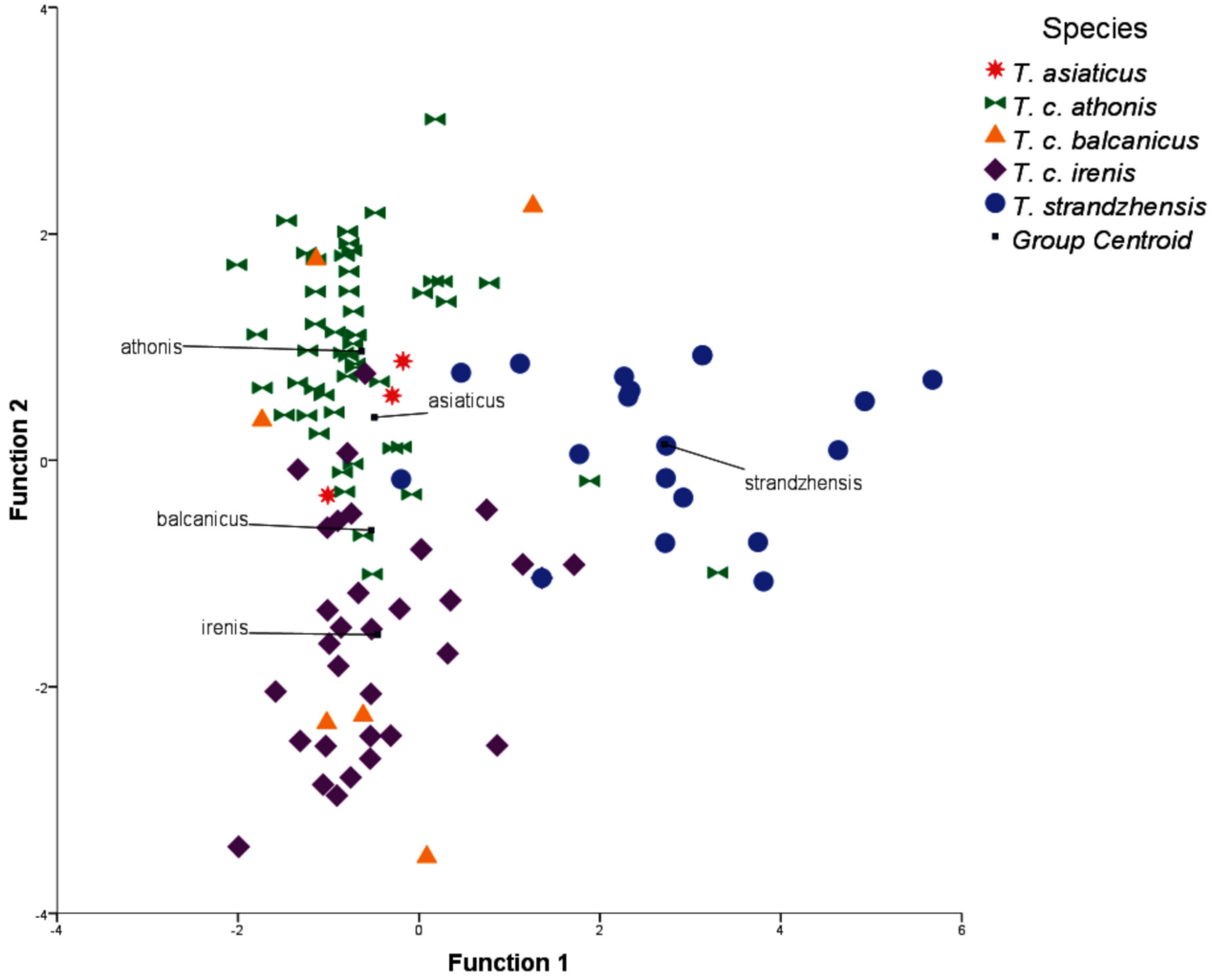

FIGURE 7. Scatter plot of the first two canonical discriminant functions for the *Trechus "subnotatus"* species group in Bulgaria.

TABLE 3. Cross-validated classification matrix for *Trechus "subnotatus"* species group in Bulgaria (number and percent classified individuals)

	Species	Predicted Group Membership					Total (n)
		T. asiaticus	*T. c. athonis*	*T. c. balcanicus*	*T. c. irenis*	*T. strandzhensis*	
Count	*T. asiaticus*	2	1	0	0	0	3
	T. c. athonis	2	45	0	2	2	51
	T. c. balcanicus	0	3	0	3	0	6
	T. c. irenis	1	3	0	27	1	32
	T. strandzhensis	0	3	0	1	15	19
%	*T. asiaticus*	66.7	33.3	0.0	0.0	0.0	100.0
	T. c. athonis	3.9	88.2	0.0	3.9	3.9	100.0
	T. c. balcanicus	0.0	50.0	0.0	50.0	0.0	100.0
	T. c. irenis	3.1	9.4	0.0	84.4	3.1	100.0
	T. strandzhensis	0.0	15.8	0.0	5.3	78.9	100.0

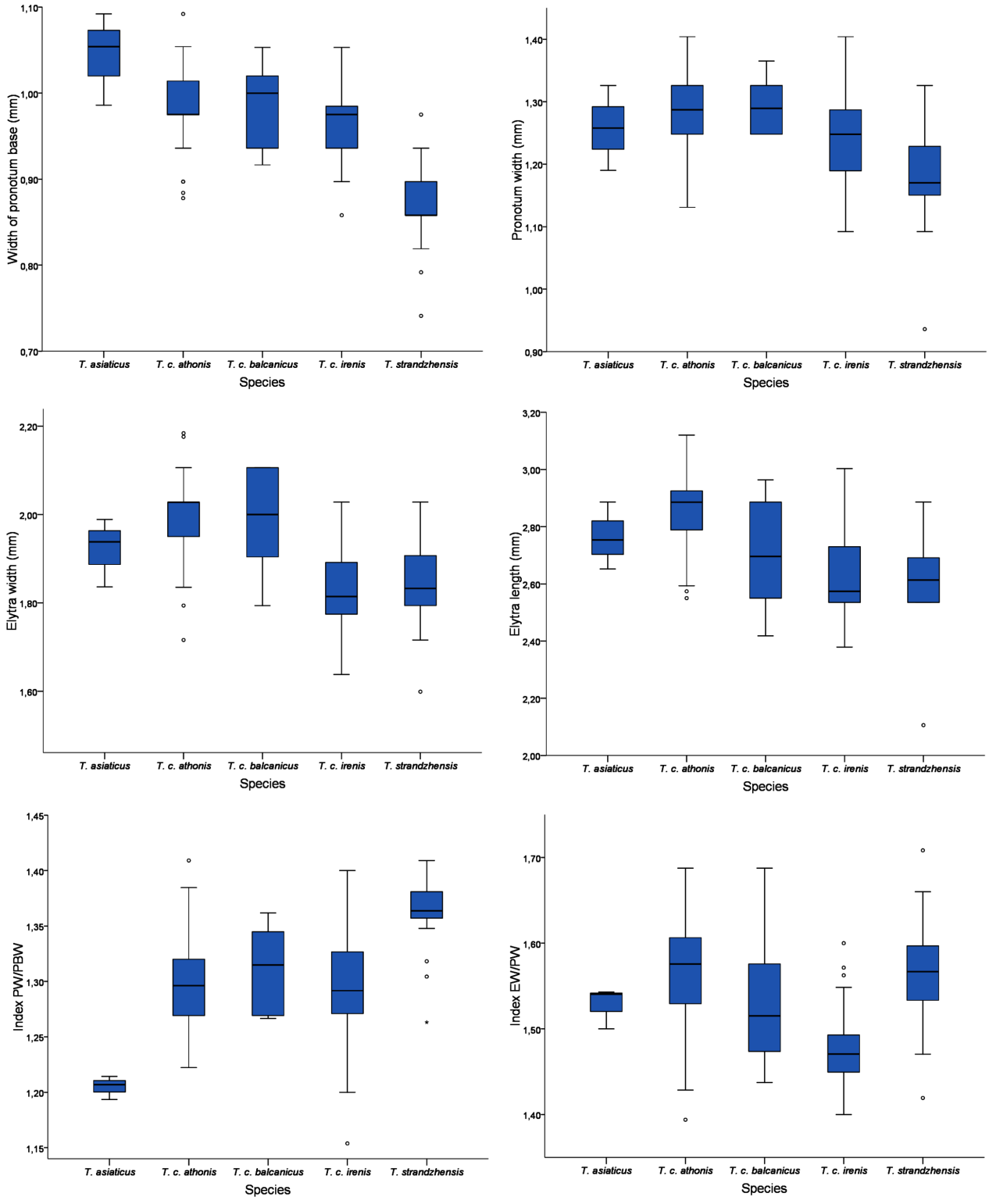

FIGURE 8. Variation in the morphometric characteristics entered in the stepwise discriminant analysis.

The results of ANOVA or ANOVA on Ranks showed significant differences overall between the morphological characteristics of the taxa left in the discriminant analysis. However, the *post hoc* tests revealed significant differences in average or median metric characteristics only between some of the taxa (Table 4). The box plot graphs (Fig. 8) represent the high variability and overlapping of the body measurements and indices entered in the discriminant analysis. *T. strandzhensis* significantly differed from all other taxa of the *T. "subnotatus"* species group from Bulgaria

in the median PBW, having the narrowest pronotum base. The species also was characterised by a significantly narrower pronotum (median) than *T. cardioderus balcanicus* and *T. cardioderus athonis. T. cardioderus athonis* was distinguished by a significantly longer (median) and wider (mean) elytra than *T. strandzhensis* and *T. cardioderus irenis. T. asiaticus* had a significantly lower mean index PW/PBW than all the others—the widest base in relation to the total width (a less heart-shaped pronotum). *T. strandzhensis* had a significantly higher mean index PW/PBW than the others—more heart-shaped pronotum, excluding *T. cardioderus balcanicus*, with which it overlaps. *T. cardioderus irenis* significantly differed from *T. cardioderus athonis* and *T. strandzhensis* in the index EW/PW, showing a lower average value due to the narrower elytra.

TABLE 4. Significant differences in average or median values of the morphometric characters of the studied taxa entered in the stepwise discriminant analysis.

Measures and ANOVA/ ANOVA on Ranks results	**Comparations**	***Post hoc* tests**		Significance
		Tukey's test	**Dunn's test**	**P**
Width of pronotum	*T. c. balcanicus* vs *T. strandzhensis*		3.28	0.011
H=27.29, p<0.001	*T. c. athonis* vs *T. strandzhensis*		4.84	<0.001
Width of pronotum base	*T. asiaticus* vs *T. strandzhensis*		4.12	<0.001
H= 46.57, p<0.001	*T. c. balcanicus* vs *T. strandzhensis*		3.84	0.001
	T. c. athonis vs *T. strandzhensis*		6.18	<0.001
	T. c. irenis vs *T. strandzhensis*		4.17	<0.001
Length of elytra	*T. c. athonis* vs *T. strandzhensis*	9.14		<0.001
F = 18.19, p<0.001	*T. c. athonis* vs *T. c. irenis*	10.34		<0.001
Width of elytra	*T. c. athonis* vs *T. c. irenis*		5.91	<0.001
H = 47.58, p<0.001	*T. c. athonis* vs *T. strandzhensis*		4.91	<0.001
	T. asiaticus vs *T. strandzhensis*	7.88		<0.001
Index PW/PBW	*T. c. irenis* vs *T. strandzhensis*	6.98		<0.001
F= 11.35, p<0.001	*T. c. athonis* vs *T. strandzhensis*	7.02		<0.001
	T. c. balcanicus vs *T. asiaticus*	4.82		0.008
	T. c. athonis vs *T. asiaticus*	5.07		0.005
	T. c. irenis vs *T. asiaticus*	4.76		0.009
Index EW/PW	*T. c. athonis* vs *T. c. irenis*	9.23		<0.001
F =11.66, p<0.001	*T. c. irenis* vs *T. strandzhensis*	6.87		<0.001

Identification key to the males of the taxa of *T.* "*subnotatus*" group in Bulgaria

1 Dorsal surface brown or reddish brown, usually with well visible prolonged humeral and oval spots before the apex on the elytra, but sometimes unicoloured; The copulatory piece of the median lobe of the aedeagus almost straight in the lateral view 2

- Dorsal surface unicoloured brown or reddish brown, shiny, and slightly iridescent (exception *T. cardioderus athonis* with varying colouration—more often with prolonged humeral, and sometimes oval spots before the apex on the elytra or unicoloured); The copulatory piece of the median lobe of the aedeagus strongly curved upward or slightly concave in the distal part 3

2 Median lobe of the aedeagus at the apex prolonged and pointed downward in the lateral view (Fig. 9); Wingless . . . . . *T. subnotatus* s. str.

- Median lobe of the aedeagus with short apex, strongly curved downward in lateral view (Fig. 10); Wider pronotum base, usually PW/PBW≥1.2; Wings developed or reduced to varying degree . . . . . *T. asiaticus*

3 Copulatory piece strongly curved upward in the distal part. . . . . 4 (*T. cardioderus*)

- Copulatory piece humpbacked in the proximal part and slightly concave in the distal part; Median lobe with prolongated, well-differentiated apex; Apical lamella elongated, separated from the remaining part by a distinct constriction (Fig. 11); Pronotum strongly heart-shaped, with narrow pronotum base; Unicoloured brown, shiny, and slightly iridescent . . . . . *T. strandzhenzis* **sp. n.**

FIGURE 9. Aedeagus and copulatory piece *T. subnotatus* s.str. (From Jeannel 1927: 443; Fig. 1053 and 1055)

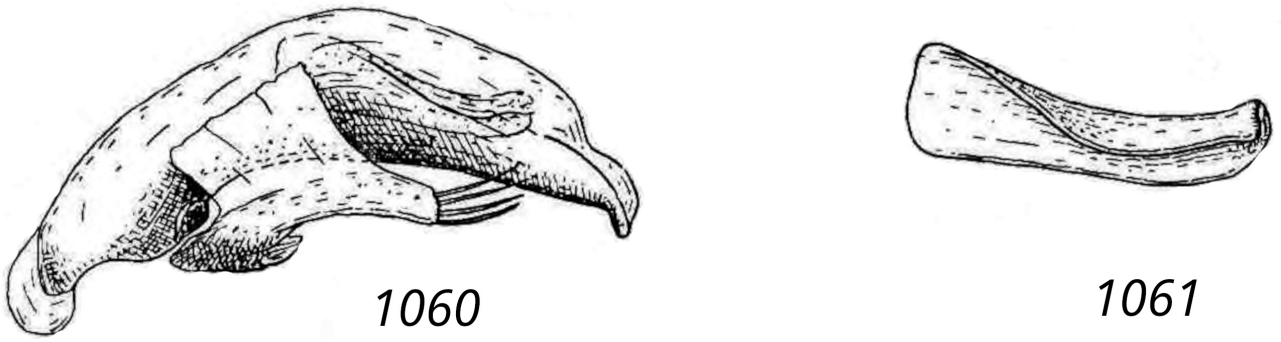

FIGURE 10. Aedeagus and copulatory piece of *T. asiaticus* (From Jeannel 1927: 444; Fig. 1060 and 1061)

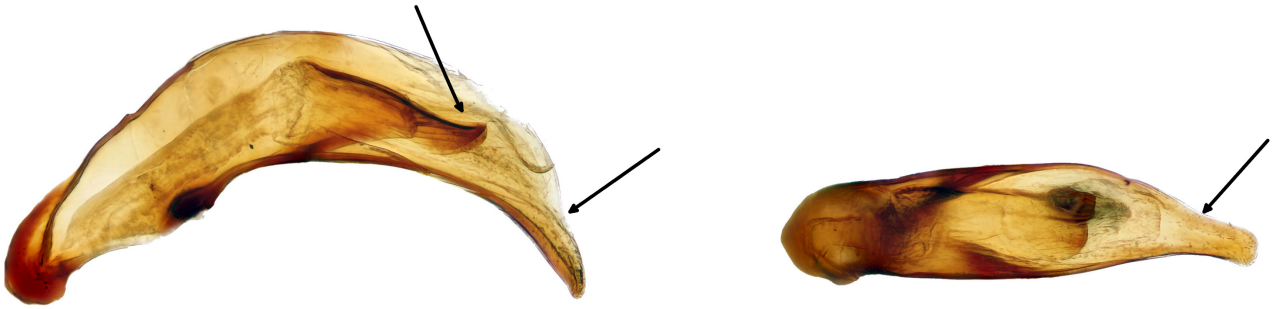

FIGURE 11. Aedeagus of *T. strandzhenzis* in lateral and dorsal view. Arrows point to diagnostic characters.

4 The apex of the median lobe prolonged 5
- The apex of the median lobe short 6
5 The apex is prolonged and gradually pointed downward in the lateral view; Apical lamella is wide and straight (not narrowing) in the dorsal view (Fig. 12); Brown or dark brown with varying colouration, most often with blurred humeral spots; Large elytra . . . . . *T. cardioderus athonis*
- The apex is strongly elongated and sharply curved downwards in the lateral view; Apical lamella separated from the main part by constriction, occasionally rather deep (Fig. 13); Unicoloured light brown or reddish brown, iridescent . . . . . *T. cardioderus balcanicus*

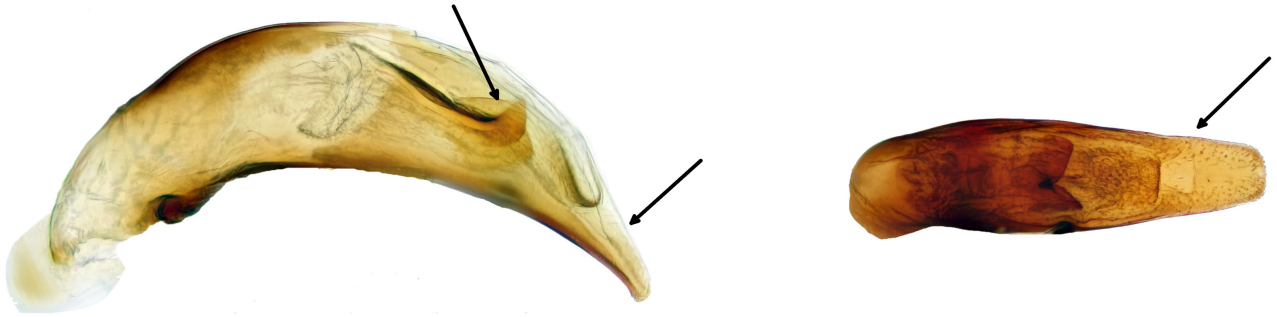

FIGURE 12. Aedeagus of *T. cardioderus athonis* in lateral and dorsal view. Arrows point to diagnostic characters.

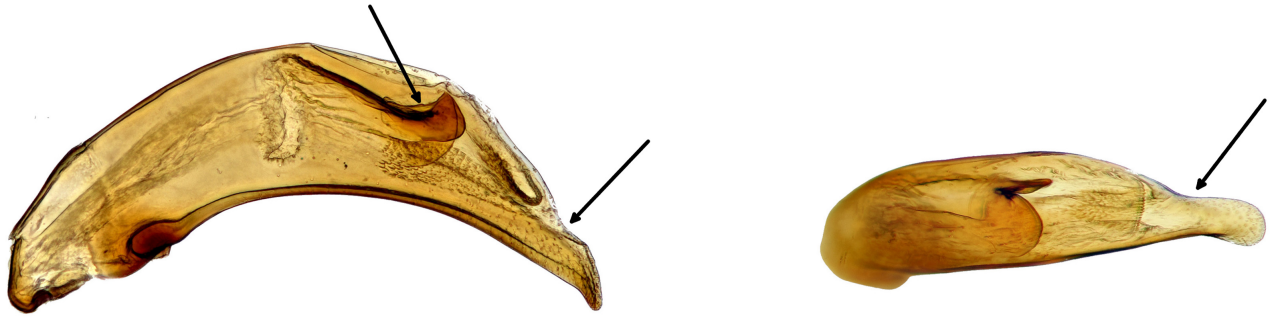

FIGURE 13. Aedeagus of *T. cardioderus balcanicus* in lateral and dorsal view. Arrows point to diagnostic characters.

6 Median lobe of the aedeagus in lateral view strongly arched at the dorsal side, and almost straight in distal 2/3 at the ventral side; Short and curved abruptly downward apex; Apical lamella with straight tip in dorsal view (Fig. 14); Unicoloured brown or dark brown; Elytra narrow, subparallel . . . . . *T. cardioderus irenis*

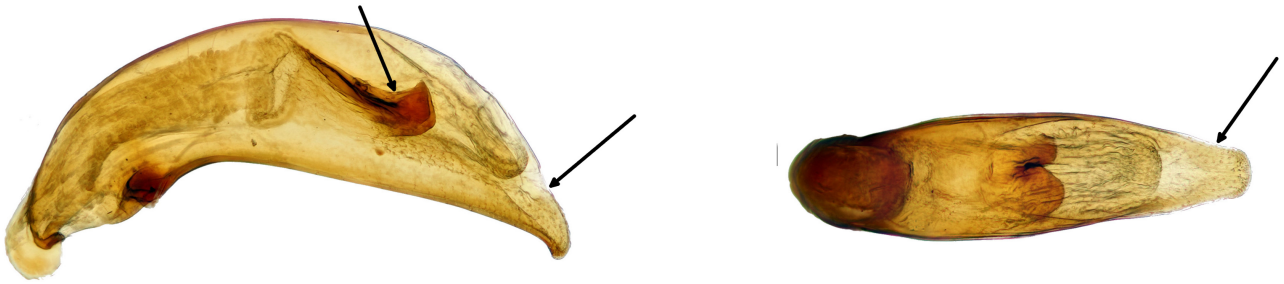

FIGURE 14. Aedeagus of *T. cardioderus irenis* in lateral and dorsal view. Arrows point to diagnostic characters.

Discussion

The presence in Bulgaria of the nominal form of *Trechus subnotatus* s.str. (Dejean, 1831), as treated in the revision of Jeannel (1927), was not proven. Most likely, all records of *T. subnotatus* s.str. in Bulgaria were based mainly on external morphological features and colouration. *T. subnotatus* was first reported in Bulgaria by Netolitzky in 1912; afterwards, Jeannel reported its presence in 1921, based on the material of Netolitzky from Tryavna and the environments of Sofia. In that work, he synonymised *T. subnotatus* s.str., *T. cardioderus athonis,* and *T. pallidipennis.* Jeannel changed his opinion in his revision of Trechini (1927) and classified *T. cardioderus athonis* as a subspecies of *T. cardioderus* due to its strongly curved copulatory piece. However, the doubt that the specimens from Bulgaria were listed in the revision, as *T. subnotatus* s.str., based on the previous work in 1921, without checking if it is not *T. cardioderus athonis,* remains. The pinned material, one male and one female labeled "Trjevna, Bulg., Netolitzky", was found in the collection of MNHN; the specimen from "environs de Sofia" was missing. We did not find the dissected aedeagus of the male specimen—most probably, it was not dissected or was lost. Pawlowski (1973) reported *T. subnotatus* s.str. in Pirin Mt. with 11 male specimens, labeled "Sarlir Pirin Mac. VII 32 Mar.

et Tab." (MNP), and commented that they differ from the typical form described by Jeannel (1927). The drawing of the median lobe of the aedeagus by Pawlowski (1973) corresponds to that of *T. cardioderus athonis*. We had the possibility of checking only one male specimen from the Pirin Mts. in the collection of IBER and identified it as *T. cardioderus athonis.* In addition, in the Pirin Mts., Mařan (1933) reported the presence of *T. cardioderus golesnicensis* in Bulgaria, but his samples could not be found and investigated. After Mařan, the subspecies was reported in Bulgaria only by citing his work. The presence of *T. cardioderus golesnicensis* in Bulgaria was not confirmed in our study. According to Jeannel (1927: 455, 466), both subspecies *athonis* and *golesnicensis* possess very similar median lobes of the aedeagus, which differ only in the curvature of the apex in the lateral view. In his revision, Jeannel (1927) gives as main difference between the two subspecies the extremely narrow pronotum of *T. cardioderus golesnicensis.* In our study, we found few specimens of the type series of *ssp. athonis* from Athos Mt. (Greece), and some specimens from the Konyavska and the Ograzhden Mts. (Bulgaria), in which the apex of the median lobe was relatively straight, although downward directed in the lateral view and slightly reminiscent of that of *T. cardioderus golesnicensis* from the Jeannel's illustration (1927: 455) (Fig. 2—k,m). However, they were just variations of *ssp. athonis,* with habitus identical to the other specimens collected from the same place and possessing the median lobe of the aedeagus with apex clearly bended downward, as is typical for *T. cardioderus athonis*, as described by Jeannel in 1927. As we did not find the type material of *T. cardioderus golesnicensis* at this stage of our research, we cannot define the differences between the two subspecies, which will be the subject of future studies.

Another inference of our study is the reconsideration of the synonymisation of *T. cardioderus balcanicus* with *T. irenis* by Moravec & Lompe (2003) and the restoration of the status of the subspecies described by Jeannel (1927). The male genitalia of the single syntype of *T. irenis* clearly differ from those in the type series of *T. cardioderus balcanicus* in the collection of Jeannel (MNHN), as well as of the specimens *T. cardioderus balcanicus* from Bulgaria. The syntype of *T. irenis* is more similar in the lateral view to that of the *T. cardioderus cardioderus* (Putzeys, 1870) than to that of *T. cardioderus balcanicus*, as was noted by Jeannel in his revision (Jeannel, 1927). As mentioned above, the use of the name *T. cardioderus balcanicus* became problematic after its revival from synonymy because of the homonymy found by Moravec & Lompe (2003). The name of the junior homonym must not be automatically replaced, as both taxa have not been congeneric since 1899 (IZNC 1999: Art. 23.9.5). It stays in use until the decision of the International Commission on Zoological Nomenclature, to which the case will be referred. Furthermore, we still consider *T. irenis* a valid taxon, but with a new status as a subspecies of *T. cardioderus* - *T. cardioderus irenis.* Although *T. irenis* was synonymised with *T. cardioderus cardioderus* by Jeannel (1927), we found clear difference between the median lobes of the aedeagi of the *T. irenis* syntype from the Jeannel's collection (MNHN) and those of *T. cardioderus* s.str. in the same collection. The sample of *T. cardioderus irenis* from Bulgaria confirmed the persistence of these differences. The description of *T. cardioderus transdanubiensis* Nonveiller, Pavićević, Popović, 1994 from Serbia and the drawings of the aedeagus in lateral view (Nonveiller *et al.* 1994: 14) resemble to great extent that of the *T. cardioderus irenis*. The type material of *T. cardioderus transdanubiensis* has to be a subject of further research for describing clear discriminant differences between both subspecies.

Many records of *T. subnotatus s. str.* and *T. cardioderus irenis* in Bulgaria were based on identification by colouration and external characteristics only and need to be revised. Usually, the unicolourous forms from the group were recorded as *T. cardioderus balcanicus* and after the synonymisation by Moravec & Lompe (2003) as *T. irenis*; those with spots on the elytra were referred to as *T. subnotatus s.str.* For example, after examining the collection material, two of the specimens published as *T. irenis* by Kostova (2009) turned out to be *T. cardioderus athonis;* the specimens from the Strandzha Mts. in Kostova & Guéorguiev (2016) reported as *T. aff. irenis* have to be referred to *T. strandzhensis*; the specimen from the Pirin Mts. reported by Teofilova (2020) as *T. subnotatus subnotatus* proved to be *T. cardioderus athonis.*

It should be noted that the species *Trechus subacuminatus* Fleischer, 1898, reported for Bulgaria by Guéorguiev (2011), Bekchiev & Guéorguiev (2014), and Belousov (2017), was erroneously referred to a winged variety of *T. subnotatus* by Jeannel (1927). Subsequently, Jeannel himself (1929) corrected this error and referred *T. subacuminatus* to the "*austriacus*" species group, as the male copulatory organ has nothing in common with those of the "*subnotatus*" species group, and for the winged form of the *T. subnotatus*, he assigned a new name, *T. subnotatus longipennis* Jeannel, 1929, which is not reported in Bulgaria.

Problematic for the Balkan fauna remain the taxa *T. subnotatus s.str.*, *T. pallidipennis, T. cardioderus athonis, T. cardioderus golesnicensis*, and *T. byzantinus* as the morphology of their aedeagi is similar. Moravec & Zieris (1998) commented that *T. pallidipennis* could probably be a synonym of *T. austriacus*, a hypothesis that was also stated

by Pawlowski (1979). However, the aedeagus on the microscope slide determined by Jeannel as *T. pallidipennis* (deposited in his collection at MNHN) is similar to that of the *T. subnotatus* s. str., with a slightly more curved copulatory piece in the distal part, and is totally different from that of taxa from the *"T. austriacus"* group.

The statistical analysis of the morphometric characteristics of the studied male specimens showed great variability in and overlap among the taxa. The width of the pronotum, the width of the pronotum base, the elytra length, the elytra width, the index EW/PW, and the index PW/PBW were defined as distinguishing characteristics between the taxa of the species group in Bulgaria. The predictors classified with relatively high efficiency the studied male specimens into the right taxon, except for *T. cardioderus balcanicus.* Wrong classification of the latter subspecies may be explained by the small sample size, its non-normal distribution, and great variability in the morphometric characteristics. The *post hoc* tests of the analyses of variance revealed significant differences between *T. strandzhensis* and all other species in the characteristics of the pronotum—it has the narrowest and most heart-shaped pronotum. *T. asiaticus* also differed significantly from all other taxa, with its wider pronotum base in relation to the width of the pronotum, a characteristic also pointed out by Jeannel (1927) and Pawlowski (1973). However, there was a slight overlap in the index PW/PBW between the highest values of *T. asiaticus* and the lowest values of *T. cardioderus irenis*, so the index could not be used as reliable diagnostic character.

In our work we have followed Jeannel's idea of dividing the subspecies of *Trechus cardioderus* based on the morphology. However, the presence of different *T. cardioderus* subspecies in relatively close locations, as it shown on the map (Fig. 1), suggests that either recent sympatric divergence has taken place with probable reproductive isolation, or much more likely the status of these taxa should be reconsidered, and they might be either regarded as distinct species or as a single polymorphic taxon. A solution to this problem may eventually be provided by a molecular approach to ascertain the extent of differences between taxa, whether hybridization exists, their descent and relationships. Furthermore, a revision of the type specimens of all taxa from the "*subnotatus"* species group and analyses of their phylogeny are sorely needed due to the ambiguous differentiation and unclear relationships among all its members.

Acknowledgements

The authors are very grateful to Dr. Borislav Guéorguiev (NMNHS) for all his support, discussions and for the provided material from the NMNH collection, as well for the type material from the collections of SDEI, HNHMB and NBC. We thank Dr. Peter Hlavač (National Museum, Praha, Czech Republic) and Dr. Ivan Löbl (emeritus curator at Muséum d'Histoire naturelle de Genève) for encouraging the research on the revision of the group in Bulgaria. We also thank Dr. Thierry Deuve, Dr. Olivier Montreuil and Dr. Antoine Mantilleri (MNHN, Paris) for the possibility to work with the former collection of R. Jeannel. Thank to Dr. Teodora Teofilova (IBER, Bulgarian Academy of Sciences) for the access to the material from the Pirin Mts. We are very grateful also to the reviewers of the manuscripts Dr. Igor Belousov (All-Russian Institute of Plant Protection, Saint Petersburg) and Dr. Arnaud Faille (State Museum of Natural History, Stuttgart), whose comments and advises significantly contributed for its improvement.

The research was supported by the project "Cybertaxonomic approach to phylogenetic studies of model invertebrate genera (Invertebrata, Arachnida, Insecta) clarifying the problems of origin, formation and conservation of the Invertebrate Fauna of the Balkan Peninsula" (National Science Fund, Ministry of Education and Science of the Republic of Bulgaria, Grant KP-06-H21/1-17.12.2018).

References

Apfelbeck, V. (1901) Izvještaj o entomološkom istraživalačkom putovanju u Tursku i Grčku u god. 1900. *Glasnik Zemaljskog Muzeja Bosni i Hercegovini*, 13, 405–438.

Apfelbeck, V. (1918) Diagnosen neuer Koleopteren von der Balkanhalbinsel. *Anzeiger der Kaiserlichen Akademie der Wissenschaften. Mathematisch-naturwissenschaftliche Klasse. Wien*, 55, 75–77.

Bekchiev, R. & Guéorguiev, B. (2014) First purposive study of beetles (Coleoptera) from endogean environments in Bulgaria: collection sites and preliminary results. *Biodiversity Journal*, 5, 327–340.

Belousov, I. (2017) Genus *Trechus* Clairville, 1806. *In*: Löbl, I. & Löbl, D. (Eds.), *Catalogue of Palearctic Coleoptera Volume 1. Archostemata—Myxophaga—Adephaga. Revised and Updated Edition*. Koninklijke Brill NV, Leiden, pp. 420–451.

Beron, P. (1972) Essai sur la faune cavernicole de Bulgarie. III. Résultats des recherches biospéléologiques de 1966 à 1970. *International Journal of Speleology*, 4: 285–349. https://doi.org/10.5038/1827-806X.4.3.4

Besuchet, C. (1957) Une technique nouvelle pour la préparation de l'édéage des Microcoléoptères. *Mitteilungen der schweizerischen entomologichen Gesellschaft*, 30, 341–342.

Clairville, J.P. (1806) *Entomologie helvétique ou catalogue des insectes de la Suisse rangés d'après une nouvelle méthode. Avec descriptions et figures*. *Zweiter Theil*. Orell, Fussli et Compagnie, Zürich, 247 pp.

Csiki, E. (1912) Új barlangi carabidák. *Rovartani Lapok*, 19 (2–3), 18–20.

Degiovanni, A. & Magrini, P. (2016) Note tassonomiche su alcuni *Trechus* italiani del "gruppo subnotatus" (sensu Jeannel, 1927), con rivalutazione di un taxon e una nuova sinonimia (Coleoptera, Carabidae, Trechinae). *Giornale Italiano di Entomologia*, 14, 375–394.

Dejean, P.F.M.A. (1831) *Species général des coléoptères, de la collection de M. le Comte Dejean. Tome cinquième.* Méquignon-Marvis, Paris, 883 pp.

Donabauer, M. (2019) A taxonomic reorganization of European *Trechus* Clairville, 1806 (Coleoptera: Carabidae: Trechinae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen*, 71, 87–117.

Donabauer, M. (2020) A contribution to the knowledge of the endemic and subendemic Carabidae (Coleoptera) from the Rila and Pirin mountain ranges in Bulgaria. *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen*, 72, 95–107.

Drenovski, Al. K. (1942) Vierter Beitrag zur Insektenfauna Bulgariens und Macedoniens (Apterygogena und Käfer). *Bulletin de la Société Entomologique de Bulgarie*, 12, 1–14. [in Bulgarian]

Faille, A., Casale, A. & Ribera, I. (2011) Phylogenetic relationship of Western Mediterranean subterranean Trechini groundbeetles (Coleoptera: Carabidae). *Zoologica Scripta*, 40, 282–295. https://doi.org/10.1111/j.1463-6409.2010.00467.x

Fleischer, A. (1898) Neue Trechus-Arten. (Coleoptera). *Wiener Entomologische Zeitung*, 17, 57–59. https://doi.org/10.5962/bhl.part.3132

Frivaldszky, J. (1879) Coleoptera nova ab Eduardo Merkl in M. Balkan inventa. *Természetrajzi Füzetek*, 3, 230–233.

Guéorguiev, V. & Guéorguiev, B. (1995) *Catalogue of the ground-beetles of Bulgaria (Coleoptera: Carabidae). Series faunistica.* Pensoft Publishers, Sofia-Moscow, 273 pp.

Guéorguiev, B. (1999) Contribution to the study of the ground-beetle fauna (Coleoptera: Carabidae) of the Osogovo Mountain, Bulgaria. III. *Historia Naturalis Bulgarica*, 10, 67–76.

Guéorguiev, B. (2004) Adephagous and some staphyliniform beetles (Insecta: Coleoptera) in the Eastern Rhodopes (Bulgaria and Greece). *In*: Beron, P. & Popov, A. (Eds.), *Biodiversity of Bulgaria. 2. Biodiversity of Eastern Rhodopes (Bulgaria and Greece)*. Pensoft & National Mususeum of Natural Hististory, Sofia, pp. 379–411.

Guéorguiev, B. (2011) New and interesting records of Carabid Beetles from South-East Europe, South-West and Central Asia, with taxonomic notes on Pterostichini and Zabrini (Coleoptera, Carabidae*). Linzer biologische Beiträge*, 43 (1), 501–547.

Guéorguiev, B. & Lobo, J. (2006) Adephagous beetles (Insecta: Coleoptera: Adephaga) in the Western Rhodopes (Bulgaria and Greece). In: Beron, P. (Ed) *Biodiversity of Bulgaria. 3. Biodiversity of Western Rhodopes (Bulgaria and Greece)*. Pensoft & National Mususeum of Natural Hististory, Sofia, pp. 283–346.

Jeannel, R. (1921) Notes sur les Trechini (Coleopt. Carabidae). *Buletinul Societàtii de Stiinte din Cluj*, 1 (1), 154–170.

Jeannel, R. (1927) *Monographie des Trechinae. Morphologie comparée et distribution géographique d'un groupe de Coléoptères. Deuxième Livraison.* Socieìteì entomologique de France, Paris, 592 pp.

Jeannel, R. (1929) Le sillon transégéen et description de Coléoptères cavernicoles nouveaux de la Grèce. *Buletinul Societàtii de Stiinte din Cluj*, 4, 59–84.

Kostova, R. (2009) Ground Beetles (Coleoptera: Carabidae) in Two Biosphere Reserves in the Rhodope Mountains, Bulgaria. *Acta Zoologica Bulgarica*, 61, 187–196.

Kostova, R. & Guéorguiev, B. (2016) The ground beetles (Coleoptera: Carabidae) of the Strandzha Mountain and adjacent coastal territories (Bulgaria and Turkey). *Biodiversity Data Journal*, 4, e8135. https://doi.org/10.3897/BDJ.4.e8135

Langourov, M., Lazarov, S., Stoev, P., Guéorguiev, B., Deltshev, Ch., Petrov, B., Andreev, S., Simov, N., Bekchiev, R., Antonova V., Ljubomirov, T., Dedov, I. & Georgiev, D. (2014) New and interesting records of the MSS and cave fauna of Vitosha Mt., Bulgaria. *Proceedings of Balkan Speleological Conference "Sofia'2014", Sofia, Bulgaria*, 28–30 March 2014, Special issue of Caving Club "Helictite", 66–76.

Mařan, J. (1933) Výsledky expedicí zoologichého oddělení Národního Musea do Bulharska. De Musaei Nationalis Pragae Sectionis zoologicae in Bulgariam expeditionibus scientificis. *Sborník Entomologického Odděleni Národního Musea v Praze*, 11, 87–91.

Mařan, J. (1939) Die Carabidenfauna der Golesnica-Planina. *Sborník Entomologického Oddělení Národního Musea v Praze*, 17, 137–150.

Moravec, P. & Lompe, A. (2003) Genus *Trechus* Clairville, 1806. *In*: Löbl, I. & Smetana, A. (Eds.) *Catalogue of Palaearctic Coleoptera. Vol. 1*. Apollo Books, Stenstrup, pp. 22–23 + 324–343.

Moravec, P. & Zieris, V. (1998) *Trechus skoupyi* sp. n. und Bemerkungen zu weiteren Trechus-Arten aus der Türkei und Griechenland (Coleóptera: Carabidae). *Klapalekiana*, 34, 203–218.

Netolitzky, F. (1912) Eine Sammelreise nach Bulgarien (Schluβ). Aufzahlung der gesammelten Käferarten. *Koleopterologische*

Rundschau, 1 (11), 156–161.
Nonveiller, G., Pavićević, D. & Popović, M. (1994) Les espèces du genre *Trechus* actuellement connues de Serbie (Coleoptera, Carabidae). *Bulletin de la Société entomologique de France*, 99 (1), 5–25.
https://doi.org/10.3406/bsef.1994.17032
Hieke, F., Wrase, D. (1988) Faunistik der Laufkäfer Bulgariens (Coleoptera, Carabidae). *Deutsche Entomologische Zeitschrift*, 35, 1–171.
https://doi.org/10.1002/mmnd.19880350102
Hurka, K, (1990) *Duvalius (Paraduvalius) hanae* sp.n. (Coleoptera, Carabidae, Trechini) from the Stara planina Mts., Bulgaria. *Acta Entomologica Bohemoslovaca*, 87, 349–351.
ICZN (1999) International Code of Zoological Nomenclature. Fourth edition. International Trust for Zoological Nomenclature. London. Available from: https://www.iczn.org/the-code/the-code-online/ (accessed 20 April 2022)
Pawlowski, J. (1973) Bulgarian species of the genus *Trechus* Clairv. (Coleoptera, Carabidae). *Acta Zoologica Cracovensia*, 18, 217–270.
Pawlowski, J. (1979) Révision du genre *Trechus* Clairv. (Coleoptera, Carabidae) du Proche Orient. *Acta Zoologica Cracovensia*, 23, 247–476.
Putzeys, J.A.A.H. (1870) Trechorum oculatorum monographia. *Entomologische Zeitung (Stettin)* 31, 145–201.
Rambousek, F. (1912) Fauna Coleoptorum Bulgarica. *Travaux de la Société bulgare des sciences naturelles*, 5, 57–113. [In Bulgarian; French summary]
Schatzmayr, A. (1909) Neue Coleopteren aus Makedonien. II. Serie. *Wiener Entomologische Zeitung*, 28, 104.
Schaum, H.R. (1857) Beitrag zur Käferfauna Griechenlands. Erstes Stück: Cicindelidae, Carabici, Dytiscidae, Gyrinidae. *Berliner Entomologische Zeitschrift*, 1, 116–158.
https://doi.org/10.1002/mmnd.18570010115
Teofilova, T. (2016) Initial Study of the Ground Beetles (Coleoptera: Carabidae) and Other Invertebrates from "Leshnitsa" Nature Reserve (Central Stara Planina Mountains, Bulgaria). *Ecologia Balkanica*, 8, 79–87.
Teofilova, T. (2017) A contribution to the study of ground beetles (Coleoptera: Carabidae) in the Western Rhodope Mts. (Bulgaria). *Journal of BioScience and Biotechnology*, 6, 203–209.
Teofilova, T. (2020) Pseudomaquises in SW Bulgaria as a habitat for the ground beetles (Coleoptera: Carabidae). *Zoology and Ecology*, 30 (1), 27–36.
https://doi.org/10.35513/21658005.2020.1.4
Teofilova, T. & Kodzhabashev, N. (2020a) Ecological, Faunistic and Zoogeographical notes on the ground beetles (Coleoptera: Carabidae) from the Eastern Rhodope Mts. of Bulgaria. *Forestry Ideas*, 26, 77–96.
Teofilova, T. & Kodzhabashev, N. (2020b) Ground beetles (Coleoptera: Carabidae) from the Sarnena Sredna Gora Mts. *In*: Georgiev, D., Bechev, D. & Yancheva, V. (Eds.), Fauna of Sarnena Sredna Gora Mts. Part 1. *ZooNotes*, Supplement 9, Available from: http://www.zoonotes.bio.uni-plovdiv.bg/Supplements/Suppl%209_Sarnena/ZooNotes_Supplement_9_95-114_2020%20Teofilova&Kodzhabashev_Carabidae.pdf (accessed 20 April 2022)
Wrase, D. (1991) Faunistik der Laufkäfer Bulgariens (Coleoptera, Carabidae). 1. Nachtrag. *Mitteilungen der Entomologischen Gesellschaft Basel*, 41, 2–20.
Yoakimov, D. (1904) Contribution to the Bulgarian insect fauna—I. Coleoptera. *Sbornik za umotvorenia, nauka i knizhnina, Sofia*, 20, 1–43. [in Bulgarian]