



***Trechus* species from Mt. Choke of northern Ethiopia related to *T. niloticus* (Quéinnec & Ollivier) with notable male genital morphology (Carabidae: Trechini)**

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Abstract

The Choke Mountain in northern Ethiopia is remarkable due to its highly diverse Trechini fauna. Based on numerous specimens recently collected in the high montane and afroalpine zones along different slopes of Mt. Choke we revise the species related to *Trechus niloticus* (Quéinnec & Ollivier) and *T. reebae* (Quéinnec & Ollivier). These species are characterized by probable synapomorphies of the male genitalia and thus may form a natural group. Four species will be newly described which all are endemic to certain parts of the volcano: *T. apertus* sp. n., *T. igori* sp. n., *T. kniphofia* sp. n., and *T. yitbareki* sp. n. From viewpoint of genital morphology, *T. apertus* sp. n. is particular remarkable due to the fact that the dorsal ostium of the male genital extends basally across three quarter of the basal bulb. A key to the smaller *Trechus* species with body size up to 4 mm is presented.

Key words: *Abyssinotus*, taxonomy, distribution, habitat, new species, key to species

Introduction

The Afromontane and Afroalpine ground beetle faunas of Ethiopia are extraordinarily unique. On the one hand, the different volcanoes of the country each have their own species composition; the ground beetle faunas of the individual massifs are largely made up of wingless species that are endemic to the separate massifs (Merene *et al.* 2023). On the other hand, there are hardly any relationships between the Afromontane and Afroalpine ground beetle faunas of Ethiopia and their respective tropical lowland. The vast majority of those species that occur above 3000 m belong to only five genera: *Trechus* Clairville, *Calathus* Bonelli, *Amara* Bonelli, *Bembidion* Latreille (subgenera *Ocydromus* Clairville, *Peryphus* Dejean), and *Harpalus* Latreille (in decreasing order of the number of species recorded in Ethiopia; Merene *et al.* 2023), all of which are of Holarctic origin and lacking in the Ethiopian lowland areas.

The Afromontane and Afroalpine ground beetle fauna of Mt. Choke in northern Ethiopia has only rarely been the subject of investigations. Only two ground beetle species groups were studied up to today: *Calathus* (Lassalle 2016) and Trechini (Pawłowski 2001, Ortuño & Novoa 2011, Quéinnec *et al.* 2021, Faille *et al.* 2023, Schmidt & Merene 2024). But even in these groups, knowledge of the local species diversity is still inadequate. In the present paper, we review the species related to *Trechus niloticus* (Quéinnec & Ollivier, 2021) and *T. reebae* (Quéinnec & Ollivier, 2021) which were previously recognized as members of a separate trechine genus (*Nilotrechus* Quéinnec & Ollivier) endemic to Mt. Choke (Quéinnec *et al.* 2021). Based on a molecular phylogenetic analysis, Faille *et al.* (2023) have shown that *Nilotrechus* is a member of a terminal clade within *Trechus* sensu lato which is endemic to northern Ethiopia, and suggested using the subgeneric name *Abyssinotus* Quéinnec & Ollivier for this clade. During our fieldwork on Mt. Choke carried out in 2019 and 2022, we were able to obtain further data on the ecology, distribution and taxonomic diversity of species related to *T. niloticus* and *T. reebae*. These data will be presented in the following, together with the description of four new species.

Materials and methods

Specimens were examined using a Leica M205-C stereomicroscope. Photographs were taken using a Leica DFC450 digital camera with a motorised focussing drive, a Leica TL5000 Ergo light base, and diffused light with a Leica hood LED5000 HDI, subsequently processed with Leica LAS application software, and enhanced with CorelDRAW Graphics Suite X5. The specimens are deposited in the Natural History Museum, Addis Ababa University (NHMAA), the Bavarian State Collection for Zoology, Munich (ZSM), the Arnaud Faille working collection (cAF) and the Joachim Schmidt working collection (CSCHM, later to be deposited in the ZSM).

Body size was measured from the tip of mandibles in the opened position to the apex of the longer elytron. The width of the head (HW) was measured across the widest portion including compound eyes. The width of pronotum (PW) and the width of elytra (EW) were measured at their widest points. The length of pronotum (PL) was measured along the median line. The apical (PAW) and basal widths (PBW) of pronotum were measured between the tips of the apical and basal angles, respectively. The length of elytra (EL) was measured from the tip of the scutellar shield to the apex of the longer elytron. The length of aedeagal median lobe (AL) was measured across the longest distance without consideration of the sagittal aileron.

Results

Trechus (Abyssinotus) apertus Schmidt, sp. n.

Fig. 1

Type material. Holotype: ♂, with label data: Ethiopia, Amhara, W-slope Mt. Choke, 3370 m, 23.II.2019, 10°38'07"N 37°45'51"E, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM). Paratypes: 8 ♂♂, 7 ♀♀, with same data as holotype (CSCHM). 4 ♂♂, 5 ♀♀, W-slope Mt. Choke, 3450 m, 22.II.2019, 10°38'09"N 37°46'06"E, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (NHMAA, CAF, CSCHM).

Etymology. The species' epithet refers to the extraordinary wide dorsal opening of the aedeagal median lobe which is a morphological peculiarity of the new species.

Description. Body length: 2.5–2.8 mm.

Proportions (n = 12): PW/HW = 1.35–1.44 (\bar{O} = 1.41); PW/PL = 1.37–1.45 (\bar{O} = 1.40); PW/PBW = 1.18–1.22 (\bar{O} = 1.20); PBW/PAW = 1.18–1.24 (\bar{O} = 1.21); EW/PW = 1.38–1.46 (\bar{O} = 1.43); EL/EW = 1.24–1.30 (\bar{O} = 1.27).

Colour: Head, pronotum and elytra blackish brown; mandibles, palps, antennal base and legs yellowish brown; antennae slightly darkened beginning from second antennomere; in most specimens 2nd maxillary palpomere somewhat darkened; elytral apical margin very narrowly yellowish.

Microsculpture: Sculpticells on frons and supraorbital area large, moderately impressed, almost isodiametric; sculpticells on clypeus very finely impressed, slightly transverse. Sculpticells on pronotal disc smaller and finer impressed than on head disc, slightly transverse. Elytra with large and deeply impressed, almost isodiametric sculpticells throughout.

Head: Moderately robust. Mandibles short, with right mandible tridentate where all teeth are almost the same length, without diastema, without recognizable separation of premolar and retinaculum (Fig. 1B); tooth of left mandible with two blunt cusps (Fig. 1C). Penultimate labial palpomere with three setae (Fig. 1F). Labrum with apical margin moderately emarginate, with six setae near apical margin (Fig. 1D). Clypeus each side with two setae. Compound eyes rather small, slightly convex; tempora about $\frac{3}{4}$ of length of eyes, markedly convex, distinctly wrinkled to the neck. Dorsal surface of head with supraorbital area and frons markedly convex, and with supraorbital furrows deeply impressed, evenly curved. Two supraorbital setae and one suborbital seta each side. Tempora distinctly pubescent. Antennae short, with second antennomere about as long as scape, and with third antennomere shorter than second.

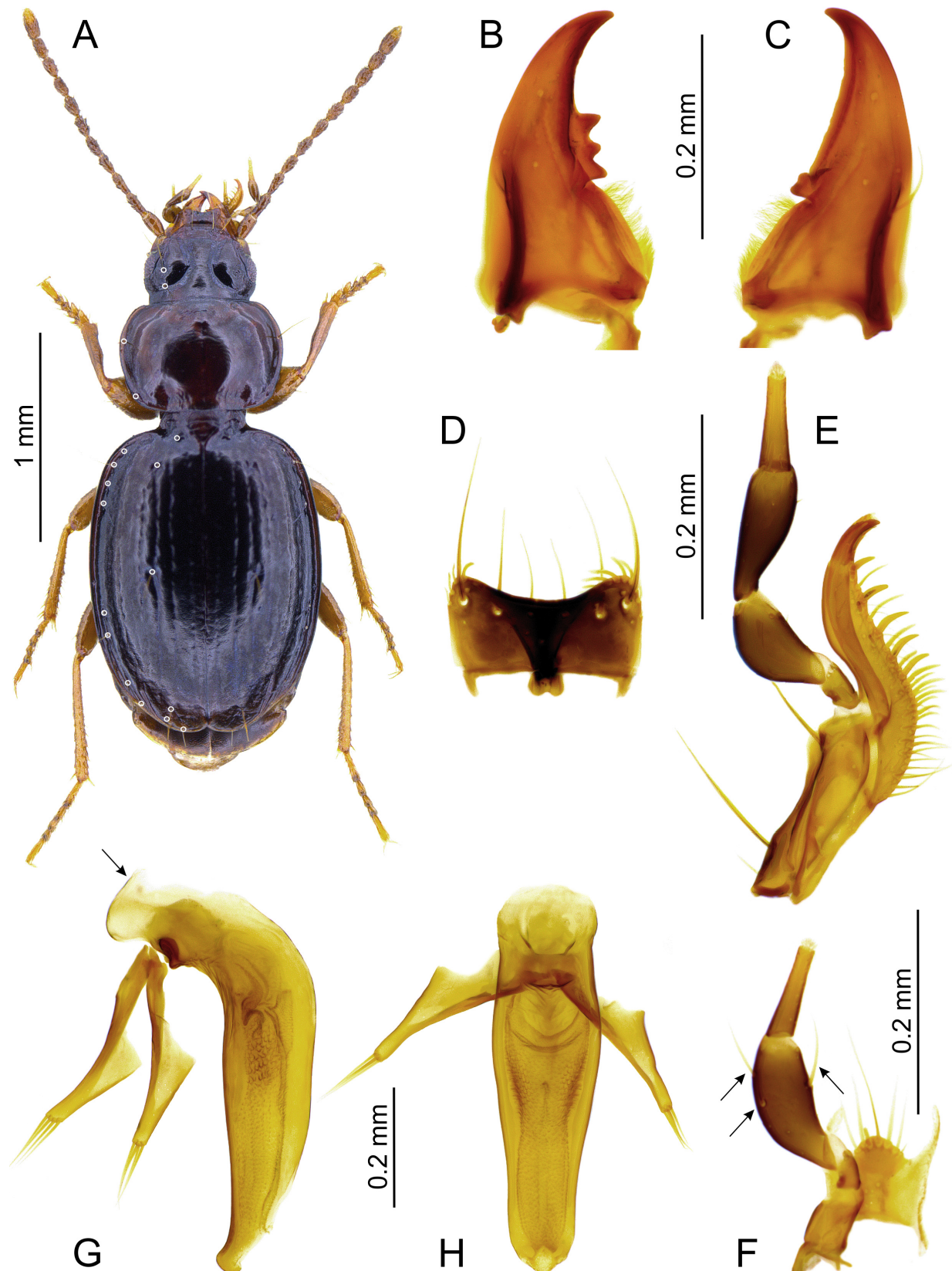


FIGURE 1. *Trechus (Abyssinotus) apertus* Schmidt, sp. n., holotype (Fig. 1A) and details of paratypes (Fig. 1B–H). **A**, habitus; the white circles point to the insertions of the supraorbital setae, pronotal lateral setae, parascutellar seta, elytral discal setae, and setae of the umbilicate series. **B**, right mandible, ventral aspect. **C**, left mandible, ventral aspect. **D**, labrum, dorsal aspect. **E**, left maxilla. **F**, left labial palpus and ligula, dorsal aspect; the arrows point to the three setae inserting on the penultimate palpomere. **G**, aedeagus, left lateral view. **H**, aedeagus, dorsal view.

Pronotum: Large and transverse, sub-discoidal, broadest slightly before middle, with base distinctly broader than apex; disc moderately convex. Anterior margin slightly concave (almost straight in middle), with anterior angles slightly protruded anteriorly, rounded; basal margin convex, with laterobasal angles markedly shifted anteriorly; lateral margin almost evenly rounded throughout; laterobasal angles very obtuse, indistinct (Fig. 1A). Marginal gutter narrow, slightly widened near laterobasal angle, extending towards laterobasal foveae. Median longitudinal impression very finely incised, disappearing near apex; anterior and posterior transverse impressions indistinct, smooth; laterobasal foveae small, moderately deep, smooth. Lateral and laterobasal setae present, with the former situated at the end of anterior pronotal third.

Pro- and mesepisternum: Glabrous and smooth.

Pterothorax: Elytra short, ovate, with disc convex, in dorsal view broadest in middle, humerus rounded but distinct, subapical sinuation indistinct, apex rounded. Striae 1–3 and anterior portion of stria 8 slightly impressed, punctate, external striae finer, 6–7 sometimes indistinct, stria 8 distinctly deepened before apex; parascutellar stria very short, deep, isolated. Recurrent preapical stria short, deep, with outer curvature directed towards the fifth stria. Parascutellar seta present; three discal setae located in the 3rd interval, adjoined to the 3rd stria (Fig. 1A): anterior seta located near the end of the anterior elytral 7th; middle seta located anterior of elytral middle, near the end of elytral 3/7; posterior seta (= subapical seta) located about 1/8 of elytral length from elytral apex; seta of the recurrent stria isolated, removed from this stria by distance of the diameter of the pore (Fig. 1A). Number and positions of the setae of the marginal umbilicate series typical of *Trechus* s. l. (Fig. 1A). Metepisternum very short, glabrous and smooth, with outer margin about as long as anterior margin.

Legs: Moderately short and robust. Protibia dilated towards apex, straight on external margin, its dorsal surface with very flat longitudinal groove without micro-setae on anterior surface. Two basal protarsomeres of males dilated and dentoid at the inner apical border (Fig. 1C).

Male genitalia: EL/AL = 2.00–2.23 (\bar{O} = 2.11; n = 8). Aedeagal median lobe robust, in lateral view markedly bent in basal third, almost straight towards apex, with ventral margin slightly convex in middle, ventrally bent towards apex, the latter with a small upwardly bent hook (Fig. 1G); in dorsal view broad in basal half, sinusoidal, narrowed from middle to apex (Fig. 1H). Dorsal surface of median lobe not sclerotized apart from the basal quarter of the basal bulb near the basal opening which is slightly sclerotized; sagittal aileron absent. Endophallus symmetrical in dorsal view, without distinct copulatory pieces, densely covered by rows of tiny scales along dorsal side of the inactive internal sac from its base to apex, and with a complex folding structure and large sclerotized scales near base of internal sac. Parameres similar in size and shape, moderately short, each with three or four apical setae.

Differential diagnosis. *Trechus apertus* sp. n. is distinguished from all previously described *Trechus* (s. l.) species of Ethiopia, by the aedeagal median lobe ostium which extends basally across three quarters of the basal bulb. Not any Ethiopian Trechina species was known so far that has a dorsal opening that includes parts of the basal bulb. In external characters, the new species differs additionally from all the small to medium-sized trechine species from Mt. Choke as follows: from *Trechus abyssinicus* (Quéinnec & Ollivier), *T. afroalpinus* (Quéinnec & Ollivier), *T. amharicus* Ortuño & Novoa and *T. lobeliae* (Quéinnec & Ollivier) in two basal protarsomeres dilated in males (one in all the latter species), from *T. amharicus* additionally in the presence of the middle seta of the elytral discal series (absent in *T. amharicus*), from *T. lobeliae* additionally in the smaller body size and the almost completely rounded pronotal laterobasal angles (rectangular in *T. lobeliae*), and from *T. abyssinicus*, *T. afroalpinus*, *T. igori* sp. n., *T. kniphofia* sp. n., *T. reebae* (Quéinnec & Ollivier) and *T. yitbareki* sp. n. in the more deeply impressed and distinctly punctate elytral striae (finely impressed and smooth or indistinctly punctate in all the latter species). In habitus, *T. apertus* sp. n. is very similar to *T. niloticus* Quéinnec & Ollivier which was described from the western crater rim of Mt. Choke. However, in *T. niloticus* the dorsal opening of the aedeagal median lobe do not reach the basal bulb (see Quéinnec *et al.* 2021: Fig. 26B, C). In addition, in *T. niloticus*, the median lobe is more elongated, with ventral margin straight in middle (convex in *T. apertus* sp. n.), its apical lamella is much longer, markedly bent ventrally (short and slightly bent ventrally in *T. apertus* sp. n.), the parameres are slenderer.

Distribution. Endemic to Mt. Choke in northern Ethiopia. The new species was only found near the top of a mountain ridge that extends from the crater rim to the west (Fig. 4).

Habitat preferences. All specimens of *T. apertus* sp. n. were sifted from the humus-rich soil under dense vegetation alongside a small brook. The brook has its source near the top of the mountain ridge and flows to the north, at an elevation of 3370–3450 m. No specimens were found on the pastures and in the bushland which bordered the brook. Based on these collecting circumstances, the new species can be considered hygrophilic and

cold-adapted. As potentially natural vegetation, a moist afro-montane forest would have formed at the site where the new species was found, but here it has given way to a cultivated steppe.

***Trechus (Abyssinotus) reebae* (Quéinnec & Ollivier, 2021)**

Fig 2A, 3A, F, I

Citations. *Nilotrechus reebae* Quéinnec & Ollivier: Quéinnec *et al.* (2021): 55.

Trechus (Abyssinotus) reebae (Quéinnec & Ollivier): Merene *et al.* (2023): 49.

Type material. Not studied. Identification is based on the original description, including habitus and male genital figures (Quéinnec *et al.* 2021) as well as on several additional specimens collected close to the type locality.

Additional material. 12 ♂♂, 14 ♀♀, Ethiopia, Amhara, Mt. Choke, western crater valley, alt. 3700–3800 m, 10°41'14"N 37°50'07"E, 24.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (NHMAA, CAF, CSCHM). 22 ♂♂, 11 ♀♀, Mt. Choke, western crater valley, alt. 3500–3600 m, 10°41'00"N 37°50'35"E, 01.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM). 11 ♂♂, 4 ♀♀, N-slope Mt. Choke, N of Waber, alt. 3450–3600 m, 10°44'48"N 37°46'22"E, 07.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM).

Description. See Quéinnec *et al.* (2021: 55–56). Proportion EL/AL = 2.01–2.12 ($\bar{\theta}$ = 2.05; n = 8).

Diagnosis. See key to species, below.

Distribution. Endemic to Mt. Choke in northern Ethiopia. Based on Quéinnec *et al.* (2021) and new sampling data, the species occurs on top of the western crater rim and on western slope of the crater valley, as well as on the north-facing mountain range north of the village Waber (Fig. 4).

Habitat preferences. Quéinnec *et al.* (2021) collected most specimens of the type series under clay at the base of a small cliff. The additional specimens of *T. reebae* were collected under stones and sifted from the humus-rich soil under dense vegetation alongside small streams, and no specimens were found on open pastures and in dry bushland areas. For the vertical distribution altitudes of 3500 to 3900 m were noted (see also Quéinnec *et al.* 2021). Based on these data, the new species can be considered hygrophilic and cold-adapted.

***Trechus (Abyssinotus) yitbareki* Schmidt, sp. n.**

Fig. 2B, 3C, F, H

Type material. Holotype: ♂, with label data: Ethiopia, Amhara, W-slope Mt. Choke, 3370 m, 23.II.2019, 10°38'07"N 37°45'51"E, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM). Paratypes: 33 ♂♂, 17 ♀♀, with same data as holotype (NHMAA, ZSM, CAF, CSCHM). 48 ♂♂, 31 ♀♀, W-slope Mt. Choke, 3450 m, 22.II.2019, 10°38'09"N 37°46'06"E, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (NHMAA, ZSM, CSCHM); of these, 1 ♂ (DNA voucher SMNS-L1821) was used for molecular genetic study (Faille *et al.* 2023).

Etymology. The new species is dedicated to one of its collectors, Yitbarek Woldehawariat, professor and entomologist at the Department of Zoological Science, University of Addis Ababa.

Description. Body length: 2.4–2.8 mm.

Proportions (n = 10): PW/HW = 1.39–1.47 ($\bar{\theta}$ = 1.43); PW/PL = 1.33–1.42 ($\bar{\theta}$ = 1.37); PW/PBW = 1.18–1.22 ($\bar{\theta}$ = 1.20); PBW/PAW = 1.21–1.29 ($\bar{\theta}$ = 1.24); EW/PW = 1.41–1.51 ($\bar{\theta}$ = 1.46); EL/EW = 1.28–1.35 ($\bar{\theta}$ = 1.31).

Colour: Head, pronotum and elytra blackish brown, pronotum sometimes more reddish; mandibles, palps, antennal base and legs yellowish brown; antennae darkened beginning from second or third antennomere; in most specimens 2nd maxillary palpomere darkened.

Microsculpture: Sculpticells on frons and supraorbital area large, moderately impressed, almost isodiametric, on clypeus very finely impressed, slightly transverse. Sculpticells on pronotal disc moderately impressed, slightly transverse. Elytra with large and deeply impressed, almost isodiametric or somewhat irregularly formed sculpticells.

Head: Compound eyes rather small, moderately convex; tempora about 4/5 of length of eyes. In all other characters as described in *T. apertus* sp. n.

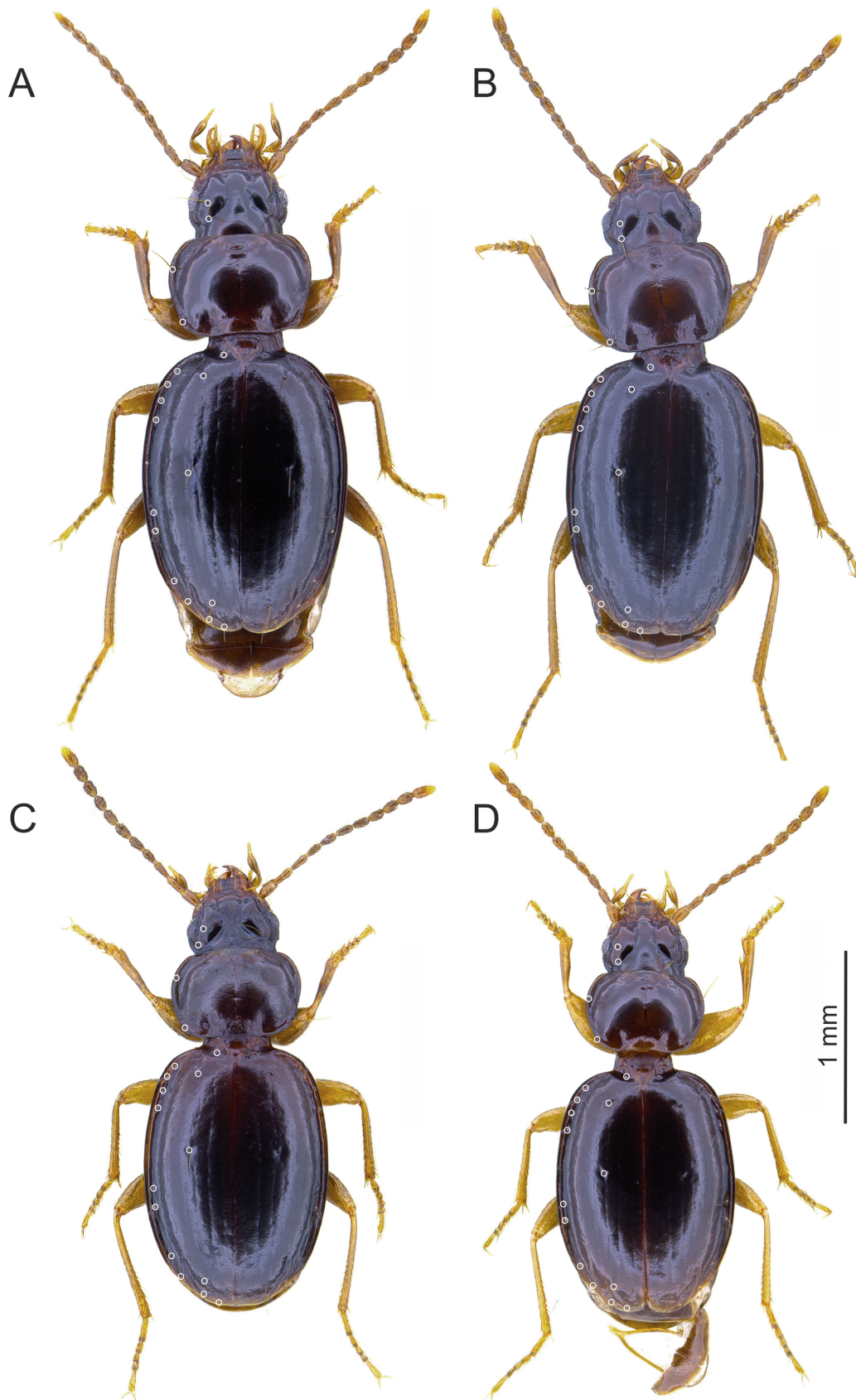


FIGURE 2. Habitus photographs of *Trechus* (*Abyssinotus*) species; the white circles point to the insertions of the supraorbital setae, pronotal lateral setae, parascutellar seta, elytral discal setae, and setae of the umbilicate series. **A.** *T. reebae* (Quéinnec & Ollivier, 2021), specimen from western crater valley. **B.** *T. yitbareki* Schmidt, sp. n., paratype. **C.** *T. kniphofia* Schmidt, sp. n., paratype. **D.** *T. igori* Schmidt, sp. n., paratype.

Pronotum: Pronotum large and transverse, sub-discoidal, broadest slightly before middle, with base distinctly broader than apex; disc moderately convex. Anterior margin slightly concave, with anterior angles slightly protruded anteriorly, rounded; basal margin convex, with laterobasal angles markedly shifted anteriorly; lateral margin almost evenly rounded throughout; laterobasal angles obtuse, sometimes indistinct. Marginal gutter narrow, extending towards laterobasal foveae, slightly widened between laterobasal angle and foveae. Median longitudinal impression finely incised, disappearing near apex and base; anterior transverse impression indistinct, smooth, posterior transverse impression broad and very shallow, smooth; laterobasal foveae small, moderately deep, smooth. Lateral and laterobasal setae present, with the former situated at the end of anterior pronotal third.

Pro- and mesothorax: Pro- and mesepisternum glabrous and smooth.

Pterothorax: Elytra short, ovate, with disc convex, in dorsal view broadest in middle, humerus rounded, subapical sinuation indistinct, apex rounded. Striae 1–3 slightly impressed, indistinct in some specimens, smooth or suggestively punctate, external striae absent apart from the apical portion of stria 8 which is distinctly deepened before apex; parascutellar stria absent. Recurrent preapical stria short, deep, with outer curvature directed towards the fifth stria. Parascutellar seta present; three discal setae located in the 3rd interval, adjoined to the 3rd stria: anterior seta located near the end of the anterior elytral 8th; middle seta located anterior of elytral middle, near the end of elytral 3/7; posterior seta (= subapical seta) located about 1/8 of elytral length from elytral apex; seta of the recurrent stria isolated, removed from this stria by distance of the diameter of the pore. Number and positions of the setae of the marginal umbilicate series as normal for *Trechus* s. l. Metepisternum very short, glabrous and smooth, with outer margin about as long as anterior margin.

Legs: Moderately short and robust. Protibia dilated towards apex, straight on external margin, its dorsal surface with longitudinal groove developed but very flat, without micro-setae on anterior surface. Two basal protarsomeres of males markedly dilated and dentoid at the inner apical border (Fig. 3C).

Male genitalia: EL/AL = 1.77–1.89 (\bar{O} = 1.82; n = 8). Aedeagal median lobe robust, in lateral view markedly bent in basal half, almost straight towards apex, with moderately long apical lamella hook-like bent dorsally (Fig. 3F); in dorsal view with side margin almost parallel, very slightly widened in apical quarter and shortly narrowed towards slender apical lamella (Fig. 3H). Dorsal opening extends basally near to the apical margin of basal bulb. Sagittal aileron absent. Endophallus symmetrical in dorsal view, without a distinct copulatory piece, densely covered by tiny scales, in the inactive position with a sac-like folding structure near its base and an area covered by large sclerotized scales on its dorsal side (Fig. 3F). Parameres similar in size and shape, rather slender, each with four apical setae.

Differential diagnosis. Externally, *T. yitbareki* sp. n. is very similar to *T. reebae*, but differs in the proportionally longer median lobe of the aedeagus (EL/AL < 1.9 in *T. yitbareki* sp. n., > 2.0 in = *T. reebae*) and in the longer apical lamella (Fig. 3F). The new species differs from the likewise similar *T. igori* sp. n. and *T. kniphofia* sp. n., prominently in the more markedly dilated protarsomeres 1 and 2 (Fig. 3C), and additionally in the more robust body which is, on an average larger, and in the larger aedeagus with longer apical lamella which is more markedly hook-like bent upwardly.

Distribution. Endemic to Mt. Choke in northern Ethiopia. The new species was only found near the top of a mountain ridge that extends from the crater rim to the west where it occurs sympatric with *T. apertus* sp. n. and *T. igori* sp. n. (Fig. 4).

Habitat preferences. The new species was found syntopic with *T. apertus* sp. n.; see above for details of the habitat.

***Trechus (Abyssinotus) kniphofia* Schmidt, sp. n.**

Fig. 2C, 3B, E, J

Type material. Holotype: ♂, with label data: Ethiopia, Amhara, E-slope Mt. Choke, Wondasha Guskum, alt. 3650 m, 10°41'05"N 37°59'21"E, 2.V.2022, leg. J. Schmidt, Yeshitla, M. (CSCHM). Paratypes: 4 ♂♂, 5 ♀♀, with same data as holotype (CSCHM). 1 ♂, 3 ♀♀, Mt. Choke, eastern crater valley, alt. 3700–3800 m, 10°42'59"N 37°54'13"E, 06.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM); 3 ♂♂, 2 ♀♀, NE-slope Mt. Choke, above Felege Birhan, alt. 3750–3850 m, 10°42'13"N 37°56'32"E, 30.IV.2022, leg. J. Schmidt, Yeshitla M. (CSCHM).

Etymology. The new species is named after the beautiful red-hot poker *Kniphofia foliosa* which is a common Asphodelaceae at sites where *T. kniphofia* sp. n. occurs.

Description. Body length: 2.3–2.8 mm.

Proportions (n = 10): PW/HW = 1.36–1.44 (\bar{O} = 1.40); PW/PL = 1.32–1.44 (\bar{O} = 1.39); PW/PBW = 1.18–1.22 (\bar{O} = 1.20); PBW/PAW = 1.16–1.29 (\bar{O} = 1.22); EW/PW = 1.41–1.51 (\bar{O} = 1.46); EL/EW = 1.31–1.38 (\bar{O} = 1.35).

Colour: Head, pronotum and elytra blackish brown; mandibles, palps and legs yellowish brown; antennae usually monochrome, in some specimens, antennae slightly darkened beginning from second or third antennomere; in most specimens 2nd maxillary palpomere darkened.

Microsculpture: Sculpticells on frons and supraorbital area large, moderately impressed, almost isodiametric, on clypeus more finely impressed. Sculpticells on pronotal disc moderately impressed, slightly transverse. Elytra with large and deeply impressed, almost isodiametric or somewhat irregularly formed sculpticells.

Head: As described in *T. yitbareki* sp. n.

Prothorax: As described in *T. yitbareki* sp. n.

Pterothorax: Striae 1–3 very slightly impressed or indistinct, smooth, first stria finer impressed than second or absent. In all other characters as described in *T. yitbareki* sp. n.

Legs: Two basal protarsomeres of males moderately dilated and dentoid at the inner apical border (Fig. 3B). In all other characters as described in *T. yitbareki* sp. n.

Male genitalia: EL/AL = 2.02–2.38 (\bar{O} = 2.23; n = 8). Aedeagal median lobe robust, in lateral view almost evenly bent throughout, straight near apex, with short apical lamella which is hook-like bent dorsally (Fig. 3E); in dorsal view with side margins almost parallel, very slightly widened in apical quarter and shortly narrowed towards slender apical lamella (Fig. 3J). Dorsal opening extends basally near to the apical margin of basal bulb. Sagittal aileron absent. Endophallus symmetrical in dorsal view, without distinct copulatory pieces, densely covered by tiny scales, in the inactive position with a sac-like folding structure near its base and an area covered by large sclerotized scales on its dorsal side (Fig. 3F). Parameres similar in size and shape, rather slender, each with four apical setae.

Differential diagnosis. In habitus and male genital characters very similar to *T. reebae* and *T. yitbareki* sp. n., but differs in the shape of the basal two protarsomeres of males which are moderately dilated (Fig. 3B; markedly dilated in the latter species, see Fig. 3A, C). The median lobe of the aedeagus is shorter and more evenly bent than in *T. yitbareki* sp. n., and is characterized by a shorter apical lamella. *T. kniphofia* sp. n. differs from the likewise similar *T. igori* sp. n. in the more robust and, on an average, larger body, and in the larger aedeagus with longer, hook-like bent apical lamella.

Distribution. Endemic to Mt. Choke in northern Ethiopia. The new species is probably the eastern vicariant of *T. reebae* sp. n., and was found along slopes on eastern margins of the crater rim (Fig. 4).

Habitat preferences. As described in *T. reebae*.

Trechus (Abyssinotus) igori Schmidt, sp. n.

Fig. 2D, 3G, K

Type material. Holotype: ♂, with label data: Ethiopia, Amhara, W-slope Mt. Choke, 3370 m, 23.II.2019, 10°38'07"N 37°45'51"E, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM). Paratypes: 8 ♂♂, 7 ♀♀, with same data as holotype (CSCHM).

Etymology. The new species is dedicated to my dear friend and colleague, the distinguished carabidologist and explorer of the high altitude environments, Igor A. Belousov, St. Petersburg.

Description. Body length: 2.2–2.3 mm.

Proportions (n = 10): PW/HW = 1.31–1.41 (\bar{O} = 1.36); PW/PL = 1.41–1.50 (\bar{O} = 1.44); PW/PBW = 1.23–1.30 (\bar{O} = 1.27); PBW/PAW = 1.07–1.12 (\bar{O} = 1.10); EW/PW = 1.44–1.53 (\bar{O} = 1.50); EL/EW = 1.30–1.35 (\bar{O} = 1.32).

Colour: Head capsule, pronotum and elytra dark brown, pronotum paler in some specimens; clypeus, labrum, mandibles, palps, antennae and legs yellowish brown.

Microsculpture: Sculpticells on frons and supraorbital area large, moderately impressed, almost isodiametric, slightly transverse on clypeus. Sculpticells on pronotal disc and elytra moderately impressed, transverse.

Head: As described in *T. yitbareki* sp. n.

Prothorax: Pronotum moderately large, transverse, sub-discoidal, with base slightly more markedly narrowed towards base than in the preceding species. In all other characters as described in *T. yitbareki* sp. n.

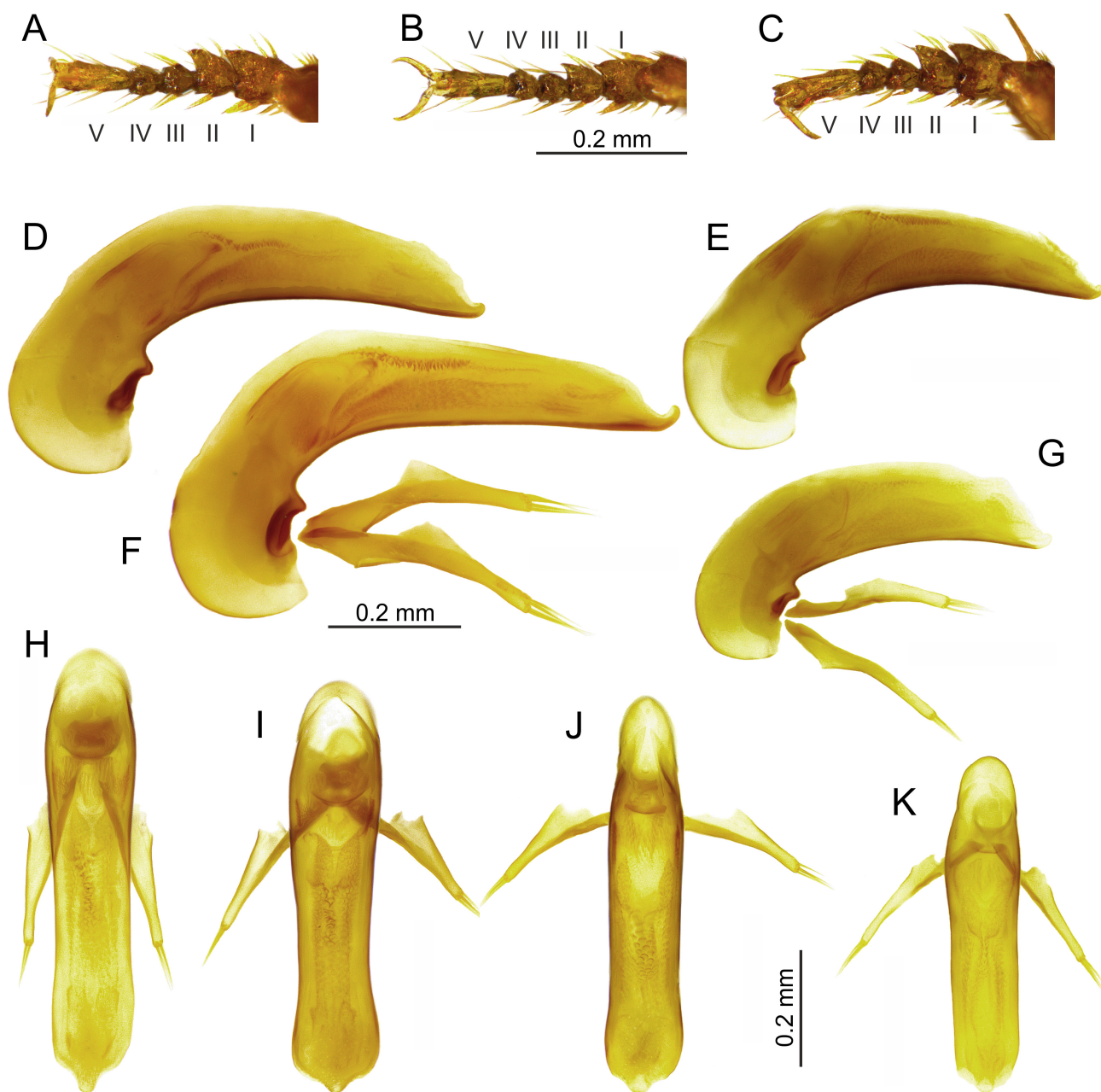


FIGURE 3. Left protarsomeres (A–C), aedeagus in left lateral view (D–G) and dorsal view (H–K) of *Trechus* (*Abyssinotus*) species. A, D, I, *T. reebae* (Quéinnec & Ollivier, 2021), specimen from western crater valley. B, E, J, *T. kniphofia* Schmidt, sp. n., paratype. C, F, H, *T. yitbareki* Schmidt, sp. n., paratype. G, K, *T. igori* Schmidt, sp. n., paratype.

Pterothorax: First stria absent in anterior 2/3, suggestively impressed before its apex, striae 2 and 3 very finely impressed, indistinct, external striae absent apart from the apical portion of stria 8. In all other characters as described in *T. yitbareki* sp. n.

Legs: As in *T. kniphofia* sp. n.

Male genitalia: EL/AL = 2.20–2.30 ($\bar{\text{O}} = 2.24$; n = 8). Aedeagal median lobe moderately robust, rather stout, in lateral view evenly curved throughout, with apical lamella very short, very slightly sclerotized, very shortly bent upwardly (Fig. 3G). Median lobe in dorsal view with side margins almost parallel, shortly narrowed towards apical lamella (Fig. 3K). Dorsal opening extends basally near to the apical margin of basal bulb. Sagittal aileron absent. Endophallus as described in *T. kniphofia* sp. n. Parameres similar in size and shape, slender, each with 3–4 apical setae.

Differential diagnosis. On average, *T. igori* sp. n. is the smallest species of the *T. reebae* group. It differs from all other species of the group by the transverse pattern of elytral microsculpture (isodiametric or somewhat irregularly shaped in the other species) and the very slightly sclerotized apex of the aedeagal median lobe. It additionally differs from *T. niloticus*, *T. reebae* and *T. yitbareki* sp. n. in the less markedly dilated basal protarsomeres in the male sex. Due to its small body length and shallower elytral striae, *T. igori* sp. n. is similar to *T. abyssinicus* and *T. afroalpinus*, however, it is easily distinguished by two basal protarsomeres dilated in males (one in the latter species).

Distribution. Endemic to Mt. Choke in northern Ethiopia. The new species was only found near the top of a mountain ridge that extends from the crater rim to the west where it occurs sympatric with *T. apertus* sp. n. and *T. yitbareki* sp. n. (Fig. 4).

Habitat preferences. The new species was found syntopic with *T. apertus* sp. n. and *T. yitbareki* sp. n.; see above for details of the habitat.

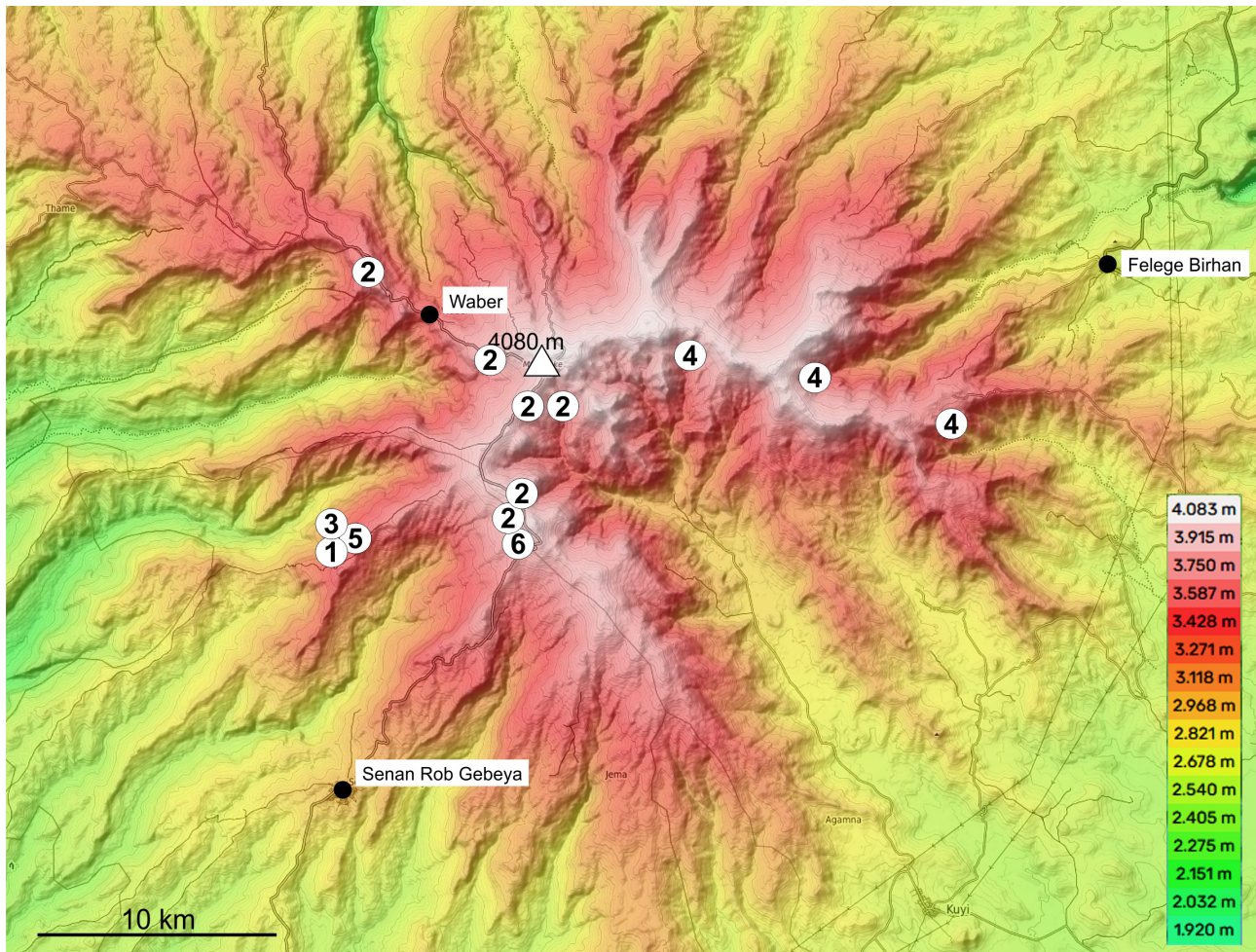


FIGURE 4. Topographic map of Mt. Choke (highest point marked by a white triangle), showing sampling localities of six *Trechus* (*Abyssinotus*) species of the *niloticus* group (white circles; the numbers refer to the different species). 1, *T. apertus* Schmidt, sp. n. 2, *T. reebae* (Quéinnec & Ollivier). 3, *T. yitbareki* Schmidt, sp. n. 4, *T. kniphofia* Schmidt, sp. n. 5, *T. igori* Schmidt, sp. n. 6, *T. niloticus* (Quéinnec & Ollivier). Sampling data of *T. reebae* and *T. niloticus* published by Quéinnec *et al.* (2021) are considered. Base map was downloaded from Topographic-map.com.

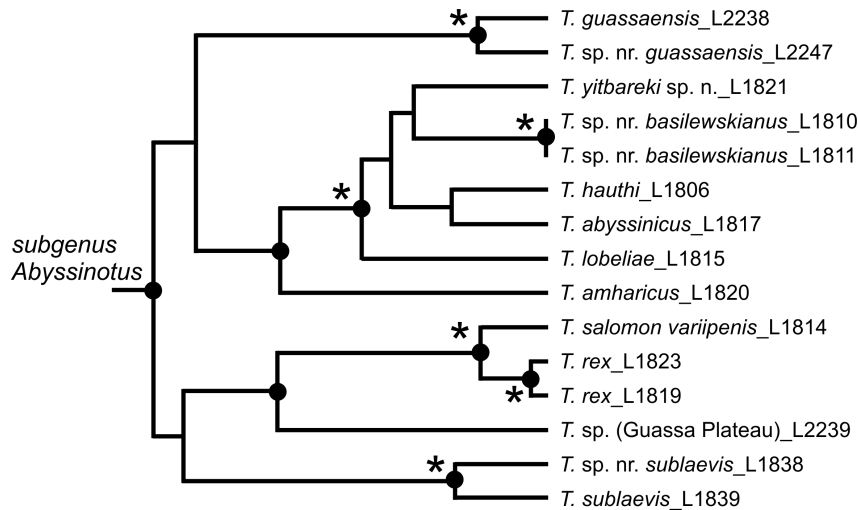


FIGURE 5. *Trechus (Abyssinotus)* subtree of the molecular phylogeny of Trechini beetles by Faille *et al.* (2023), modified (see that paper for details). Black circles and stars at branch nodes refer to posterior probabilities ≥ 0.98 and bootstrap values > 75 , respectively.

Key to the *Trechus* species from Mt. Choke with body length up to 4 mm

- 1 Microphthalmic species with compound eyes about half as long as tempora. Entire body yellowish brown. Male protarsomeres not dilated. *T. hauthi* Schmidt & Faille
- Compound eyes longer than tempora. Body reddish to dark brown. At least basal protarsomere of male dilated 2
- 2 Only the first protarsomere of male dilated 3
- Protarsomeres 1 and 2 of male dilated 6
- 3 Pronotum shape as in *Zabrus*, with sides not clearly convergent toward base, albeit sinuate, and basolateral angles large, rectangular or slightly acute *T. lobeliae* (Quéinnec & Ollivier)
- Pronotal basolateral angles small, obtuse or rounded, its sides markedly constricted toward base. 4
- 4 Elytra with second discal seta absent *T. amharicus* Ortuño & Novoa
- Elytra with second discal seta present 5
- 5 First protarsomere of male moderately dilated with long apical tooth at the interior margin. Aedeagal median lobe with apical lamella well sclerotized, hook-like bent upwardly. *T. afroalpinus* (Quéinnec & Ollivier)
- First protarsomere of male very slightly dilated with short apical tooth. Aedeagal median lobe with apical lamella very weakly sclerotized, with tip rounded *T. abyssinicus* (Quéinnec & Ollivier)
- 6 Dorsal opening of the aedeagal median lobe extends basally across three quarters of the basal bulb. *T. apertus* Schmidt sp. n.
- The dorsal opening of the aedeagal median lobe not reaching the basal bulb. 7
- 7 Two basal protarsomeres of males markedly dilated, with the first tarsomere about two times as broad as the third. 8
- Two basal protarsomeres of males moderately dilated, with the first tarsomere about 1.5 times as broad as the third. 10
- 8 Aedeagal median lobe markedly bent downwardly before apical lamella (Quéinnec *et al.* 2021, Fig. 26B) *T. niloticus* (Quéinnec & Ollivier)
- Ventral margin of aedeagal median lobe straight before apical lamella. 9
- 9 Aedeagal median lobe proportionally longer ($EL/AL < 1.9$), with ventral margin straight in middle and with apical lamella long. *T. yitbareki* Schmidt sp. n.
- Aedeagal median lobe proportionally shorter ($EL/AL > 2.0$), with ventral margin concave in middle and with apical lamella short *T. reebae* (Quéinnec & Ollivier)
- 10 Sculpticells on disc of elytra somewhat irregularly shaped, almost isodiametric. Apex of the aedeagal median lobe well sclerotized. *T. kniphofia* Schmidt sp. n.
- Sculpticells on disc of elytra transverse. Apex of the aedeagal median lobe very slightly sclerotized *T. igori* Schmidt sp. n.

Discussion

Based on the following three character states which are considered synapomorphies, the four new species described in this paper, together with the earlier described *T. niloticus* and *T. reebae* (Quéinnec *et al.* 2021) form a natural

group (in the following the *T. niloticus* group): i) aedeagal median lobe, in dorsal view, with margins parallel or slightly widened just before apex, abruptly narrowed to a slightly protruding tip (Fig. 1H, 3H–K; Quéinnec *et al.* 2021: Fig. 25C, 26C); ii) dorsal surface of the inactive endophallus densely covered by rows of tiny scale-like sclerites (Fig. 1G, D–G; Quéinnec *et al.* 2021: Fig. 25B, 26B); iii) endophallus with a complex folding structure near its base (Fig. 1G, D–G; Quéinnec *et al.* 2021: Fig. 25B, 26B). As no other species with these characteristics are known from other mountains in Ethiopia, it is likely that the *T. niloticus* group evolved on Mt Choke. However, the vast mountainous areas of northern Ethiopia are far from being sufficiently researched and therefore, much more efforts in field explorations are needed to better understand the biogeographical history of the group.

The morphological diversity of the Ethiopian *Trechus* s. l., not least in the subgenus *Abyssinotus*, is extremely high and has led to a misunderstanding of the actual relationships and to taxonomic inflation (Pawłowski 2003, Quéinnec *et al.* 2021, Faille *et al.* 2023). The dentition patterns of the *Abyssinotus* mandibles and the male genital morphology of *Abyssinotus* are of particular interests in evolutionary morphology of trechine beetles. The former were described in detail by Quéinnec *et al.* (2021). These authors concluded from the markedly divergent characteristics of the teeth on the right mandible in the different species that the high altitude *Trechus*-like species occurring on Mt. Choke are members of different clades outside *Trechus* (s. l.). However, based on a molecular genetic phylogeny, Faille *et al.* (2023) have shown that all these species are members of a single large clade endemic to the highlands of northern Ethiopia, and that this clade is an ingroup of *Trechus* (s. l.). It can therefore be assumed that the enormous diversity in the morphology of the mandibles is a consequence of recent events in the evolution of this clade, i.e. it represents derived character states, but not an indication of a higher phylogenetic age of the individual species groups.

The same can be assumed for the particular male genital morphology of *T. apertus* sp. n. with a dorsal ostium which extends basally very near to the basal ostium. Noteworthy, Magrini *et al.* (2012) have described the aedeagal median lobe ostium of the South Ethiopian species *T. relictus*, which extends basally close to the basal bulb, and concluded that this pattern may be archaic according to the plesiomorphic state in Trechini (Schmidt *et al.* 2021). However, as shown by the molecular phylogeny, *T. relictus* is member of a terminal clade within the subgenus *Minitrechus* (Faille *et al.* 2023). A widely open dorsal ostium was also indicated for *T. reebae* of the Ethiopian *T. niloticus* group (Quéinnec *et al.* 2021) and in *Epaphiopsis hiekei* Belousov & Kabak from Vietnam (Belousov & Kabak 2016). A multiple secondary development of this character state within Ethiopian and Asian Trechina species groups can thus be assumed. The phylogenetic position of *T. yitbareki* sp. n., which is considered close related to *T. reebae* of the *T. niloticus* group, as member of the subgenus *Abyssinotus*, was shown by Faille *et al.* (2023; Fig. 5). In the Ethiopian *T. apertus* sp. n., the development to a fully open median lobe is much further advanced than in any other African *Trechus* species.

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Literature

Belousov, I.A. & Kabak, I.I. (2016) *Epaphiopsis (Epaphiama) hiekei* n. sp., the first member of the genus from Vietnam (Coleoptera, Carabidae, Trechini). *Entomologische Blätter und Coleoptera*, 112 (1), 63–66.

- Faille, A., Hofmann, S., Merene, Y., Hauth, D., Opgenoorth, L., Woldehawariat, Y. & Schmidt, J. (2023) Explosive radiation versus old relicts: The complex history of Ethiopian Trechina, with description of a new genus and a new subgenus (Coleoptera, Carabidae, Trechini). *Deutsche Entomologische Zeitschrift*, 70 (2), 311–335.
<https://doi.org/10.3897/dez.70.107425>
- Lassalle, B. (2016) Nouveaux *Calathus* d’Ethiopie (Coleoptera, Carabidae). *Faunitaxys*, 4 (6), 1–12.
- Magrini, P., Quéinnec, E. & Vigna Taglianti, A. (2012) A new subgenus and two new species of *Trechus* from Ethiopia (Coleoptera, Carabidae). *Fragmenta entomologica, Roma*, 44 (1), 19–32.
<https://doi.org/10.4081/fe.2012.30>
- Merene, Y., Lorenz, W., Opgenoorth, L., Woldehawariat, Y. & Schmidt, J. (2023) Ground and tiger beetles (Coleoptera: Carabidae, Cicindelidae) of the Federal Democratic Republic of Ethiopia: a provisional faunistic checklist based on literature data. *Zootaxa*, 5247 (1), 1–345.
<https://doi.org/10.11646/zootaxa.5247.1.1>
- Ortuño, V.M. & Novoa, F. (2011) A new species of *Trechus* from the Ethiopian Highlands (Coleoptera: Carabidae: Trechinae) and key to the *Trechus* species of Ethiopia. *Annals of the Entomological Society of America*, 104 (2), 132–140.
<https://doi.org/10.1603/AN10122>
- Pawłowski, J. (2001) Le genre *Trechus* Clairville, 1806 (Coleoptera: Carabidae: Trechini) dans la collection Ethiopienne du Musée Royal de l’Afrique Centrale. I. Groupe du *T. chokensis*. *Elytron*, 15, 97–108.
- Pawłowski, J. (2003) Preliminary report on Ethiopian species of the genus *Trechus* Clairville, 1806 (Coleoptera: Carabidae). *Baltic Journal of Coleopterology*, 3 (2), 157–160.
- Quéinnec, E., Ollivier, E. & Reeb, C. (2021) Insights on Ethiopian montane ground beetle biodiversity: Taxonomic study of afro-alpine and sub-alpine Trechini (Coleoptera: Carabidae: Trechinae). *Journal of Insect Biodiversity*, 27 (1), 1–70.
<https://doi.org/10.12976/jib/2021.27.1.1>
- Schmidt, J. & Merene, Y. (2024) Taxonomy, distribution and habitat of the giant *Trechus* beetles endemic to Mt. Choke, Ethiopia (Coleoptera: Carabidae). *Taxonomy*, 4 (1), 27–50.
<https://doi.org/10.3390/taxonomy4010003>
- Schmidt, J., Scholz, S. & Maddison, D.R. (2021) *Balticeler kerneggeri* gen. nov., sp. nov., an enigmatic Baltic amber fossil of the ground beetle subfamily Trechinae (Coleoptera, Carabidae). *Deutsche Entomologische Zeitschrift*, 68 (1), 207–224.
<https://doi.org/10.3897/dez.68.66181>