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Taxonomy, Distribution and Habitat of the Giant *Trechus* Beetles Endemic to Mt. Choke, Ethiopia (Coleoptera: Carabidae) †

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Abstract: The Holarctic ground beetle genus *Trechus* Clairville, 1806, is highly diverse in the Ethiopian highlands, both in terms of species numbers and morphology. Particularly noteworthy are the extraordinarily large species of the subgenus *Abyssinotus* Quéinnec and Ollivier, 2021, with a body length up to 8.5 mm, that occur on Mt. Choke in northern Ethiopia. Recent, intensive field work on Mt. Choke resulted in a significantly large number of specimens that are the basis for our taxonomic revision of the species related to the giant species, *T. dimorphicus* Pawłowski, 2001 and *T. gigas* Pawłowski, 2001. We describe three new species and one new subspecies and discuss a likely interspecific hybrid that combines morphological character states of representatives of the *dimorphicus* and *gigas* subgroups of *Abyssinotus*. An iconography of males and females as well as photographs of the aedeagi of all the considered species are presented. The distributions of the species are detailed and knowledge of the species-specific habitat preferences is summarized. Based on the distributions and habitat specificity, a threat assessment based on the current land use pattern at Mt. Choke is provided.

Keywords: *Abyssinotus*; Afroalpine; biogeography; habitat; hybridization; systematics; Trechini

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1. Introduction

Within the beetle fauna of the Ethiopian highlands, the genus *Trechus* Clairville, 1806 is particularly noteworthy in several respects. Although the genus is of Holartic origin, it is by far the most species-diverse ground beetle genus in Ethiopia, with 77 species described to date [1]. All of the species are wingless and endemic to single volcanos, with the exception of *T. patrizzii* Jeannel, 1960 that occurs on some immediately adjacent mountains in southern Ethiopia [1,2]. The elevational distribution of *Trechus* reflects the adaptation of this group to colder temperatures, and species are restricted to the Afromontane and Afroalpine belts, with observed occurrences between 1800 and 4300 m above sea level [3,4]. The external morphology of the Ethiopian *Trechus* species is extremely diverse, and, in this respect, they are unlike *Trechus* species from any other region of the world [4–10]. Most surprising are the results of a recent molecular phylogenetic study showing that morphologically highly divergent *Trechus* species, syntopically occurring, e.g., on Mt. Choke in northern Ethiopia, belong to one and the same lineage (subgenus *Abyssinotus* Quéinnec and Ollivier, 2021) [1]). The same pattern was found for the Bale and Arsi Mountains in southern Ethiopia (subgenus *Minitrechus* Magrini, Quéinnec and Vigna Taglianti, 2009) [1]. Within the subgenus *Abyssinotus*, two species are particularly conspicuous due to their markedly large body size (≥6 mm) with respect to other members of the genus and due to the pilosity

of the female elytra: *T. gigas* Pawłowski, 2001 and *T. dimorphicus* Pawłowski, 2001. Detailed distributional patterns and habitat preferences of these species are unknown. During our fieldwork on Mt. Choke, comprehensive faunistic and ecological data were collected for these species and are presented herein. In addition, based on the newly collected material, three giant *Trechus* species and one subspecies are newly described and added to the fauna of the Ethiopian Highlands.

2. Materials and Methods

This study is based on about 1800 specimens of the revised and newly described taxa. The specimens are deposited in the following collections:

CAF: Arnaud Faille working collection, Stuttgart, Germany.

CSCHM: Joachim Schmidt working collection, later to be deposited in ZSM.

NHMAA: Natural History Museum, Addis Ababa University.

ZSM: Zoologische Staatssammlung, Munich.

Specimens were examined by a stereomicroscope Leica M205-C (Leica Microsystems, Wetzlar, Germany). The photographs were taken with a Leica DFC450 digital camera (Leica Microsystems, Wetzlar, Germany) using a motorized focusing drive, light base Leica TL5000 Ergo, diffused light with Leica hood LED5000 HDI, subsequently processed with Leica LAS 4.13 application software (Leica Microsystems, Heerbrugg, Switzerland), and enhanced with CorelDRAW Graphics Suite X5.

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

3. Results

3.1. The Trechus gigas Subgroup

Species of *Trechus* subgenus *Abyssinotus*, characterized by large body size with respect to *Trechus* s. l. (6.3–8.5 mm), moderately transverse pronotum with sides markedly narrowed towards the base, obtuse pronotal laterobasal angles, presence of four humeral setae of the elytral umbilicate series, and distinct sexual dimorphism, with males, on average, larger than females, and elytra densely pubescent in females and glabrous in males.

This subgroup includes four species endemic to Mt. Choke: *T. gigas*, *T. gizufu* Schmidt, sp. n., *T. regina* Schmidt, sp. n., and *T. rex* Schmidt, sp. n. The species occur in strict allopatry, with their respective distributions restricted to different valley systems along slopes of the volcanic mountain.

3.1.1. *Trechus (Abyssinotus) gigas* Pawłowski, 2001

Figures 1A, 2A and 3A,B.

Citations: *Trechus gigas* Pawłowski, 2001 [7], p. 102; locus typicus: Mt. Choke, 3500–4000 m "near summit".

Trechus gigas Pawłowski: Ortuño and Novoa [11], p. 136.

Trechus (*Abyssinotus*) *gigas* Pawłowski: Quéinnec et al. [4], p. 14, partim. Remarks: In addition to the type specimens, Quéinnec et al. [4] listed one female specimen "*T. gigas*" from their sampling point "station VI", which is located near the crater rim on the western side of the volcano. This location is not part of the distributional area of *T. gigas*. Very probably, the cited specimen belongs to *T. rex* sp. n. (see below).

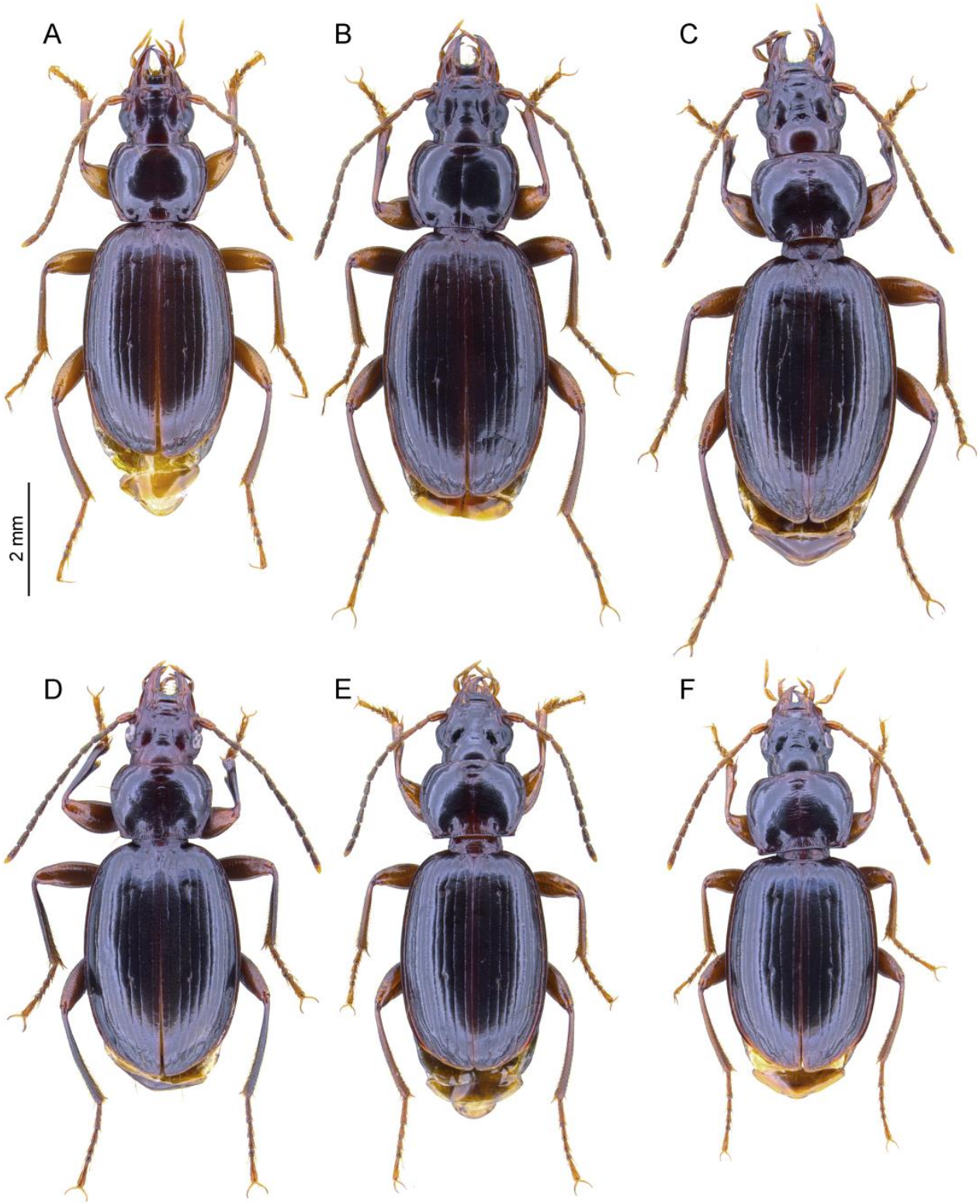

Figure 1. *Trechus* subgenus *Abyssinotus*, male specimens, dorsal aspect of body. (**A**): *T. gigas*, specimen from the SE-slope of Mt. Choke, above Wondasha Guskuam. (**B**): *T. gizufu* Schmidt, sp. n., paratype. (**C**): *T. rex* Schmidt, sp. n., paratype. (**D**): *T. regina* Schmidt, sp. n., paratype. (**E**): *T. dimorphicus*, specimen from the E-slope of Mt. Choke, above Felege Birhan. (**F**): *T. salomon*, specimen from the western crater valley of Mt. Choke.

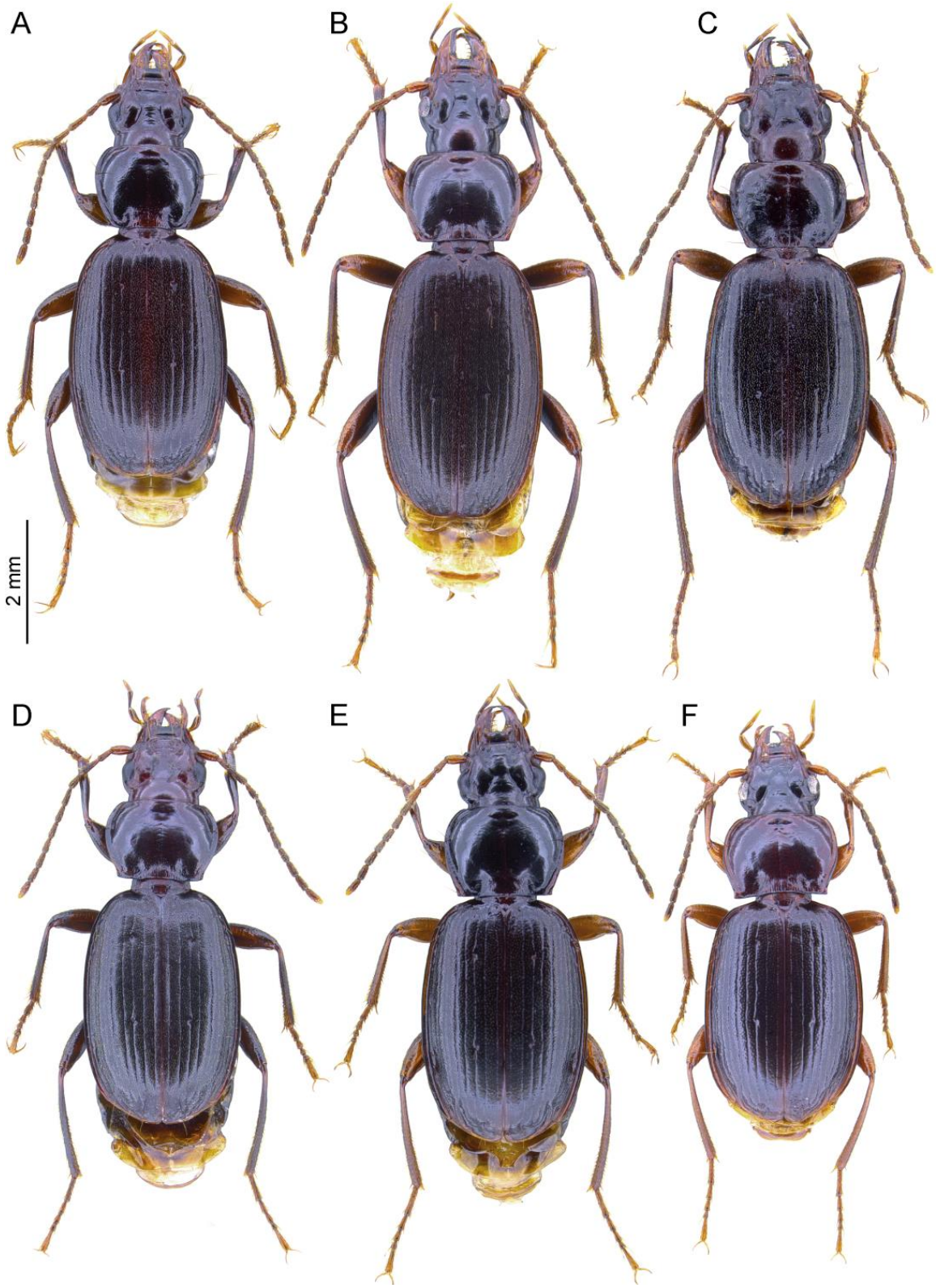

Figure 2. *Trechus* subgenus *Abyssinotus*, female specimens, dorsal aspect of body. (**A**): *T. gigas*, specimen from the SE-slope of Mt. Choke, above Wondasha Guskuam. (**B**): *T. gizufu* Schmidt, sp. n., paratype. (**C**): *T. rex* Schmidt, sp. n., paratype. (**D**): *T. regina* Schmidt, sp. n., paratype. (**E**): *T. dimorphicus*, specimen from the E-slope of Mt. Choke, above Felege Birhan. (**F**): *T. salomon*, specimen from the western crater valley of Mt. Choke.

Figure 3. *Trechus* subgenus *Abyssinotus*, aedeagus in left lateral aspect (**A**,**C**,**E**,**G**,**I**,**K**) and dorsal aspect (**B**,**D**,**F**,**H**,**J**,**L**). (**A**,**B**): *T. gigas*, specimens from the SE-slope of Mt. Choke, above Wondasha Guskuam. (**C**,**D**): *T. gizufu* Schmidt, sp. n., paratypes. (**E**,**F**): *T. regina* Schmidt, sp. n., paratypes. (**G**): *T. rex* Schmidt, sp. n., paratype. (**H**): *T. rex* Schmidt, sp. n., holotype. (**I**,**J**): *T. rex* Schmidt, sp. n., non-type specimens from north of Waber. (**K**,**L**): *T. rex* Schmidt, sp. n., non-type specimens from the N-slope of Mt. Choke.

Trechus (*Abyssinotus*) *gigas* Pawłowski: Merene et al. [2], p. 47, partim. Remarks: These authors refer to the same material as Quéinnec et al. [4]; see comments above.

Type material: Not studied. Identification is based on the original description, including habitus and male genital figures of the holotype specimen [7] as well as of the species' redescription including habitus and male genital figures of paratype specimens published by Quéinnec et al. [4].

Additional material: 16 males, 5 females, Ethiopia, Amhara, E-slope Mt. Choke, Wondasha Guskuam, alt. 3650 m, 10°41′05″ N 37°59′21″ E, 2.V.2022, leg. J. Schmidt, Yeshitla, M. (cSCHM).

Measurements and proportions: These data are based on the additional material collected. Body length is 6.7–7.0 mm in females, 7.0–7.5 mm in males. Length of aedeagal median lobe is 2.05–2.15 mm.

Proportions (n = 5 in females, n = 10 in males): PW/HW = 1.28–1.30 (Ø = 1.29, females), 1.29–1.33 (Ø = 1.31, males); PW/PL = 1.31–1.35 (Ø = 1.34, females), 1.28–1.34 (Ø = 1.30, males); PW/PBW = 1.28–1.34 (Ø = 1.31, females), 1.22–1.29 (Ø = 1.26, males); PBW/PAW = 1.10–1.16 (Ø = 1.12, females), 1.13–1.21 (Ø = 1.17, males); EW/PW = 1.40–1.46 (Ø = 1.43, females), 1.45–1.54 (Ø = 1.50, males); EL/EW = 1.48–1.50 (Ø = 1.49, females), 1.48–1.53 (Ø = 1.50, males); EL/AL = 1.80–1.88 (Ø = 1.85).

Sexual dimorphism: Female specimens differ from males by smaller body length and the presence of dense pilosity on the elytra which give the specimens a dull appearance.

Identification: See key to species of the *gigas* subgroup of *Abyssinotus* and differential diagnosis of the new species described below.

Distribution: The type series of *T. gigas* was collected by R.O.S. Clarke during his 1972 expedition to the Amhara region of Ethiopia. Based on the label data, he collected the specimens "near summit" of the Choke Mountain ("Mts Choché") on the 17th of December 1972, together with additional species of the genus [2,4,7,12]. However, the exact location of the collecting site is unknown so far [4]. Based on the additional *T. gigas* material we collected during our own fieldwork on Mt. Choke in May 2022, the species-specific distributional range can now be narrowed down to the easternmost part of the crater rim, west and above the village of Wondasha Guskuam (Figure 4). Very probably, Clarke and his expedition team reached the Choke crater rim by the old trail along the east-trending ridge, from the towns of Felege Birhan or Debre Werk, both of which are located east of the mountain. The sampling site of the newly collected material of *T. gigas* is situated near to this trail, on the southern slope of the ridge, close to its top. Because in the large east-trending valley to the north of this ridge, we detected occurrences of the closely related *T. gizufu* sp. n. (Figure 4), we assume that the distributional area of *T. gigas* is limited to the southern slope of this ridge. This hypothesis is based on the presumption that *T. gigas* and *T. gizufu* sp. n., as well as the likewise closely related *T. regina* sp. n. and *T. rex* sp. n., are allopatric distributed species, each with distributional areas restricted to separated valley systems on Mt. Choke (Figure 4).

Habitat: The label data of the *T. gigas*-type specimens do not present any information about the collecting circumstances. All of the additional specimens sampled in 2022 were found on a very small spot in the source region of a small mountain stream, in the Afroalpine zone. At this spot, the stream water penetrates the vegetation that grows on a 90° steep rock face (Figure 5). Here, the *T. gigas* specimens were found in rock crevices under dense vegetation cover in close contact with water. However, no specimens could be found in the adjacent habitats. Due to the vegetation cover and the penetrating stream water, the temperature on the rock face was much colder than on the soil surface of the adjacent habitats. Based on these observations, we believe that *T. gigas* is a hygrophilic species, adapted to colder temperatures.

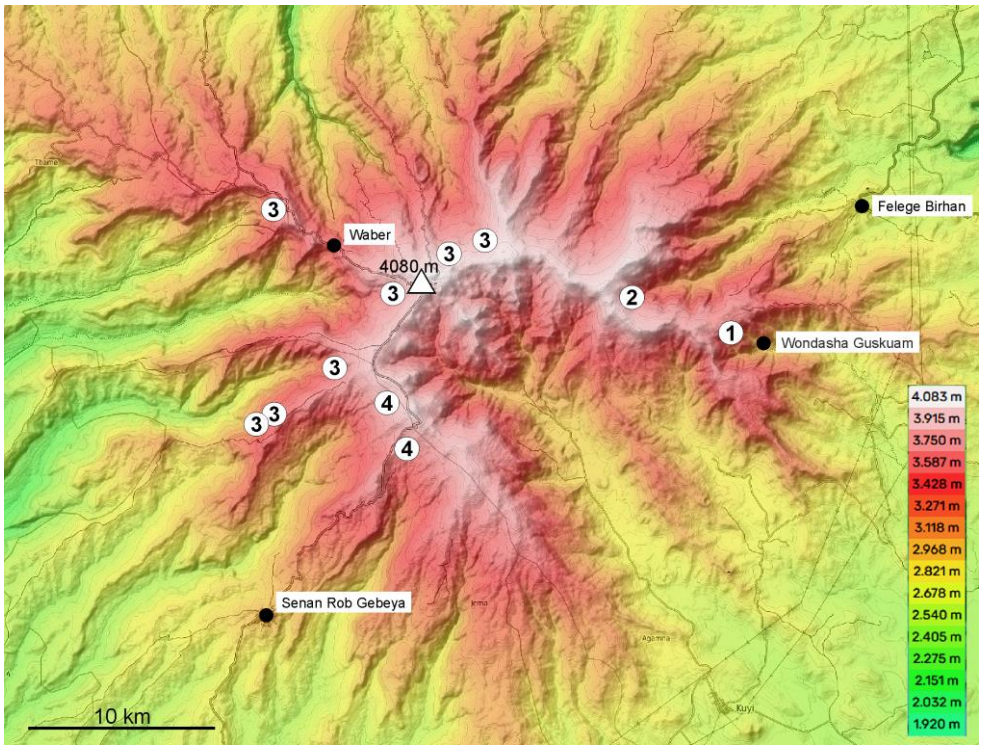

Figure 4. Topographic map of Mt. Choke (highest point marked by a triangle), showing locations of the towns and villages mentioned in the text and sampling localities of species of the *T. gigas* subgroup of *Abyssinotus* (white circles; the numbers refer to the different species). 1, *T. gigas*. 2, *T. gizufu* Schmidt, sp. n. 3, *T. rex* Schmidt sp. n. 4, *T. regina* Schmidt, sp. n. Base map from Topographic-map.com (https://de-de.topographic-map.com/map-v693q/%C3%84thiopien/ (assessed on 1 January 2024)).

Figure 5. Slope of Mt. Choke above the village of Wondasha Guskuam with a sampling site of *Trechus gigas* at an elevation of 3650 m (May 2022); the white arrow (**A**) points to the rock face in the middle of the bed of a small stream in the Afroalpine zone, covered by dense vegetation under which the specimens were found. The black arrow (**B**) points to the position of the photographer in Figure 6.

Figure 6. Southeastern slope of Mt. Choke above the village of Wondasha Guskuam, showing a deforested landscape characterized by intensively grazed pastures and arable land up to the Afroalpine zone (May 2022). The wooded area in the background is eucalyptus plantings around a homestead. The white arrow points to the sampling site of *Trechus gigas*, below the rock in the foreground (see Figure 5). This rock is overflowed by a small stream that carries very little water in the dry season.

Threat assessment: The size of the spot where *T. gigas* was found is about 10 square meters. During our exploration of this mountain slope, we did not find another likewise wet and shadowed area as we did not find any additional occurrence of *T. gigas*. The whole slope area above the village of Wondasha Guskuam is highly overgrazed, without remains of natural forest, and with the establishments of field cultivations and eucalyptus plantations extending above 3600 m in elevation (Figure 6). We therefore conclude that *T. gigas* is a critically endangered species, which will probably become extinct in the near future.

3.1.2. *Trechus (Abyssinotus) gizufu* Schmidt, sp. n.

Figures 1B, 2B and 3C,D.

Type material: Holotype male, with label data: Ethiopia, Amhara, 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).

Paratypes: 5 males, 2 females, same data as holotype (CSCHM).

Etymology: The specific epithet is built by the Amharic word “gizufu” (=the giant) and refers to the markedly large body size of the species (noun in apposition).

Description: Body length: 7.8 and 7.9 mm in the two females, 8.0–8.4 mm in the six males.

Proportions (n = 2 in females, n = 5 in males): PW/HW = 1.31, 1.32 (females), 1.35–1.39 (Ø = 1.36, males); PW/PL = 1.30, 1.31 (females), 1.30–1.37 (Ø = 1.33, males); PW/PBW = 1.27, 1.29 (females), 1.26–1.31 (Ø = 1.28, males); PBW/PAW = 1.12, 1.18 (females), 1.17–1.21 (Ø = 1.19, males); EW/PW = 1.39 (females), 1.45–1.48 (Ø = 1.46, males); EL/EW = 1.57 (females), 1.52–1.57 (Ø = 1.56, males); EL/AedL = 1.71–1.75 (Ø = 1.73).

Color: Blackish brown; mandibles, palps, basal 3–4 antennomeres, femoral apex and tarsi lighter brown.

Microsculpture: Head with moderately small, moderately deep engraved, slightly transverse meshes on disc, supraorbital area and clypeus, and with almost isodiametric sculpticells near base. Pronotum with smaller and more finely engraved sculpticells than on head; meshes slightly transverse on disc and more irregularly shaped in pronotal basolateral foveae. Elytral intervals with very narrow, transverse sculpticells, which are moderately deep-engraved in females and very slightly engraved in males.

Head: Proportions averaged for *Trechus* (s. l.). Right mandible bidentate, with anterior denticle markedly small, basal denticle markedly large, and with a wide diastema between the denticles. Labrum with apical margin moderately emarginated, with six setae near the apical margin. Clypeus on each side with two or three setae. Eyes moderately small, about 1.5 times as long as the tempora, slightly convexly protruded. Two supraorbital setae on each side in normal position for Trechina. Supraorbital furrows moderately deep, ±evenly bent on disc. Tempora moderately convex, distinctly wrinkled to the neck, with sparse micro-setae. Mid of head moderately convexly elevated. Antennae moderately slender, with the third antennomere longest.

Prothorax: Pronotum moderately small and transverse, without pilosity, moderately transverse, with base distinctly broader than apical margin, broadest slightly before the middle. Disc moderately convex. Anterior margin slightly concave, with anterior angles distinct, rounded, moderately protruded. Basal margin almost straight, with laterobasal angles not or very slightly shifted posteriad. Lateral margin almost evenly convex, with basolateral angles not protruded laterally; the latter small, slightly obtuse. Marginal gutter moderately broad in anterior 2/3, widened towards the base. Median longitudinal impression sharp but finely incised on disc, disappearing near apex, somewhat deepened before base. Anterior transverse impression indistinct, smooth; posterior one shallow, interrupted in middle, smooth. Laterobasal foveae moderately small but deep, delimited from the lateral gutter by a wide, elevated area, smooth. Lateral and laterobasal setae present, with the former situated slightly anterad of the maximum width of pronotum. Proepisternum glabrous and smooth.

Pterothorax: Elytra with dense pilosity in females, apparently smooth in males (in anterior half with sparse micro-pilosity, visible at magnification 100x). Elytra in dorsal view long and very slender ovate, broadest distinctly posterad middle, shoulders flatly rounded, apical sinuation distinct, apex rounded with the indication of a very obtuse apical angle, in lateral view slightly convex on disc. Striae 1–8 complete, moderately deep impressed, finely punctate, intervals slightly convex, parascutellar stria not connected with the first stria, about 1/12 of the length of elytra. Recurrent preapical stria markedly deep near elytral apex, connected with the seventh stria. Parascutellar seta present. Discal setae located in the 3rd interval, adjoined to the 3rd stria; anterior seta located near the end of the anterior elytral 5th; second seta located distinctly behind elytral middle (about at level of the maximum elytral width); posterior discal seta (= subapical seta near the end of 3rd stria) present, located about 1/12 of the elytral length from the elytral apex; subapical seta of the recurrent stria isolated, removed from this stria by a distance of about 2 diameters of the setiferous pore. Number and positions of the setae of the marginal umbilicate series as in *Trechus* s. str. (humeral series consist of four setae). Metepisternum very short, glabrous and smooth, with an outer margin about as long as the anterior margin.

Legs: Moderately long and robust. Protibia dilated towards the apex, straight, with a longitudinal groove on the dorsal surface developed, and with few very fine setae on the

anterior surface near the apex. Two basal protarsomeres of males dilated and dentoid at the inner apical border.

Male genitalia: Aedeagal median lobe large and elongated, with a length of 2.60–2.65 mm (n = 5), in lateral view with ventral surface markedly bent in basal third, almost straight in the middle, markedly bent dorsally towards the apex, and with a large and dorsally bent apical hook; in dorsal view moderately slender, on right side with a marked concavity before the apex; basal bulb small with a large sagittal aileron. Endophallus with a large, slender sack-like, moderately sclerotized copulatory piece; length of the copulatory piece slightly less than half of the length of the median lobe. Parameres with 7–8 apical setae.

Sexual dimorphism: Female specimens differ from males by slightly smaller body length (see above, for details), but these data have to be confirmed based on additional material. In addition, females differ significantly by the presence of dense pilosity on the elytra which gives the specimens a dull appearance.

Differential diagnosis: The only *Abyssinotus* species that has developed 7–8 apical setae on the parameres of the aedeagus (maximum five apical setae in other species of the subgenus), and sometimes more than four setae on clypeus. Larger than *T. gigas* (body length 7.8–8.4 mm, instead of 6.7–7.5 mm in *T. gigas*), with larger aedeagal median lobe (2.6 mm, instead of 2.1 mm in *T. gigas*), and with the ventral surface of median lobe less convexly rounded in the middle (compare Figure 3C,D and Figure 3A,B). Elytra are more slender than in *T. regina* sp. n. and *T. rex* sp. n. (EL/EW > 1.5 in *T. gizufu* sp. n.; EL/EW < 1.5 in *T. regina* sp. n. and *T. rex* sp. n.), the aedeagal median lobe with smaller basal bulb, larger apical hook, and larger copulatory piece, in dorsal view more slender with marked convexity on right side before apical lamella; this convexity lacks in the latter species (compare Figures 3D and 3F,H,J,L).

Distribution: The specimens were collected in the uppermost part of a valley on the eastern slope of Mt. Choke, above the town of Felege Birhan (Figure 4). *Trechus gizufu* sp. n. seems to be endemic to this valley. Very probably, the east-trending mountain ridge, which marks the southeastern rim of the crater, separates the distributional area of *T. gizufu* sp. n. from that of *T. gigas*, which occurs south of this ridge.

Habitat: The specimens were found in wet coarse gravel, shadowed by vegetation and rocks, along small streams in the Afroalpine zone, immediately adjacent to running water, and in stone packs traversed by running water, together with the trechine *Baehria separate* Schmidt and Faille and Dytiscidae beetles (Figure 7). Based on this finding, we assume that *T. gizufu* sp. n. is a hygrophilic species, probably adapted to a rheophilic way of life, and prefers colder temperatures.

Threat assessment: Due to the markedly small distributional area of the new species which, very probably, is restricted to the sides of small streams on the upper slopes of a single valley on the eastern slope of Mt. Choke, future population development of *T. gizufu* sp. n. strongly depends on human use of this valley, primarily through grazing and deforestation of the last remnants of the *Erica* forest. Both forms of land use lead to the loss of shading of the streams and heating of the soil surface, which means that the habitat of the species is lost. The grazing pressure in significant parts of this valley is already very high, and the settlements now extend to the lower limit of the Afroalpine zone (Figure 7). With their need for firewood, the locals are continuously reducing the extent of the remaining forest. Therefore, we conclude that *T. gizufu* sp. n. is a species that may be in danger of extinction.

3.1.3. *Trechus (Abyssinotus) rex* Schmidt, sp. n.

Figures 1C, 2C and 3G–L.

Type material: Holotype male, with label data: Ethiopia, Amhara, W-slope Mt. Choke, alt. 3680–3780 m, 10°40′11″ N 37°48′33″ E, 11.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM).

Paratypes: 48 males, 34 females, same data as holotype (CSCHM, NHMAA, ZSM); 29 males, 27 females, W-slope Mt. Choke, alt. 3700–3900 m, 10°42′17″ N 37°50′29″ E, 25.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CAF, CSCHM, NHMAA,

ZSM); of these, 1 male with the additional label "L1823" was used in the molecular study by [1]; 11 males, 10 females, W-slope Mt. Choke, alt. 3450 m, 10°38′09″ N 37°46′06″ E, 22.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CAF, CSCHM, NHMAA); of these, 1 female with the additional label "L1819" was used in the molecular study by [1]; 10 males, 8 females, W-slope Mt. Choke, alt. 3370 m, 10°38′07″ N 37°45′51″ E, 23.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM, NHMAA).

Figure 7. Human-shaped Afroalpine environments and forest remnants on the eastern slope of Mt. Choke above the town of Felege Birhan (May 2022). Small streams shadowed by vegetation are the habitat of *Trechus gizufu* Schmidt, sp. n.

Additional material: 15 males, 8 females, N-slope Mt. Choke, alt. 3800–3950 m, 10°43′16″ N 37°51′15″ E, 26.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); of these, 1 male with the additional label "L1819" was used in the molecular study by [1]; 14 males, 11 females, N-slope Mt. Choke, alt. 3750–3850 m, 10°43′51″ N 37°52′15″ E, 9.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM); 2 males, 1 female, N-slope Mt. Choke, N of Waber, alt. 3450–3600 m, 10°44′48″ N 37°46′22″ E, 7.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM).

Etymology: The specific name is derived from the Latin "rex" (=the king), and refers to the significant body size and robust body form that makes this species one of the largest *Trechus* known to occur in Ethiopia (noun in apposition).

Description: Body length: 7.1–7.8 mm in females, 7.5–8.5 mm in males.

Proportions (n = 10 in females and males): PW/HW = 1.27–1.32 (Ø = 1.30, females), 1.27–1.36 (Ø = 1.32, males); PW/PL = 1.36–1.43 (Ø = 1.38, females), 1.35–1.40 (Ø = 1.37, males); PW/PBW = 1.22–1.31 (Ø = 1.28, females), 1.22–1.28 (Ø = 1.25, males);

PBW/PAW = 1.13–1.22 (Ø = 1.16, females), 1.15–1.22 (Ø = 1.18, males); EW/PW = 1.44–1.49 (Ø = 1.45, females), 1.48–1.56 (Ø = 1.52, males); EL/EW = 1.37–1.47 (Ø = 1.41, females), 1.42–1.46 (Ø = 1.44, males); EL/AL = 1.68–1.90 (Ø = 1.81).

Color: Blackish brown; mandibles, palps, scape and basal half of 2nd antennomere, and legs lighter brown; femoral base and tibia often darkened.

Microsculpture: On head and pronotum as described in *T. gizufu* sp. n. Elytral intervals with very narrow, very slightly engraved transverse sculpticells, even more slightly engraved in males; in the latter, the sculpticells are visible at a magnification not below 80×. Elytra of male ± distinctly iridescent.

Head: Rather robust; clypeus on each side with two setae; antennae moderately short. In all other characters as described in *T. gizufu* sp. n.

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

Pterothorax: Elytra in dorsal view moderately long, ovate, broadest near the middle, shoulders broadly rounded, apex rounded. Recurrent preapical stria connected with the fifth or seventh stria. Parascutellar seta present. Posterior discal seta (=subapical seta near the end of 3rd stria) located about 1/10 of the elytral length from the elytral apex. In all other characters as described in *T. gizufu* sp. n.

Legs: Moderately short, robust. In all other characters as described in *T. gizufu* sp. n.

Male genitalia: Aedeagal median lobe large and elongated, with a length 2.35–2.60 mm (n = 16), in lateral view with ventral surface markedly bent in basal third, straight in middle, slightly bent dorsally near apex, and with a moderately large, dorsally bent apical hook; in dorsal view moderately broad, with apical lamella distinctly bent to the right (but see section on geographical variation). Basal bulb robust with sagittal aileron large. Endophallus with a sack-like, moderately sclerotized copulatory piece; length of the copulatory piece about 1/4 of the length of the median lobe. Parameres with 3–4, very seldom 5, apical setae.

Sexual dimorphism: Female specimens differ from males by smaller body length and proportionally smaller elytra (see above, for measurement details) and by the presence of dense pilosity on the elytra which gives the specimens a dull appearance.

Differential diagnosis: Body and aedeagus, on average, are larger than in *T. gigas* and *T. regina* sp. n., the ventral surface of the aedeagal median lobe is straight. The median lobe is broader (dorsal view, Figure 3H,J,L), its apical hook and copulatory piece much smaller, the basal bulb larger, and the elytra shorter than in *T. gigas* and *T. gizufu* sp. n. Aedeagus with median lobe is more robust than in *T. regina* sp. n., its apex broader, in lateral view less curved dorsad, and with copulatory piece stouter (see Figure 3E–L).

Distribution and geographical variability: The species was found in the uppermost parts of several high valleys on western and northern slopes of Mt. Choke (Figure 4). Because occurrences of *T. rex* sp. n. are restricted to the small streams in the interior parts of the valleys, the different populations seem effectively separated by the drier slopes and ridges between these valleys. This situation leads us to assume that populations from different valley systems are genetically isolated. Indeed, we identified two populations that are geographically separated from those occurring on the western slopes of Mt. Choke and slightly differ by genital morphology. Specimens of these populations are thus not included in the type series (see section on Additional material): Specimens from a population found on the western slope of the northernmost ridge of Mt. Choke, north of the village Waber, are characterized by the ventral surface of aedeagal median lobe obtusely angled before apex (lateral view, Figure 3I). Specimens found on the slope of the northern crater rim are characterized by the aedeagal median lobe with a broader and almost straight apex (dorsal view, Figure 3L). Additional investigations are needed to better understand whether or not these populations represent subspecies or species different from *T. rex* sp. n.

Habitat: As described in *T. gizufu* sp. n. All specimens were found in the soil and under stones very close to running water; most of the specimens were found within the cavities of stone packs which are traversed by running water, together with the Trechini beetle *Baehria separate* Schmidt and Faille, 2023 and the Dytiscidae beetle *Ilybiosoma* cf. *discicollis* (Ancey, 1882) (Figure 8).

Threat assessment: As noted for *T. gizufu* sp. n., the habitat suitability of the cold-adapted, hygrophilic *T. rex* sp. n. is strongly influenced by human impact all over its distributional area. Deforestation and intensive grazing with sheep, goats and horses lead to the loss of the vegetation cover and strong warming of the ground during the daytime. On the other hand, we observed a large distributional area for *T. rex* sp. n., compared to other species of the *gigas* subgroup, probably making this species more robust against extinction (Figure 4). However, this finding has to be critically reviewed based on additional material and using methods of molecular phylogeny. There is a high probability that populations from different valley systems represent genetically different lineages. If so, the endangerment situation has to be assessed highly for any of these lineages. This holds particularly true for the population found northwest of the village of Waber, which seems to be restricted to a very small section of a single stream whose bank is at least partially shaded by vegetation. In all other areas of this northernmost part of Mt. Choke, the mountainsides are already extremely man-made, with sun-exposed creek beds without any shading from vegetation.

3.1.4. *Trechus (Abyssinotus) regina* Schmidt, sp. n.

Figures 1D, 2D and 3E,F.

Type material: Holotype male, with label data: Ethiopia, Amhara, SW-slope Mt. Choke, alt. 3630–3730 m, 10°38′02″ N 37°50′08″ E, 28.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM).

Paratypes: 121 males, 62 females, same data as holotype (CAF, CSCHM, NHMAA, ZSM); 97 males, 49 females, W-slope Mt. Choke, "Shoa Kidaneberet" valley, alt. 3700–3800 m, 10°39′08″ N 37°49′45″ E, 8.V.2022, leg. J. Schmidt, Yeshitla M. (CAF, CSCHM, NHMAA, ZSM).

Etymology: The specific name is derived from the Latin "regina" (=the queen) and refers to the fact that this species, although exceedingly large compared to *Trechus* s.l., is somewhat smaller than the closely related species *T. rex* sp. n.

Description: Body length: 6.3–6.9 mm in females, 6.4–7.0 mm in males.

Proportions (n = 10 in females and males): PW/HW = 1.30–1.33 (Ø = 1.31, females), 1.28–1.34 (Ø = 1.32, males); PW/PL = 1.37–1.42 (Ø = 1.40, females), 1.35–1.42 (Ø = 1.39, males); PW/PBW = 1.26–1.36 (Ø = 1.30, females), 1.24–1.33 (Ø = 1.28, males); PBW/PAW = 1.06–1.13 (Ø = 1.11, females), 1.06–1.23 (Ø = 1.15, males); EW/PW = 1.40–1.46 (Ø = 1.44, females), 1.49–1.52 (Ø = 1.52, males); EL/EW = 1.40–1.44 (Ø = 1.42, females), 1.38–1.45 (Ø = 1.42, males); EL/AL = 1.66–1.77 (Ø = 1.72).

Color: Tibia dark brown; in all other characters as described in *T. rex* sp. n.

Microsculpture: As described in *T. rex* sp. n.

Head, prothorax, pterothorax, legs: As described in *T. rex* sp. n.

Male genitalia: Aedeagal median lobe large and elongated, with length 2.30–2.40 mm (n = 10), in lateral view with ventral surface markedly bent in basal third, straight in middle, markedly bent dorsally in apical third, with a moderately large apical hook; in dorsal view moderately slender, with apical lamella distinctly bent to the right. Basal bulb moderately large with a sagittal aileron large. Endophallus with a sack-like, moderately sclerotized copulatory piece; length of the copulatory piece slightly more than 1/3 of the length of the median lobe. Parameres with 3–4, exceptionally 5 apical setae.

Figure 8. Grazing forest with *Erica* in the Afroalpine zone on the western slope of Mt. Choke (February 2019). The small stream in the foreground is the habitat of *Trechus rex* Schmidt, sp. n. Specimens were found in the cavities of the stone packs in the stream bed along which the water flows. In order to find the beetles, the creek bed was partially dug up.

Sexual dimorphism: As described in *T. rex* sp. n.

Differential diagnosis: In external characters very similar to *T. rex* sp. n., however, the body and aedeagus, on average, are smaller, median lobe more slender, with its apex more markedly bent dorsally (lateral view) and the copulatory piece larger (Figure 3E,F). Body stouter than in *T. gigas* and *T. gizufu* sp. n. (EL/EW = 1.40–1.44 in *T. regina* sp. n.; EL/EW > 1.5 in *T. gigas* and *T. gizufu* sp. n.), shape of aedeagal median lobe and copulatory piece different (see Figure 3A–F).

Distribution: Endemic to the uppermost parts of two large valleys on the southwestern slope of Mt. Choke, northeast of the small town of Rob Gebeya (Figure 4). The distributional area of *T. regina* sp. n. is separated from that of *T. rex* sp. n. by a step mountain ridge that extends from the rim of the crater to the southwest.

Habitat: As described in *T. rex* sp. n.

Threat assessment: During our fieldwork in February 2019 and May 2022, large numbers of specimens of the new species could be found in the beds of small streams flowing through remnants of *Erica* forests in the Afroalpine zone. Based on this observation, we conclude that *T. regina* sp. n. is a locally common species. However, *T. regina* sp. n. is adapted to wet, cold and shadowed habitats, and the size of its distributional area is small, restricted to the uppermost parts of two valleys on Mt. Choke. Due to the continued expansion of settlements into the Afroalpine zone of the mountain, the beetle's habitats are continually being reduced. Therefore, we conclude that *T. regina* sp. n. is a species potentially becoming at risk in the near future.

3.2. The Trechus dimorphicus Subgroup

Species of *Trechus* subgenus *Abyssinotus* characterized by large body size with respect to *Trechus* s. l. (6.0–7.2 mm; in populations of *T. salomon variipenis* ssp. n., some specimens with slightly smaller body size could be found), markedly transverse pronotum with broad base, rectangular or slightly acute pronotal laterobasal angles, presence of 1 (very seldom 2) additional seta posterior of the four humeral setae of the elytral umbilicate series, and ±distinct sexual dimorphism with female elytra densely or sparsely pubescent (but see variability of this character in *T. salomon* Quéinnec and Ollivier, 2021); significant differences in body length of males and females could not be observed.

This subgroup includes two species endemic to Mt. Choke: *T. dimorphicus*, and the polytypic *T. salomon*. The species occur in strict allopatry, with their respective distributions restricted to different valley systems along slopes of the volcanic mountain.

3.2.1. *Trechus (Abyssinotus) dimorphicus* Pawłowski, 2001

Figures 1E, 2E and 9A,B.

Citations: *Trechus dimorphicus* Pawłowski, 2001 [7], p. 105; locus typicus: Mt. Choke, 3500–4000 m "near summit".

Trechus dimorphicus Pawłowski: Ortuño and Novoa [11], p. 136.

Trechus (*Abyssinotus*) *gigas* Pawłowski: Quéinnec et al. [4], p. 13.

Trechus (*Abyssinotus*) *gigas* Pawłowski: Merene et al. [2], p. 47.

Type material: Not studied. Identification is based on the original description, including habitus and male genital figures of the holotype specimen [7] as well as of the species' redescription including habitus and male genital figures of paratype specimens presented by Quéinnec et al. [4].

Additional material: 26 males, 15 females, Ethiopia, Amhara, 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).

Measurements and proportions: These data are based on the additional material collected. Body length is 6.0–7.0 mm in females, 6.2–7.0 mm in males. Length of aedeagal median lobe is 2.02–2.20 mm.

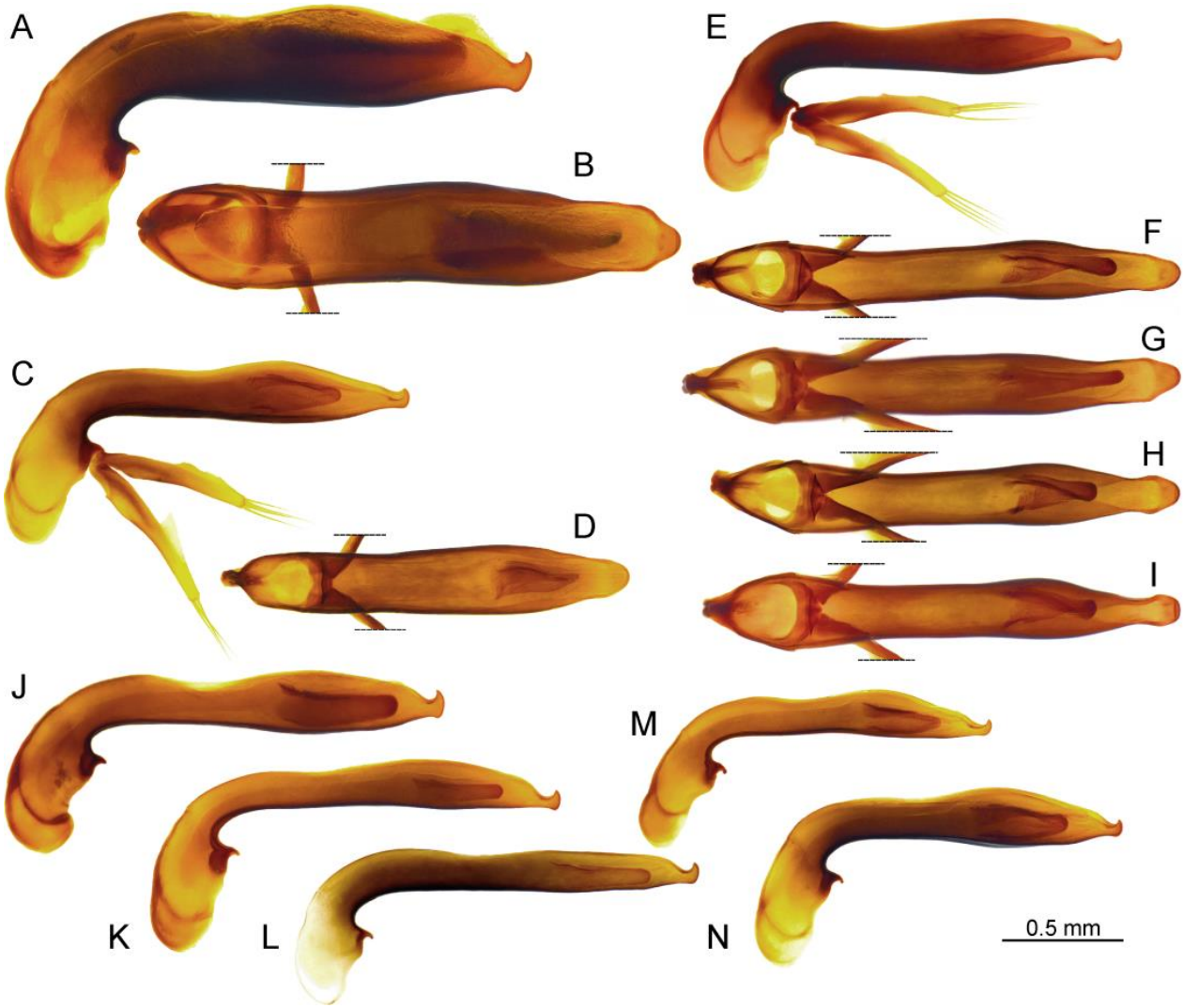

Figure 9. *Trechus* subgenus *Abyssinotus*, aedeagus in left lateral aspect (**A**,**C**,**E**,**J**–**N**) and dorsal aspect (**B**,**D**,**F**–**I**). (**A**,**B**): *T. dimorphicus*, specimens from above Felege Birhan. (**C**,**D**): *T. salomon salomon*, specimens from the type locality. (**E**–**I**): *T. salomon variipenis* Schmidt, ssp. n., paratypes. (**J**–**N**): *T. salomon variipenis* Schmidt, ssp. n., non-type specimens from above Gumadur.

Proportions (n = 10 in females and males): PW/HW = 1.31–1.37 (Ø = 1.35, females), 1.29–1.40 (Ø = 1.36, males); PW/PL = 1.34–1.41 (Ø = 1.37, females), 1.35–1.40 (Ø = 1.38, males); PW/PBW = 1.21–1.33 (Ø = 1.28, females), 1.26–1.32 (Ø = 1.28, males); PBW/PAW = 1.13–1.24 (Ø = 1.21, females), 1.14–1.24 (Ø = 1.19, males); EW/PW = 1.36–1.44 (Ø = 1.39, females), 1.38–1.47 (Ø = 1.44, males); EL/EW = 1.40–1.44 (Ø = 1.42, females), 1.41–1.46 (Ø = 1.44, males); EL/AL = 1.60–1.75 (Ø = 1.70).

Sexual dimorphism: Female specimens differ from males by the presence of dense punctures and very fine pilosity on the elytra.

Identification: See key to species of the *gigas* subgroup of *Abyssinotus* and Identification chapter of *T. salomon*, below.

Distribution: As noted above for *T. gigas*, also the type series of *T. dimorphicus* was collected by R.O.S. Clarke during his 1972 expedition to the Amhara region of Ethiopia. Clarke collected specimens of both these species "near summit" of Mt. Choke on the 17th of December 1972, without presenting more detailed locality data [7]. In addition, there is no evidence that both species were collected at the same place or mountain slope. Based on newly sampled *T. gigas* material, we assume that Clarke collected along slopes on the

southeastern part of the crater rim and found specimens of *T. gigas* above the village of Wondasha Guskuam (see above, for details). During our own fieldwork at this place, we could not find any specimen of *T. dimorphicus*. However, we collected several *T. dimorphicus* specimens in the northerly adjacent valley above the town of Felege Birhan, together with *T. gizufu* (Figures 4 and 10). We therefore conclude that *T. dimorphicus* is endemic to this valley. If so, then Clarke has been collecting on both sides of the ridge that extends east from the southeastern rim of the crater. However, we cannot exclude that *T. dimorphicus* has a wider distributional area that includes the slopes on both sides of this mountain ridge. Additional fieldwork is needed to better understand the distributional pattern of this species.

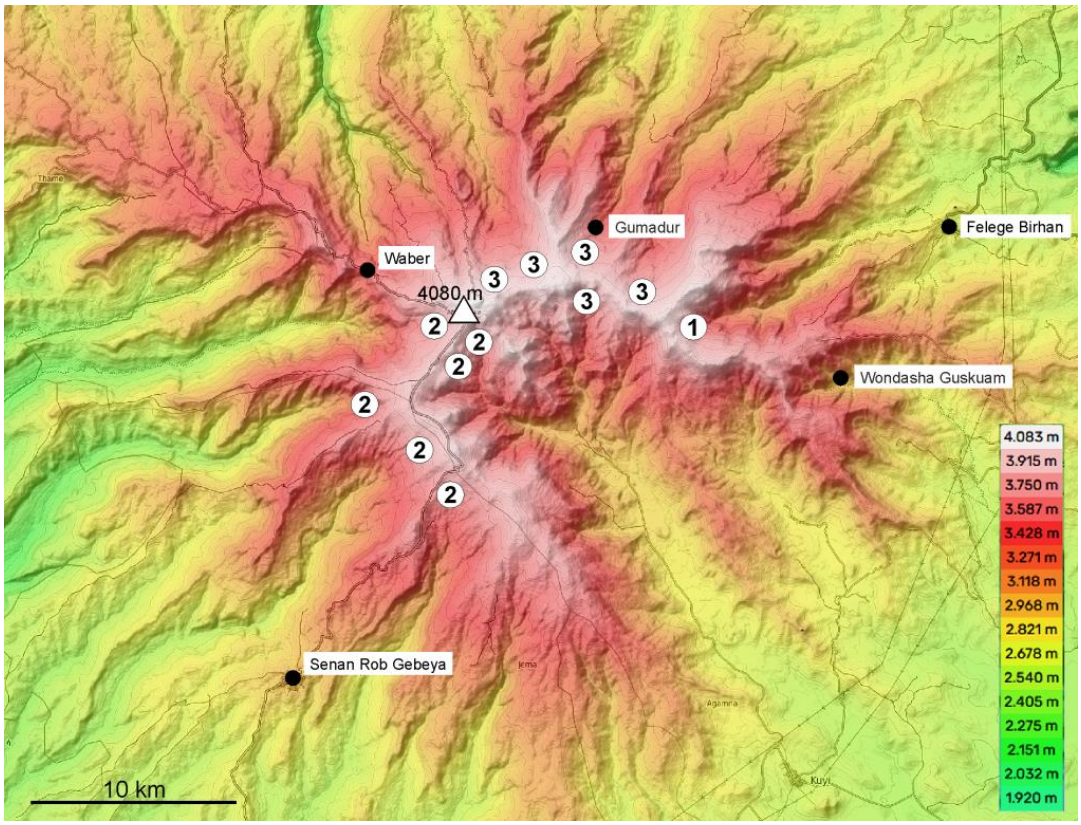

Figure 10. Topographic map of Mt. Choke (highest point marked by a white triangle), showing locations of the towns and villages mentioned in the text and sampling localities of species of the *T. dimorphicus* subgroup of *Abyssinotus* (white circles; the numbers refer to the different species and subspecies). 1, *T. dimorphicus*. 2, *T. salomon salomon*. 3, *T. salomon variipenis* Schmidt, ssp. n. Base map from Topographic-map.com (https://de-de.topographic-map.com/map-v693q/%C3%84thiopien/ (assessed on 1 January 2024)).

Habitat: Similar to species of the *T. gigas* subgroup, *T. dimorphicus* also seems to be strictly adapted to cold and humid conditions. In the Afroalpine zone, it occurs in the cavities of stone packs and coarse gravel in close contact with water. In shady areas along small streams, it was found syntopic with *T. gizufu* sp. n. (see above) and additionally in open areas in the source region of the streams under stones and in the root area of the riparian plants.

Threat assessment: Although *T. dimorphicus* probably has the same small range as *T. gizufu* sp. n., we assume that this species is less threatened by deforestation and intensive grazing than the latter, since *T. dimorphicus* also inhabits the open areas in the headwaters of streams where *T. gizufu* sp. n. is absent.

3.2.2. *Trechus (Abyssinotus) salomon* Quéinnec and Ollivier, 2021

Figures 1F, 2F and 9C,D.

Citations: *Trechus* (*Abyssinotus*) *salomon* Quéinnec and Ollivier, 2021 [4], p. 17.

Trechus (*Abyssinotus*) *salomon* Quéinnec and Ollivier: Merene et al. [2], p. 47.

Type material: Not studied. Identification is based on the original description, including habitus and male genital figures of paratype specimens presented by Quéinnec et al. [4] as well as a large number of additional specimens newly collected at the type locality.

Additional material: 139 males, 61 females, Ethiopia, Amhara, Mt. Choke, northwestern crater valley, alt. 3780–3900 m, 10°42′12″ N 37°50′58″ E (=locus typicus), 27.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CAF, CSCHM, NHMAA, ZSM); 49 males, 17 females, 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. (CAF, CSCHM, NHMAA, ZSM); 288 males, 121 females, W-slope Mt. Choke, alt. 3700–3900 m, 10°42′17″ N 37°50′29″ E, 25.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CAF, CSCHM, NHMAA, ZSM); 35 males, 14 females, W-slope Mt. Choke, alt. 3680–3780 m, 10°40′11″ N 37°48′33″ E, 11.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM); 73 males, 25 females, W-slope Mt. Choke, "Shoa Kidaneberet" valley, alt. 3700–3800 m, 10°39′08″ N 37°49′45″ E, 8.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM, ZSM); 85 males, 13 females, SW-slope Mt. Choke, alt. 3630–3730 m, 10°38′02″ N 37°50′08″ E, 28.II.2022, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM).

Measurements and proportions: These data are based on the additional material collected at the type locality. Body length: 6.0–7.2 mm in females, 6.1–7.2 mm in males. Length of aedeagal median lobe: 1.55–1.72 mm.

Proportions (n = 10 in females and males): PW/HW = 1.39–1.46 (Ø = 1.42, females), 1.43–1.50 (Ø = 1.46, males); PW/PL = 1.37–1.44 (Ø = 1.41, females), 1.37–1.41 (Ø = 1.40, males); PW/PBW = 1.21–1.30 (Ø = 1.25, females), 1.18–1.28 (Ø = 1.24, males); PBW/PAW = 1.21–1.30 (Ø = 1.25, females), 1.23–1.34 (Ø = 1.28, males); EW/PW = 1.36–1.42 (Ø = 1.38, females), 1.38–1.46 (Ø = 1.42, males); EL/EW = 1.35–1.39 (Ø = 1.36, females), 1.35–1.42 (Ø = 1.38, males); EL/AL = 2.22–2.43 (Ø = 2.30).

Sexual dimorphism: Most of the male specimens are characterized by smooth elytra and most of the females by the presence of ± dense puncture and very fine pilosity on the elytra. In females, the density of the puncture varies from relatively dense (similar to *T. dimorphicus*) to very extensive. In addition, we found males with punctured elytra, at least in its anterior third (3.5–7.6%), and females with completely smooth elytra (1.5–20.0%) in the populations studied.

Identification: See key to species of the *gigas* subgroup of *Abyssinotus*. *Trechus salomon* differs from the closely related species *T. dimorphicus* by larger pronotum (Ø PW/HW = 1.42 in females and 1.46 in males, instead of 1.35 in females and 1.36 in males of *T. dimorphicus*) with larger laterobasal angles, shorter elytra (Ø EL/EW = 1.36 in females and 1.38 in males, instead of 1.42 in females and 1.44 in males of *T. dimorphicus*), and much smaller aedeagus (EL/AL = 2.22–2.43, instead of 1.60–1.75 in *T. dimorphicus*).

Distribution and geographical variation: Western slopes of Mt. Choke and the western part of its crater valley (Figure 10). Along the northern and northeastern slopes of Mt. Choke and in the eastern crater valley, populations could be observed which differ from the typical *T. salomon* by more slender aedeagal median lobe and copulatory piece. Members of these populations are described as a separate subspecies, below.

Habitat: As described in *T. dimorphicus*.

Threat assessment: During our fieldwork in the Afroalpine zone along the western slopes of Mt. Choke, we found *T. salomon* in large numbers along different water bodies. Therefore, we assume that *T. salomon* is a common species that is currently not threatened by human activities.

3.2.3. *Trechus (Abyssinotus) salomon variipenis* Schmidt, ssp. n

Figure 9E–I.

Type material: Holotype male, with label data: Ethiopia, Amhara, N-slope Mt. Choke, alt. 3750–3850 m, 10°43′51″ N 37°52′15″ E, 9.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM).

Paratypes: 53 males, 41 females, with same data as holotype (CSCHM, NHMAA, ZSM); 8 males, 14 females, N-slope Mt. Choke, alt. 3800–3950 m, 10°43′16″ N 37°51′15″ E, 26.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 43 males, 31 females, Mt. Choke, northeastern crater valley, alt. 3700–3800 m, 10°42′59″ N 37°54′13″ E, 6.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM).

Additional material: 209 males, 54 females, NE-slope Mt. Choke, alt. 3700–3880 m, 10°42′56″ N 37°55′16″ E, 4.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM); 84 males, 47 females, NE-slope Mt. Choke, above Gumadur, alt. 3750–3850 m, 10°44′10″ N 37°53′48″ E, 5.V.2022, leg. J. Schmidt, Yeshitla M. (CSCHM, ZSM).

Etymology: The specific name refers to our observation that the new subspecies is characterized by a markedly high variability in the shape of the penis (see description).

Description: Body length: 5.9–7.6 mm in females of the type series (specimens from NE-slope Mt. Choke: 5.3–7.6 mm), 6.3–7.6 mm in males of the type series (specimens from NE-slope Mt. Choke: 5.4–7.5 mm).

Proportions (n = 10 in females and males from the type locality): PW/HW = 1.35–1.44 (Ø = 1.40, females), 1.39–1.45 (Ø = 1.42, males); PW/PL = 1.39–1.48 (Ø = 1.43, females), 1.36–1.43 (Ø = 1.40, males); PW/PBW = 1.20–1.29 (Ø = 1.24, females), 1.22–1.27 (Ø = 1.24, males); PBW/PAW = 1.20–1.29 (Ø = 1.24, females), 1.22–1.28 (Ø = 1.26, males); EW/PW = 1.35–1.40 (Ø = 1.38, females), 1.35–1.46 (Ø = 1.42, males); EL/EW = 1.36–1.41 (Ø = 1.38, females), 1.37–1.45 (Ø = 1.40, males); EL/AL = 1.82–2.20 (Ø = 2.03).

Color and microsculpture: As described in the nominotypical form.

Head, pronotum, elytra and legs: As described in the nominotypical form.

Aedeagus: Length median lobe: 1.70–2.00 mm in specimens from the type series (specimens from the NE-slope of Mt. Choke: 1.40–1.95). The median lobe is comparatively long and narrow, particularly if viewed from the dorsad (Figure 9F–I), in most specimens with both lateral margins distinctly concave before apical lamella (dorsal view, Figure 9G–I). The copulatory piece is moderately long and slender, sac-like, and often twisted in on itself (Figure 9F–I). Specimens from the NE-slope of Mt. Choke are characterized by a markedly high variability in the shape of the median lobe (Figure 9J–N).

Sexual dimorphism: As described in the nominotypical form.

Identification: *Trechus salomon variipenis* ssp. n. differs from the nominotypical form by the aedeagal median lobe, which is longer (EL/AL = 1.82–2.20 instead of 2.22–2.43) and narrower if viewed from the dorsad (Figure 9F–I), and by the longer and more slender copulatory piece (dorsal view). Specimens from the NE-slope of Mt. Choke, which are characterized by a high variability in the length and shape of the median lobe, differ likewise by both, a narrower apical portion of the median lobe, and a narrower copulatory piece, if viewed from the dorsad.

Distribution and geographical variation: Distributed along the northern slopes of Mt. Choke and the northeastern part of the crater valley (Figure 10). Specimens from populations occurring on the NE-slope of Mt. Choke (see Additional material) were found to be highly variable in body length as well as length and shape of aedeagus (Figure 9J–N). Therefore, specimens from this population are not included in the type series of *T. salomon variipenis* ssp. n. Additional investigations including molecular genetic analyses are needed to better understand the causes of the observed morphological variability.

Habitat: As described in *T. dimorphicus*.

Threat assessment: As in the nominotypical form.

3.3. Key to Species of the gigas and dimorphicus Subgroups of Trechus subgenus Abyssinotus

1 Pronotum, on average, smaller and less transverse (PW/HW = 1.29–1.36; PW/PL = 1.30–1.40), with laterobasal angles obtuse; elytra with umbilicate series consists of four humeral and two subapical setae, without additional interjacent setae **2**

-Pronotum, on average, larger and more transverse (PW/HW = 1.35–1.46; PW/PL = 1.37–1.43), with laterobasal angles rectangular; umbilicate series of elytra with 1–2 additional setae between the humeral and subapical series **5**

2 Elytra slender ovate (EL/EW > 1.48) **3**

-Elytra broader ovate (EL/EW < 1.48) **4**

3 Smaller (body length 6.7–7.5 mm), with smaller aedeagal median lobe (ca. 2.1 mm), and with the ventral surface of median lobe more convexly rounded in the middle (Figure 3A); maximum of five apical setae on the parameres of the aedeagus . . . . . ***T. gigas***

-Larger (body length 7.8–8.4 mm), with larger aedeagal median lobe (ca. 2.6 mm), and with the ventral surface of median lobe less convexly rounded in the middle (Figure 3C); 7–8 apical setae on the parameres of the aedeagus developed . . . . . ***T. gizufu* Schmidt, sp. n.**

4 Smaller (body length 6.3–7.0 mm), with aedeagal median lobe more slender and with copulatory piece relatively thin (Figure 3E,F) . . . . . ***T. regina* Schmidt, sp. n.**

-Larger (body length 7.1–8.5 mm), with aedeagal median lobe more robust and with copulatory piece stout (Figure 3G–L) . . . . . ***T. rex* Schmidt, sp. n.**

5 Pronotum, on average, smaller (PW/HW = 1.35–1.36) with laterobasal angles very small, elytra longer; aedeagal median lobe markedly large and robust (Figure 9A,B) with length > 2.0 mm. . . . . ***T. dimorphicus***

-Pronotum, on average, larger (PW/HW = 1.40–1.46) with larger laterobasal angles, elytra shorter; aedeagal median lobe more slender (Figure 9C–N), with length < 2.0 mm (*T. salomon*). **6**

6 Aedeagal median lobe broader in dorsal view, with shorter and broader copulatory piece (Figure 9D) . . . . . ***T. s. salomon***

-Aedeagal median lobe narrower in dorsal view, with longer and more slender copulatory piece (Figure 9F–I). . . . . ***T. s. variipenis* Schmidt, ssp. n.**

3.4. A Likely Hybrid Trechus dimorphicus × T. gizufu

Figure 11B.

Material: 1 female, with label data: Ethiopia, Amhara, 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).

Description: Body length: 7.7 mm.

Proportions: PW/HW = 1.37; PW/PL = 1.39; PW/PBW = 1.26; PBW/PAW = 1.21; EW/PW = 1.44; EL/EW = 1.40.

Color: Dark brown; mandibles, palps, antennae and legs lighter brown.

Microsculpture: As described in *T. gizufu* sp. n.

Head: Clypeus with two setae on the right side and three on the left side. In all other characters as in *T. dimorphicus*.

Prothorax: As in *T. dimorphicus*.

Pterothorax: Elytra almost smooth, with a very fine and sparse puncture in the anterior quarter. In all other characters as in *T. dimorphicus*.

Legs: As in *T. dimorphicus*.

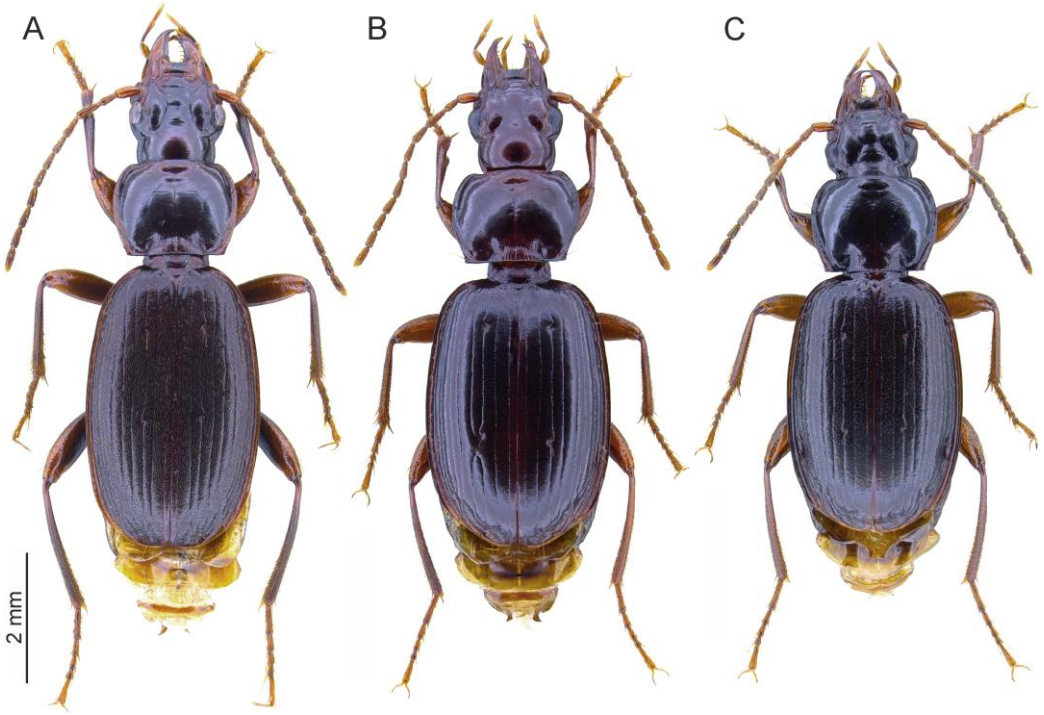

Figure 11. *Trechus* subgenus *Abyssinotus*, female specimens from the E-slope of Mt. Choke, above Felege Birhan, dorsal aspect of the body. (**A**): *T. gizufu* Schmidt, sp. n., paratype. (**B**): Probable hybrid *T. dimorphicus* × *T. gizufu*. (**C**): *T. dimorphicus*.

Diagnosis: The likely hybrid differs from both the probable parent species by the almost smooth elytra (densely punctured and pubescent in females of *T. dimorphicus* and *T. gizufu* sp. n.; see Figure 11A–C). In this character state, the likely hybrid remembers a male of one of the latter species. It has the following character states in common with *T. dimorphicus*: (1) more transverse pronotum; (2) broad pronotal base with laterobasal angles rectangular; (3) broader ovate elytra; (4) one additional seta between the humeral group and the subapical group of elytral umbilicate setae. The likely hybrid has the following character states in common with *T. gizufu* sp. n.: (1) markedly large body size; (2) one additional seta on clypeus.

4. Discussion

With a maximum elevation slightly exceeding 4000 m above sea level, Mt. Choke in northern Ethiopia is one of the highest mountain massifs in the country [13]. However, its horizontal extent is small compared to the famous Simien and Bale Mountains in northern respectively southern Ethiopia, at an elevation of 3000 m with a maximum diameter of about 50 km (Figures 4 and 10). Despite the limited extent of Afromontane and Afroalpine environments on this mountain, the number of ground beetle species endemic to the volcano is astonishingly high. Together with the three species newly described here, 15 endemic species of the genus *Trechus* are currently known to occur on Mt. Choke [1]. The monotypic Trechina genus *Baehria* was hitherto only found in the Afroalpine zone of Mt. Choke [1]. In the genus *Calathus* Bonelli, three species endemic to Mt. Choke were recognized [14,15]. Although little is known about additional ground beetle taxa occurring on this mountain (see [2], for details), based on the available data mainly in the Trechini, it seems obvious that Mt. Choke is one of the striking hotspots of ground beetle diversity in Ethiopia.

The results of our study suggest that the actual *Trechus* diversity on Mt. Choke may be higher than what is presently described. More intensive fieldwork combined with molecular genetic studies are needed to address the question of whether the morphologically divergent populations of *T. salomon* and *T. rex* sp. n., which were found to occur in the

separate valley systems, are members of a morphological cline or represent different species. Our results further indicate that *Trechus* evolution on Mt. Choke may be influenced by hybridization events. Within the comprehensive material sampled on the eastern slope of Mt. Choke, *T. dimorphicus* and *T. gizufu* sp. n. were found to be syntopic (Figures 4 and 10), a single female specimen was collected that combines certain character states of both the latter species (Figure 11). The likely hybrid *T. dimorphicus* × *T. gizufu* sp. n. is the second morphological evidence of interspecific hybridization in Trechini. The first hybrid was reported from the Cantabrian Mountains of Spain (probable *Trechus croceus* × *T. riberai*) [16]. However, as long as we cannot rule out that the Ethiopian specimen described above is an extreme aberration or even an unknown species, our interpretation must be regarded as preliminary. Additional fieldwork as well as molecular genetic investigations are needed to confirm this hypothesis.

Faille et al. [1] showed that *Trechus* species from Mt. Choke are characterized by very different patterns of external morphology (body sizes, setation patterns, dentition of mandibles, number of dilated protarsomeres, pilosity of elytra; [4,7]) belong to a single clade (subgenus *Abyssinotus* in sense of Faille et al.). Within *Abyssinotus*, the *dimorphicus* and *gigas* subgroups are members of a terminal clade (in the following the "di-gi clade") that evolved during the Late Miocene. The di-gi clade might be the sister clade of a hitherto undescribed species from the Guassa Plateau [1]. Faille et al. included only two representatives of the di-gi clade in their molecular phylogeny of Ethiopian Trechini beetles (see Faille et al., Figure 3: species ID L1814, for *T. salomon variipenis* ssp. n., and species IDs L1819 and L1823, for *T. rex* sp. n.) [1]. However, based on the morphological data presented above, there can be no doubt that all the species of the *dimorphicus* and *gigas* subgroups are members of the di-gi clade.

Within the *Trechus* fauna of Mt. Choke, species of the di-gi clade seem to be more tightly adapted to life in the stream gravel, in close contact with water, than any other species of the genus. It seems likely that this particular adaptation is a synapomorphy of the di-gi clade. If so, evolution of this clade bears some information regarding the palaeoclimatic history of East Africa. It seems likely that the di-gi clade represents a relic of more humid conditions in the area before the Pliocene. Geological studies have shown that, during the Pliocene–Pleistocene, North and East Africa underwent climatic oscillations with markedly wetter and drier conditions, and stepwise increase in aridity [17–19]. Brühl [20] summarized biogeographical data from flightless insects including ground beetles. The author found certain evidence that the high mountains of East Africa served as refugees for the cold-adapted forest fauna during arid periods of the Pleistocene. Our results show that this applies not only to the mesophilic fauna but also to hygrophiles. The presence of different lineages of the *dimorphicus* and *gigas* subgroups on each of the main valley systems along the slopes of Mt. Choke lead to suggest that the local climatic conditions remained stable enough to maintain habitat conditions even for the strictly hygrophilous species. This hypothesis is further supported by the presence of the endemic, quasi-rheophilic, trechine genus *Baehria* on Mt. Choke [1]. Several, local endemic, hygrophilous species of the *Trechus* subgenus *Minitrechus* were also detected in the Bale Mountains in southern Ethiopia, and their detection was taken as an indication of the quasi-stability of the environmental conditions over the Pleistocene period [21].

Our most recent field data from Mt. Choke suggest that current anthropogenic impacts, i.e., large-scale forest destruction, intensive grazing, and expansion of arable farming up to the Afroalpine zone, cause the substantial reduction of the habitat area for members of the di-gi clade. The situation seems to be particularly dramatic for *Trechus gigas*, as we have only been able to find this species in a very restricted area, despite intensive sampling efforts broadly along the slopes of Mt. Choke. Due to anthropogenic overuse of the landscape, this spot may represent the entire remainder of shaded mountain streams in the area of the species. *Trechus gigas* is likely one of the most endangered insect species in Ethiopia. Our results thus also point to the urgent need for effective protection of the high mountain environments in Ethiopia.

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