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Scarodytes costatus nov.sp. from the Bingöl Province in Turkey, the first species of the genus with costate elytra (Insecta: Coleoptera: Dytiscidae: Deronectina)

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A b s t r a c t: *Scarodytes costatus* nov.sp. is described from the Bingöl Province in eastern Turkey. At first glance the new species is externally similar to species of the *Nebrioporus carinatus*-complex which are endemic to the Iberian Peninsula and the French Pyrenees. A thorough study of the extern morphology and of the male genitalia shows, however, that the new species must be placed in the genus *Scarodytes* GOZIS, 1914. This is the first species of the genus with distinct costae on the elytra. So far the species has been found only in the type locality. The new species is described in detail, its habitus, male genitalia and other features are illustrated and its systematic position is thoroughly discussed. Notes on the "mesoventral column" are added as well as a discussion about the potential function of elytral costae as defence against loss of manoeuvrability by the "Bernoulli principle".

K e y w o r d s: Coleoptera, Dytiscidae, *Scarodytes*, new species, description, mesoventral column, Bernoulli principle, Turkey.

Introduction

In the period between May 2014 and September 2015 the senior author collected intensively at several localities in the Bingöl and Diyarbakır provinces in eastern Turkey. All specimens found could be determined without great problems, except one evidently new species with costate elytra (Fig. 1). There was no doubt that the species belongs to the subtribe Deronectina of the tribe Hydroporini, but it was impossible to attribute the specimens to one of the know genera. At first, the introduction of a new generic name for this species was considered, but a thorough study of all important characters, a comparison with those of other genera of the subtribe and the exclusion of all but one of these genera lead finally to the result which we present here – the species is attributed to the genus *Scarodytes* GOZIS, 1914, although so far no species of the genus is known which has costate elytra. Below we give a description of the new species, followed by a separate section discussing its systematic position.

The species of the genus *Scarodytes* are distributed in the western Palearctic, with most of them occurring in Europe. *Scarodytes halensis* (FABRICIUS, 1787) – the type species of the genus – occurs also in Northern Africa, Asia minor and the Near and Middle East, *Scarodytes malickyi* WEWALKA, 1977 is known from Greece and Asia minor and *Scarodytes margaliti* WEWALKA, 1977 from the Near East. Together with *S. costatus*

nov.sp. the genus now includes 11 species, one of which has two subspecies (NILSSON & HÁJEK 2017a, 2017b).

Fig. 1: Oblique frontal view of *Scarodytes costatus* nov.sp.

Material and methods

Specimens were studied with an Olympus SZX16 stereomicroscope. For most figures stacks of micrographs were made with a Canon EOS 650D camera attached to the stereomicroscope. These stacks were subsequently treated with the image stacking software Helicon Focus Pro version 6.4.1. Figure 1 was made with a Leica Z16 APO stereo macroscope combined with a Leica MC170 HD camera. For the SEM-micrographs specimens were placed on stubs and coated with gold (Sputter Coater, Quorum Technologies Ltd., Ashford, England). Micrographs were taken with an ESEM XL30 (Philips, Amsterdam, The Netherlands) and Scandium FIVE software (Olympus, Münster, Germany) in the Phyletisches Museum (Jena, Germany). Figure 5 was made whilst preparing the manuscript of ANGUS et al. (1993), but was not included in the final version of that publication. Adobe Photoshop CS5 software was used to retouch micrographs and ink drawings.

The aedeagus was studied wet for drawings. Authors' remarks are given in square brackets. When describing structures of the ventral surface terms like "ascending", which describe the relative height between different parts, must be understood as relating to how these structures appear when the beetle is upside down.

The terminology to denote the orientation of the male genitalia follows MILLER & NILSSON (2003). In the locality data, slashes indicate line breaks. The following abbreviations are used in the text: TL (total length), TL-h (total length without head), MW (maximum width). Collection codens used in the text are NMW (Naturhistorisches Museum Wien, Vienna, Austria) and CHF (coll. H. Fery, property of the NMW).

Taxonomy

***Scarodytes costatus* nov.sp.**

T y p e l o c a l i t y: Turkey, Bingöl province, Solhan District, N Hazarşah village, ca. 1740 m, 39.020N 40.890E. The brook, in the rest pools of which the specimens have been found, is called "Hazarşah brook" (in Google Map given as "Hazaryah Deresi").

T y p e m a t e r i a l: H o l o t y p e: ♂, "20.8.2014 Turkey, Bingöl prov./ca. 10 km N Bingöl-Solhan road/N Hazarşah village/rest pools of brook, 1740 m/39.020N 40.890E, M. Aykut leg." [printed], " Holotype/Scarodytes costatus nov.sp./Aykut & Fery det. 2017" [red, printed] (NMW). N o t e s: The holotype is slightly damaged on the right side of the pronotal disc, lacks the last antennomere of the left antenna and the inner metatarsal claw; the left mid-leg is disarticulated; the last abdominal ventrite was removed from the rest of the abdomen for studying the aedeagus; abdomen and aedeagus are glued onto the card behind the specimen.

P a r a t y p e: 1♀, same label data as holotype, except red paratype label; the paratype lacks the last nine antennomeres of the right antennae (CHF).

D e s c r i p t i o n o f h o l o t y p e:

H a b i t u s elongate oval, elytra appearing strongly vaulted due to high costae (Figs 1, 2; for comparison *S. halensis* in Fig. 4 and *Nebrioporus carinatus* (AUBÉ, 1838) in Fig. 5); sides of elytra evenly rounded; maximum width near midlength of elytra. Pronotum widest at base, here slightly broader than elytra at shoulders; thus body outline with weak discontinuity at shoulders. Dorsal surface brownish yellow to large extent with large brownish dots on pronotum and very indistinct vittae on elytra; surface appearing silky shining, almost matt due to dense punctation and/or reticulation. Ventral surface black to large extent, rather shiny in part; appendages brownish yellow.

D o r s a l s u r f a c e: H e a d: Anterior margin of head truncate, not indented; clypeus almost trapezoidal; generally brownish yellow; anterior margin of clypeus, clypeal grooves and near eyes diffusely brownish; vertex blackish brown; entire surface distinctly reticulate, rather matt; meshes small, polygonal, near anterior margin transversely shaped; punctation double and rather dense; diameter of smaller punctures that of one mesh, diameter of larger punctures that of two meshes; near anterior margin of clypeus larger punctures very sparse, becoming denser towards vertex; distance between larger punctures more or less that of diameter of two or three meshes, somewhat larger on centre of frons; smaller punctures becoming less dense posteriad; clypeal grooves very distinct and large; grooves and impressed stripe beside inner margin of eyes with dense larger punctures and stronger impressed reticulation; setae on head absent.

P r o n o t u m: Maximum width at base, margin in posterior two thirds almost straight, converging forwards, rounded in anterior third; posterior angles slightly acute, because somewhat protruded backwards; thus base of pronotum sinuate; lateral rim distinct, but disappearing short before anterior angle; sublateral depression parallel to lateral margins deeply impressed in posterior half, especially deep at base; however, pronotum without sublateral crease. Centre of disk with very deeply impressed longitudinal groove.

Pronotum brownish yellow like head, left and right of centre with large diffusely delimited brownish dot, extending until sublateral depression; near lateral and posterior margins brownish, lateral rim dark brown; at anterior margin blackish brown vertex of head translucent. Distinct reticulation only present near margins and before central groove, elsewhere only traces of reticulation perceptible. Punctation simple and more or less even, denser than on head, denser still in lateral and central depressions; punctures with diameter like that of larger ones on head. Very few setae present near side margins.

E l y t r a: Each elytron with four costae, inner (= first) one especially high, running from shortly behind anterior to shortly before posterior margin; second costa very indistinct and short, present only in anterior elytral half; third costa distinct, but weaker than first one, running from shortly behind anterior margin and ending far before elytral hind margin; sublaterally with fourth costa, weaker than third, starting behind first elytral quarter and running parallel to margin (and thus curved) almost until elytral apex. Sides of elytra slightly concavely sinuate preapically and apex indistinctly pointed.

Entire surface of elytra densely and evenly punctured; punctures slightly smaller than those on pronotum and denser; distance between punctures mostly smaller than their diameter; reticulation actually absent, only sporadic traces recognisable. Spaces between punctures smooth and shiny, but overall elytra appearing rather matt due to dense punctation. Punctation less dense on costae, these thus appearing somewhat less matt and standing out from rest of surface. Sutural puncture line very distinct, slightly impressed; base of elytra with short, curved line of deeply impressed punctures starting between suture and sutural line and running anteriorly parallel to base until interspace between first and second costa; no further puncture lines present on elytra. Margin of elytra with thin rim until shortly before apex. When viewed perpendicularly, elytral margin only perceptible immediately behind shoulders and near apex, due to sides of elytra projecting over margin and obscuring it. In lateral view side margin moderately ascending to shoulders; epipleuron visible until shoulders.

Elytra brownish yellow, somewhat lighter than head and pronotum; lateral rim slightly more brownish. Costae somewhat lighter than interspaces between them. At first glance elytra appearing non-vittate, but when carefully inspected diffusely delimited light brownish longitudinal vittae recognisable: one vitta between sutural line and first costa, starting somewhat behind base and running as far as end of first costa; a short very weak further vitta indicated in anterior fourth of elytra between first and second costa; fourth costa at midlength also with short vitta. Suture, sutural line and curved short line near base shining through dark brownish. Setae on elytra very short and sparse, present especially near side margins and in posterior fourth, but only recognisable if adequately illuminated.

V e n t r a l s u r f a c e: C o l o u r: Predominantly black; prosternum medially black, laterally brownish, but head black translucent; mouthparts and legs brownish yellow; gula, genae in part, prosternal process, propleuron and posterior third of metacoxal processes dark brownish; hypomeron (= pronotal epipleuron) and elytral epipleuron brownish yellow; first abdominal ventrite totally, second ventrite laterally and third to fifth ventrite laterally and posteriorly dark brown. Last ventrite dark brownish to large extent. Antennae brownish yellow, tenth antennomere distally very weakly darkened, eleventh more distinctly darkened in distal half. Last labial and maxillary palpomeres also darkened distally.

H e a d: Underside of head with gula smooth and very shiny, laterally and medially with some punctures. Genae with crease behind eyes, but only laterally distinctly engraved, more medially somewhat irregularly shaped; before crease surface mainly smooth and shiny, but more medially with weak reticulation; behind crease surface reticulate; some strong wrinkles present between eyes and mouthparts. Third antennomere distinctly shorter than second, fourth longer than third, but shorter than second; fifth to tenth as long as fifth, eleventh again longer.

P r o t h o r a x: Prosternum anteromedially (before procoxae) strongly vaulted and very coarsely sculptured; laterally (before propleuron) smooth and shiny, with very few punctures. Hypomeron latero-anteriorly flattened to a more or less triangular flat part; this part provided with some punctures; hypomeron else in large part smooth and shiny, posteriad with weak reticulation and some punctures.

Prosternal column (declivitous part of prosternum between procoxae, before prosternal process; sometimes treated as belonging to prosternal process) moderately ascending posteriad (as viewed in beetle turned upside down), between procoxae with indistinct protuberance near anterior part of procoxae. Prosternal process weakly inclined; broadly lanceolate, weakly costate longitudinally, in cross-section more or less roof-like, laterally very weakly impressed, lateral rim narrow; prosternal column and process covered with coarse punctures, between punctures surface smooth and shiny. Tip of process shortly rounded, reaching between mesocoxae and until anteromedial process of metaventrite.

P t e r o t h o r a x: Mesepimeron and mesepisternum mostly smooth and shiny, but nevertheless some very small punctures and extremely weakly impressed reticulation on parts of their surfaces, perceptible at high magnification. Metepisternum triangular (Fig. 6), covered with obliquely stretched punctures, surface between punctures smooth and shiny. Lateral planes of "mesoventral column" parallel (Figs 13, 15; see separate section on this structure below). Anteromedial process of metaventrite rather narrow (ca. 1/3 of maximum width of mesofemur), reaching almost until middle of mesocoxae; distally with very short depression for reception of prosternal process.

Lateral part of metaventral wings very narrow and strongly curved backwards (Fig. 6). Metacoxal lines diverging anteriad, becoming indistinct before hind margin of metaventrite. Hind margin of metacoxal processes obliquely incised; interlaminary bridge shortly visible (Fig. 11), but not as fully exposed as in species of *Deronectes*; bridge step-like, transformed into a more or less triangular (or wing-like shaped) elevation on second abdominal ventrite. Metaventrite and metacoxal plates densely covered with large punctures (Fig. 6; for comparison *Scarodytes fuscitarsis* (AUBÉ, 1838) in Fig. 7, *S. halensis* in Fig. 8 and *Nebrioporus carinatus* in Fig. 9); punctation somewhat denser on metacoxal plates; centre of each puncture situated in a conical pit, sides steeper anteriorly than posteriorly, most pits more weakly delimited posteriorly than anteriorly, pit around centre of each puncture smooth and shiny; surface between punctures also smooth and shiny; thus, entire surface rather shiny and not appearing matt (Fig. 6). Metaventrite with small impunctate area left and right of midline and with impunctate rhomboidal smooth area medially before hind margin. Anterior and posterior margin of metacoxal plates impunctate and smooth, surface of plates near lobes of metacoxal processes largely impunctate and smooth, more laterally weakly reticulate. Metacoxal processes covered with smaller and denser punctures, less dense near apex and on lobes; shiny between punctures, but here nevertheless very weakly reticulate.

E l y t r a: Elytral epipleura anteriorly rather broad (broader than mesotibiae), more or less abruptly becoming narrower at level of first abdominal ventrite; epipleura punctured more or less like dorsal surface of elytra. Sublateral carina on ventral side of elytra distinct, and elevated before elytral apex, but without ligula.

A b d o m e n: First three ventrites rigidly connected. First abdominal ventrite punctured like metacoxal plates, second ventrite laterally with punctation denser, but becoming sparser lateromedially and almost absent medially (behind hind-margin of metacoxal

processes); punctures on third to fifth ventrites somewhat smaller and generally denser, right and left middle slightly sparser. Last abdominal ventrite almost triangular, very weakly depressed subapically; apex rounded, but rim of ventrite very weakly pointed; very coarsely punctured, thus surface strongly and roughly structured. Entire abdomen without reticulation.

L e g s more or less simple; protibiae not conspicuously broadened distally. Metafemora with irregular puncture line in distal half along midline, before and behind with only few punctures; more proximally punctation becoming less sparse and puncture line no longer recognisable. Anterior face of metatibiae almost impunctate, but with a few setiferous punctures proximally and near ventral margin.

Protarsal claws distinctly prolonged; anterior claw weakly and evenly curved, somewhat more curved near end; posterior claw strongly curved at base, then almost straight and distally curved again. First three protarsomeres broadened, more or less as long as broad; ventral surfaces with some simple setae (no suckers). Fifth protarsomere rather short, and thick, much shorter than claws and not much longer than third protarsomere; midline on ventral surface with three spines. Mesotarsomeres not broadened, first three ventrally with a few simple setae and fifth on ventral surface with three spines along midline; claws slightly prolonged, weakly curved, more so near end. First metatarsomere slightly more than twice as long as second, as long as second and third together; fifth tarsomere about 1.5x as long as fourth; claws subequal, anterior claw slightly shorter.

S e t a t i o n: Prosternum medially and prosternal process with some setae; metaventrite medially and behind mesocoxae with very few setae; setae on metacoxal processes more numerous; setae very sparse on first and second abdominal ventrites; other ventrites with many setae; each of third to fifth ventrites with tuft of very long setae medially.

A e d e a g u s: Median lobe weakly and evenly tapering to apex in ventral view (Fig. 18), apex very broadly rounded; lateral view as in Fig. 19; left paramere as in Fig. 20.

Fe m a l e (paratype): genitalia not studied; specimen deviating from male in several characters:

- maximum width of pronotum somewhat before posterior angles, sides more rounded over entire length, posterior angles not acute, but slightly obtuse; thus discontinuity of body outline at shoulders more distinct (Fig. 3);
- pronotal and elytral pattern more developed, several longitudinal brownish vittae perceptible (Fig. 3);
- first elytral costa medially stronger raised, second and third costae less prominent; short "costa" between first and second costa actually not perceptible;
- entire surface of pronotum and elytra provided with dense short setae and reticulate between punctures; thus upper surface appearing more matt than in male holotype;
- postocular crease on ventral surface of head rather sharp over entire length, more strongly reticulate behind and also with some meshes before;
- distal darkening of antennae beginning already at eighth antennomere;
- protibiae narrower and longer than in male;
- first three protarsomeres not broadened; fifth tarsomere narrower and longer, almost as long as tarsomeres two and three together, with only two spines along

midline on ventral surface; protarsal claw not prolonged, somewhat shorter than mesotarsal claws;

- metaventrite with very weakly impressed reticulation between punctures; metacoxal plates with more distinct reticulation between punctures; thus, venter somewhat less shiny than in males;
- abdomen between punctures reticulate;
- last abdominal ventrite more depressed before apex; apex less broadly rounded, rim more pointed and slightly curved upwards.

M e a s u r e m e n t s: Holotype: TL = 4.1 mm, TL-h = 3.6 mm, MW = 2.15 mm; TL/MW = 1.86; TL-h/MW = 1.67; female paratype: TL = 4.3 mm, TL-h = 3.8 mm, MW = 2.25 mm; TL/MW = 1.91; TL-h/MW = 1.68.

D i f f e r e n t i a l d i a g n o s i s: Here we give only the most important differences of *S. costatus* nov.sp. (firstly) to other species of the genus (after the dash):

- strong costae on elytra – elytra without costae or swellings;
- elytral vittae strongly reduced and very diffusely delimited – vittae well extended and delimited;
- posterior angles of pronotum slightly acute and protruded backwards in male – posterior pronotal angles shortly rounded and not protruded backwards;
- interlaminary bridge weakly exposed – bridge fully concealed;
- punctures on metaventrite and metacoxal plates large and posteriorly very weakly delimited – punctures smaller and more distinctly delimited (although punctures in *S. fuscitarsis* also rather large; see Fig. 7);
- interspaces between punctures on metaventrite and metacoxal plates reticulate in female – interspaces smooth (although traces of such reticulation observed also in some females of other species);
- rather irregular puncture line along midline of metafemora distinct only in distal third, proximally concealed by punctation before and behind – puncture line more regular and distinct over almost entire length;
- fifth protarsomere in male shorter than in female – differences not present or subtle.

D i s t r i b u t i o n: Known so far only from the type locality in eastern Turkey, Bingöl province, N Hazarşah village. This village is situated about 35 km NE Bingöl and about 15 km W Solhan.

E c o l o g y: The holo- and the paratype have been collected in two residual pools (Figs 21, 22) of a brook which has much water and very strong flow in early spring, but is dry in summer. It is engraved in the rocky mountainous landscape, its bottom is sandy only in part and mostly covered with gravels; the vegetation is very sparse. Three further collecting attempts in 2015 were not successful: in May and September the brook was flowing too strongly and in July the senior author found only some specimens of *Nebrioporus stearinus stearinus* (KOLENATI, 1845) and *Scarodytes halensis*.

E t y m o l o g y: The specific name *costatus* is an adjective in the nominative singular. It is a Latin word meaning "provided with ribs" and relates to the costate elytra of the new species (see NILSSON 2010: 10 and STEARN 2005: 393).

Generic classification of *Scarodytes costatus* nov.sp.

The systematic position of the new species is a great challenge. There is little doubt that it belongs to the subtribe Deronectina of the tribe Hydroporini (although no synapomorphy of this subtribe is known): the protarsi are pseudotetramerous (small fourth tarsomere concealed), the prosternal process is in a distinctly different plane from the anterior part of the prosternum (see fig. 3.3.a on p. 39 of MILLER & BERGSTEN 2016), the epipleura are not supplied with an oblique subhumeral carina and are abruptly narrowed at the level of the first abdominal ventrite, the hind margin of the metacoxal processes is obliquely incised (but not as deeply incised as e.g. in specimens of *Graptodytes* SEIDLITZ, 1887) and the hind-claws are equal in length. However, the species cannot be assigned undoubtedly to any of the known genera of Deronectina. It might be easy to justify the introduction of a new genus for this species, but we did not do so because it is quite likely that future molecular studies would result in its synonymisation.

At first glance, the very distinct elytral costae lead to the genera *Deronectes* SHARP, 1882, or *Nebrioporus* RÉGIMBART, 1906, because some of their members have also distinctly costate elytra (as an example see *Nebrioporus carinatus* in Fig. 5; see also FERY & BRANCUCCI 1987, 1997 and ANGUS et al. 1993). The former should be excluded because all *Deronectes* have black or brown non-vittate elytra, a matt venter, the entire anterior surface of the metatibiae covered by spiniferous punctures and the interlaminary bridge broadly exposed. In addition, no *Deronectes* is known which possesses hooked parameres.

Nebrioporus is a more suitable candidate. However, all of its costate species have distinct preapical elytral spines, widely rounded posterior pronotal angles (Fig. 5) and are endemic to the Iberian Peninsula – some thousands of kilometres further west. Additionally, almost all *Nebrioporus* have the venter matt (Fig. 9), except the African *Nebrioporus kilimandjarensis* (RÉGIMBART, 1906) (which possesses preapical elytral extensions) and the Indian *Nebrioporus melanogrammus* (RÉGIMBART, 1899) (of which at least the females have preapical elytral spines). *Nebrioporus canaliculatus* (LACORDAIRE, 1835) shall be also shortly mentioned because of its longitudinal elytral swellings; however, these swellings are rather flat, the pronotum is almost cordiform, the venter is very finely punctured and matt and the parameres are only simply hooked (see fig. 7e in TOLEDO 2009).

NILSSON & ANGUS (1992: 278) wrote: "Costate elytra are present in some species of *Deronectes* and *Nebrioporus*. The distribution of other characters suggests that this character has evolved independently in these two genera." This is why one should not fixate on the costate elytra and take into account species groups or genera which have the elytra even and without spines. Here we have among *Nebrioporus* the species of the *ceresyi*-group – in particular *Nebrioporus ceresyi* (AUBÉ, 1838) with distinct acute posterior angles of the pronotum – but all members of the group have very finely punctured matt venter and rather simply hooked parameres.

If we take other genera into consideration the members of which have vittate elytra without spines (although the new species has only very indistinct vittae), a shiny venter (at least in larger parts) and hooked parameres, then we must accept that *Scarodytes* GOZIS, 1914 is the best option for the placement of the new species.

The following features also point to *Scarodytes*:

- as in all other members of *Scarodytes* the new species has a crease behind the eye on the ventral surface of the head ("postocular ridge" in TOLEDO 2009), no punctures before and behind this crease and the surface is largely smooth before it and at least in part reticulated behind;
- the shape of the "mesoventral column" (see below) is similar to that of other members of the genus;
- the punctures on the metaventrite and the metacoxal plates are rather large (much larger than in *Nebrioporus*; cf. Figs 6-9);
- the shape of the median lobe in ventral view is quite diverse in *Scarodytes* (see FERY 2011) and several members of the genus have its apex broadly rounded in ventral view; however, except *Nebrioporus depressus* (FABRICIUS, 1775) and *N. crotchi* (PREUDHOMME DE BORRE, 1871) all species of *Nebrioporus* have the apex pointed (see TOLEDO 2009);
- the shape of the parameres is very similar to that of all other members of *Scarodytes*.

Notes on the "mesoventral column"

The shape of the so-called "mesoventral column" is important for the classification of the new species described below. This structure of swimming beetles needs a rather detailed explanation because it is difficult to observe and seems almost never have been dealt with in the literature. In particular, a modern detailed description of this part of the mesothorax is unknown to us.

If head and prothorax of a dytiscid beetle are removed from the rest of its body one can then see the front of the mesothorax (Figs 10, 12-14). At the sides are the mesepimeron (a) and the mesepisternum (b); between the two mesocoxae (j) is what is often called the "mesosternum" (d), e.g. in GUIGNOT (1947: 9), PEDERZANI (1995: 11), LARSON et al. (2000: 35). In BALKE (2005: 103, fig. 7.6.3 D) the upper end of one tine of the "mesosternal fork" (see below) is denoted by the abbreviation "ms" (for mesosternum) and the trapezoidal area beside that tine is the lower part of one of the lateral planes mentioned below. Today the term "mesosternum" is replaced with "mesoventrite" (see the Glossary in LAWRENCE et al. 2000).

The only author who dealt intensively with this column was SHARP (1882: 223 and fig. 23 on plate VII). Figure 10 is a modified version of SHARP's figure. The text for his figure is "Mesosternum of *Dytiscus* (*D. marginalis*, L.); a, episternum; b, epimeron; c, portion of margin of middle coxal cavity; d, medisternum." (SHARP 1882: 984; unfortunately, SHARP 1882: 984 mistakenly mixed up the terms "episternum" and "epimeron" in the explanations for fig. 23 on plate VII). For comparison we give in Fig. 12 a frontal view onto the respective structures for a *Nebrioporus carinatus* (cf. also Figs. 13 and 14). SHARP described this structure as "middle portion... of the mesosternum" which "when disarticulated" has "more or less the form of a short six-sided column" of which only the four anterior planes are visible if not disarticulated. The two anterior planes (called "facettes" by SHARP l.c.) are placed immediately behind the procoxae and hollowed for their accommodation (indicated by "d" in Figs 10 and 12). At their upper end the "column" is deeply channelled (roof like, with ridge at bottom) for receiving the apex of

the prosternal process; this structure is called "mesosternal fork" by SHARP (1882: 224) (the "tines" of this fork are indicated by arrows "e" in Fig. 12).

The other two visible planes of the "column" border on the two anterior ones and form with their upper end the sides of the "mesosternal fork". These two lateral planes are in other species of Deronectina more or less diverging backwards over almost their entire vertical length and, thus, are visible in frontal view (see arrows "f" in Figs 12 and 14). In all *Scarodytes*, however, these planes are parallel in their upper part and, thus, are invisible in frontal view (see Fig. 13). They diverge backwards only in their lowest part and pass here into a horizontally oriented small branch on each side. These branches together with the proper "column" form what SHARP l.c. described "as being somewhat T shaped" (indicated by us in Figs 10 and 12). Figure 15 shows a ventral view of the mesoventral column of *S. halensis* and Fig. 16 that of *Deronectes hispanicus* (ROSENHAUER, 1856). Figure 17 is a lateral view of the respective structures of *S. fuscitarsis.*

Fortunately, it is not necessary to disarticulate a specimen for studying the two lateral planes – their upper two thirds can be observed simply by moving the anterior legs somewhat up and forwards.

Notes on costate elytra

The influence of size and shape on the swimming strategies of Dytiscidae was treated in RIBERA et al. (1997), but to our knowledge the function of uneven elytral surfaces of swimming beetles has never been studied systematically.

The junior author has long been interested in the question "Why have some species of *Deronectes* and *Nebrioporus* developed costate elytra?" There are also members of other genera which have such unusually shaped elytra (e.g. *Peschetius* GUIGNOT, 1942, *Stictotarsus* ZIMMERMANN, 1919, and *Yola* GOZIS, 1886), but so far no costate member of *Scarodytes* was known. The finding of the new species raises the question again. It was found in residual pools of a brook which in spring flows with very high velocity. The costate *Deronectes* and *Nebrioporus* are also known largely (although not exclusively) from waters with rather rapid flow. Here the specimens are swimming between the gravels searching for food. The velocity of the water between the gravels will be less than in the open water of a brook, but there will be still a certain degree of water flow. If a beetle is swimming between the gravels it is very likely that its upper surface will come close to the gravel surface and if the beetle has a flat elytral surface it will be attracted to the gravel and cannot escape anymore.

Why this? This is a result of the Bernoulli principle (also known as "Bernoulli's paradox"): "Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy" (Wikipedia, accessed in February 2017; see also MICHELS 1956: 89). This may appear rather theoretical, but many experiments can be found in the literature and on the Internet which demonstrate the often very surprising consequences of Bernoulli's principle. In addition many economically very important applications rely on this principle – for example our airplanes would not fly without it (nor birds either). Another example shall be added which comes close to our beetle-effect: if ships are swimming parallel to each other and come too close, the water between both ships will run faster and faster and the pressure in the water will decrease more and more and finally the ships are fully attracted

each to the other and lose their manoeuvrability. This undesirable and also dangerous situation can only be stopped by stopping the ships (relative to the flow of water).

And our water beetles? Those with costate elytra have developed a perfect strategy – their costae prevent large parts of their upper surface becoming too close to the surface of the gravel; thus, the velocity of the water flow between the beetle's elytral surface and the gravel will not increase considerably, the pressure will not decrease and the beetle will not be attracted to the gravel. What about the ventral side of the beetles? Here they have their legs and also other parts of the surface are much more irregularly structured so that Bernoulli's principle has much less opportunities to act. Definitively, the occurrence of costate elytra in *Scarodytes* is a piece of evidence that this character has evolved independently also in other genera such as *Deronectes* and *Nebrioporus* and – if our assumption is correct – is an adaption to environments with high water flow.

Elytral costae may have also other functions (see e.g. the terrestrial (!) *Typhlodessus monteithi* BRANCUCCI, 1985), but the interpretation given above seems to be very plausible for some dytiscids. Other water beetles may have developed other strategies, such as longitudinal striae or grooves, setae on the elytra, a more globulous body shape or whatever else. This all may be worth studying in detail and our considerations may stimulate eventual future experimental studies.

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Zusammenfassung

Die bisher bekannten Vertreter der Gattung *Scarodytes* GOZIS, 1914 weisen keine besonderen Strukturen der Flügeldecken auf, sind sich extern-morphologisch äußerst ähnlich und ohne Studium der männlichen Genitale nur schwer unterscheidbar. *Scarodytes costatus* nov.sp. ist die erste Art der Gattung mit longitudinal angeordneten Rippen auf den Flügeldecken (Fig. 1). Sie wird ausführlich beschrieben, ihr Habitus, ihre wesentlichen differenzierenden externen Merkmale sowie das männlichen Genital werden illustriert und mit denen einiger anderer Arten der Gattung verglichen.

Wegen der Flügeldeckenstruktur erinnert die neue Art auf den ersten Blick an einige Vertreter der Gattungen *Deronectes* SHARP, 1882 und *Nebrioporus* RÉGIMBART, 1906 (siehe Fig. 5), welche ebenfalls stark gerippte Flügeldecken besitzen. Deshalb wird die Platzierung der neuen Art in der Gattung *Scarodytes* ausführlich begründet. Sie konnte bisher nur vom locus typicus im Osten der Türkei nachgewiesen werden, obwohl in mehreren nahe gelegenen weiteren Gewässern intensiv gesammelt wurde. Die in der westlichen Paläarktis weit verbreitete Gattung *Scarodytes* enthält nun mit der neuen Art insgesamt 11 Arten, von denen eine in zwei Unterarten aufgespalten ist.

In einem extra Abschnitt wird auf die "mesoventrale Säule" eingegangen, eine Struktur am vorderen Ende des Pterothorax, die nach unserer Kenntnis seit ihrer Beschreibung durch SHARP (1882:

223) völlig unbeachtet blieb. Die Seitenflächen dieser sechseckigen Säule sind bei den Vertretern der Gattung *Scarodytes* weitgehend parallel, im Gegensatz zu den Arten anderer Gattungen des Subtribus Deronectina. Auch bei der neuen Art sind diese Flächen parallel – ein Merkmal, welches die Gattungszugehörigkeit der neuen Art deutlich unterstützt.

In einem weiteren Abschnitt wird die Funktion von Rippen auf den Flügeldecken von Schwimmkäfern hinterfragt. Eine mögliche Erklärung könnte Bernoulli's Paradoxon liefern: kommen sich zwei Körper in strömendem Wasser zu nahe, so sinkt der Druck im Bereich zwischen ihnen und sie ziehen sich gegenseitig so weit an, dass sie aneinander haften bleiben. Übertragen auf Schwimmkäfer bedeutet das: kommt ein Käfer in strömendem Wasser mit seiner Oberseite einem im Wasser befindlichen flachen Stein zu nahe wird er von diesem angezogen, bleibt haften und ist manövrierunfähig – zumindest wenn er keine Rippen auf den Flügeldecken hat und diese den Käfer daran hindern dem Stein zu nahe zu kommen. Von Vertretern der Gattungen *Deronectes* und *Nebrioporus* mit gerippten Flügeldecken ist bekannt, dass sie wie die neue Art fast ausschließlich in Bächen mit deutlicher Strömung vorkommen. Bei zukünftigen Untersuchungen – auch experimenteller Art – sollte das Bernoulli Paradoxon als eine mögliche Erklärung für das Vorhandensein von Flügeldeckenrippen durchaus in Betracht gezogen werden.

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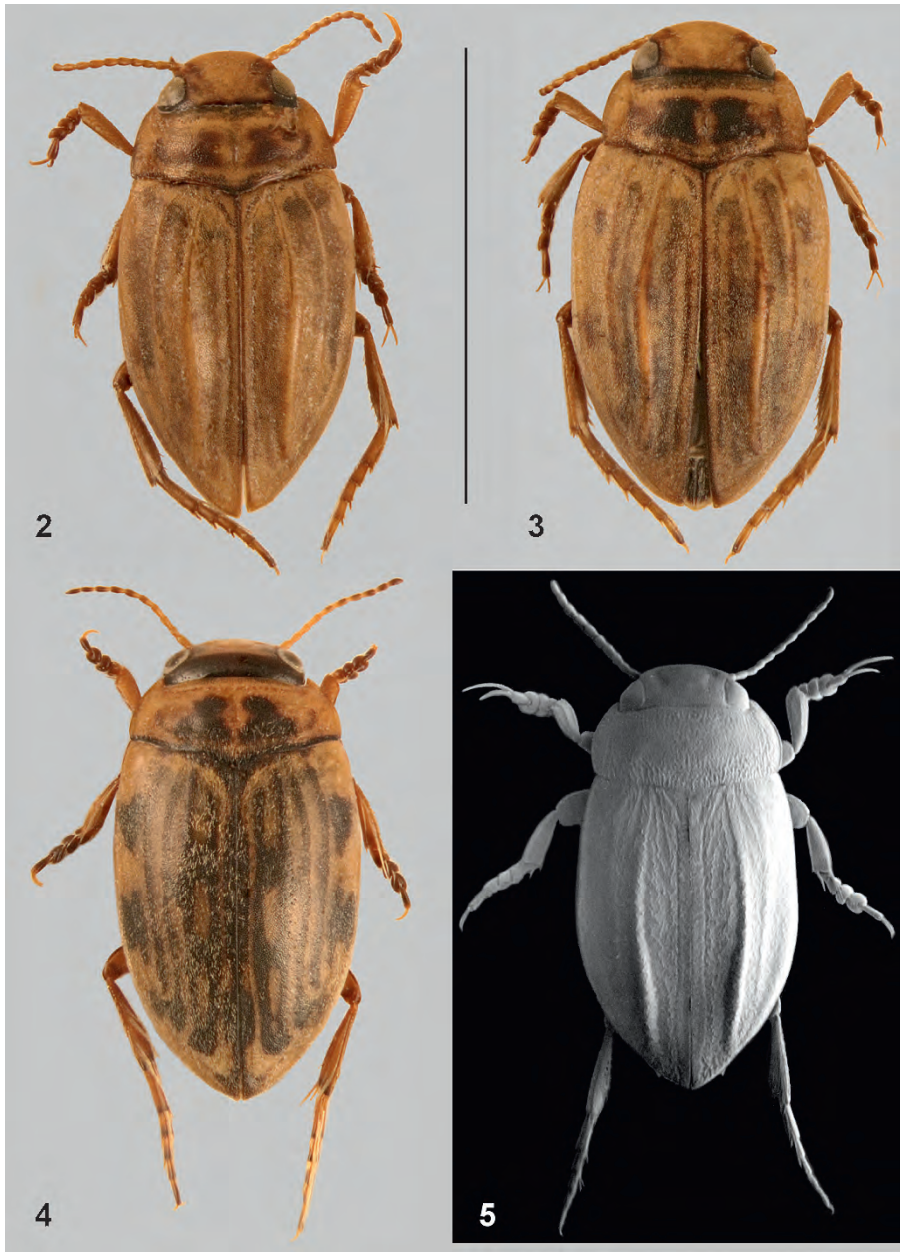
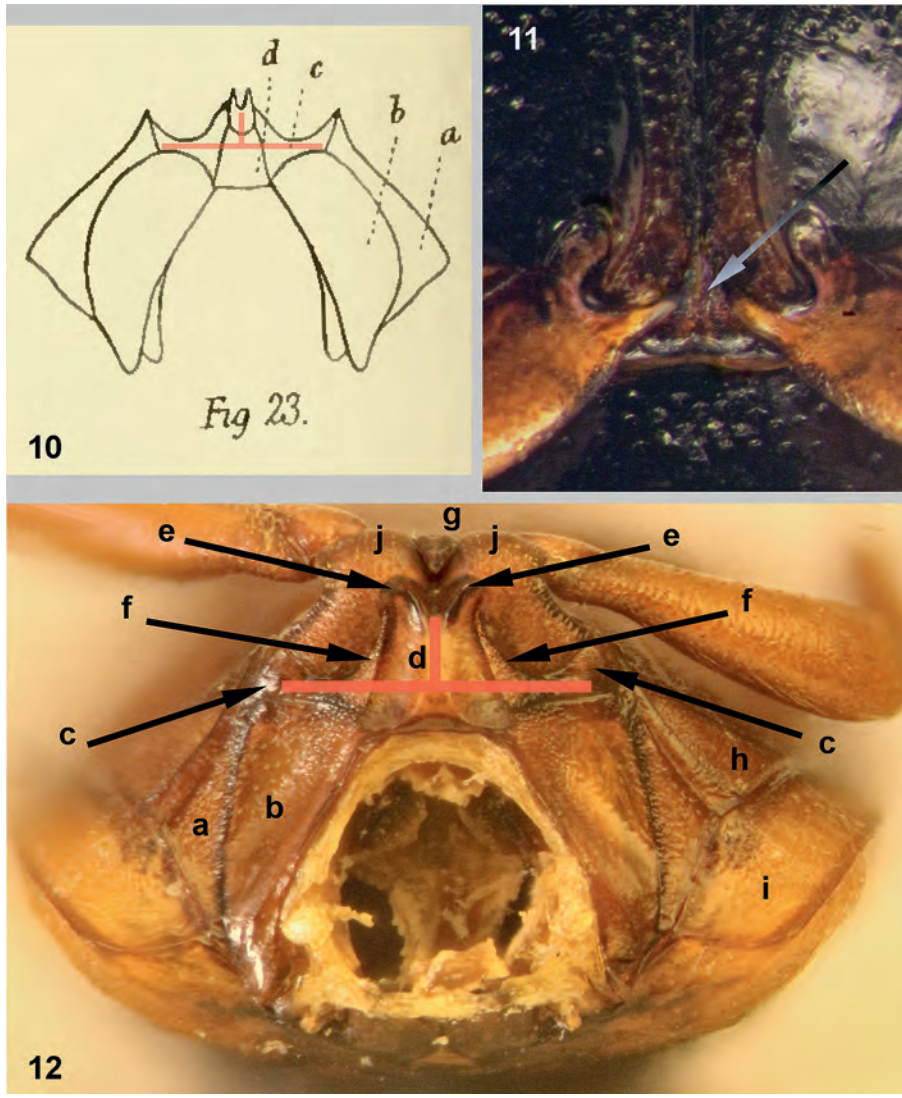
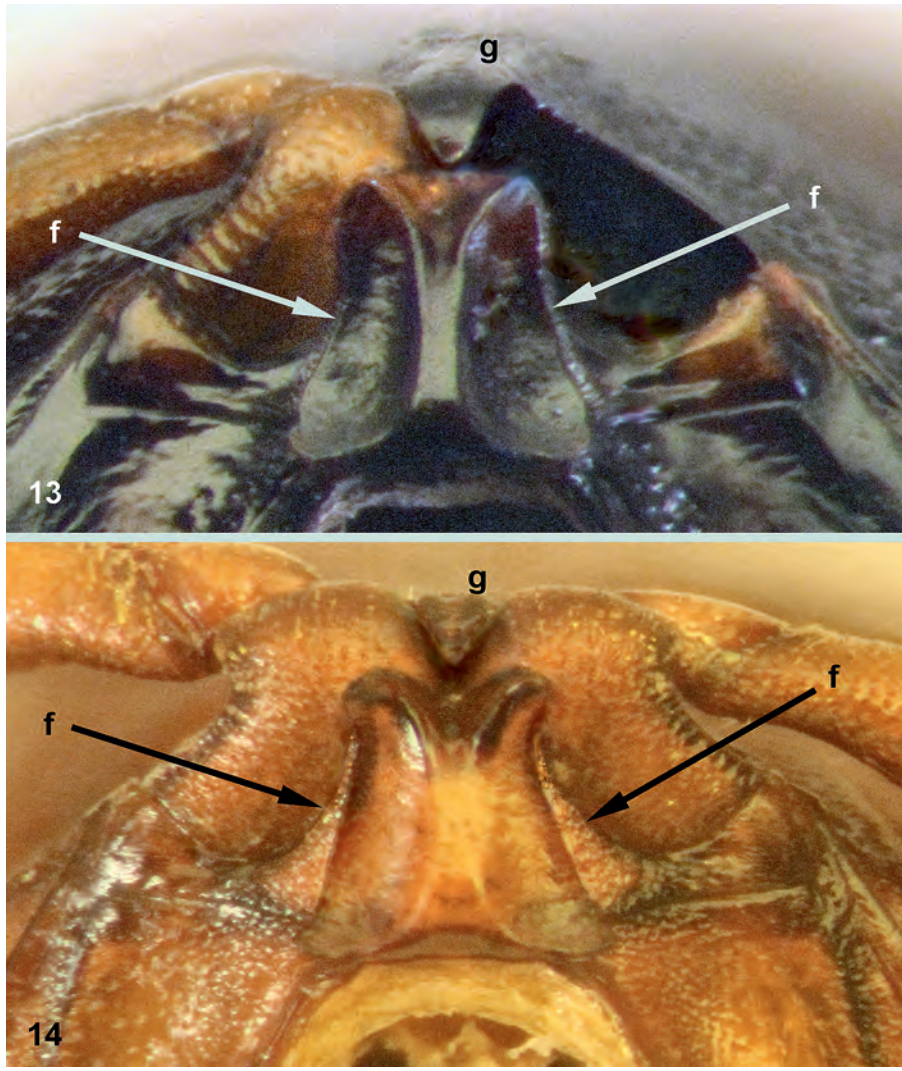


Figs 2-5: Habitus of: *Scarodytes costatus* nov.sp. (**2**) holotype (male) and (**3**) paratype (female); (**4**) *S. halensis* (female from Wallern, Lake Neusiedel, Austria); (**5**) *Nebrioporus carinatus* (male from Esclavitud, La Coruña, Spain) (scale bar 4 mm for *Scarodytes*, 5.2 mm for *Nebrioporus*).

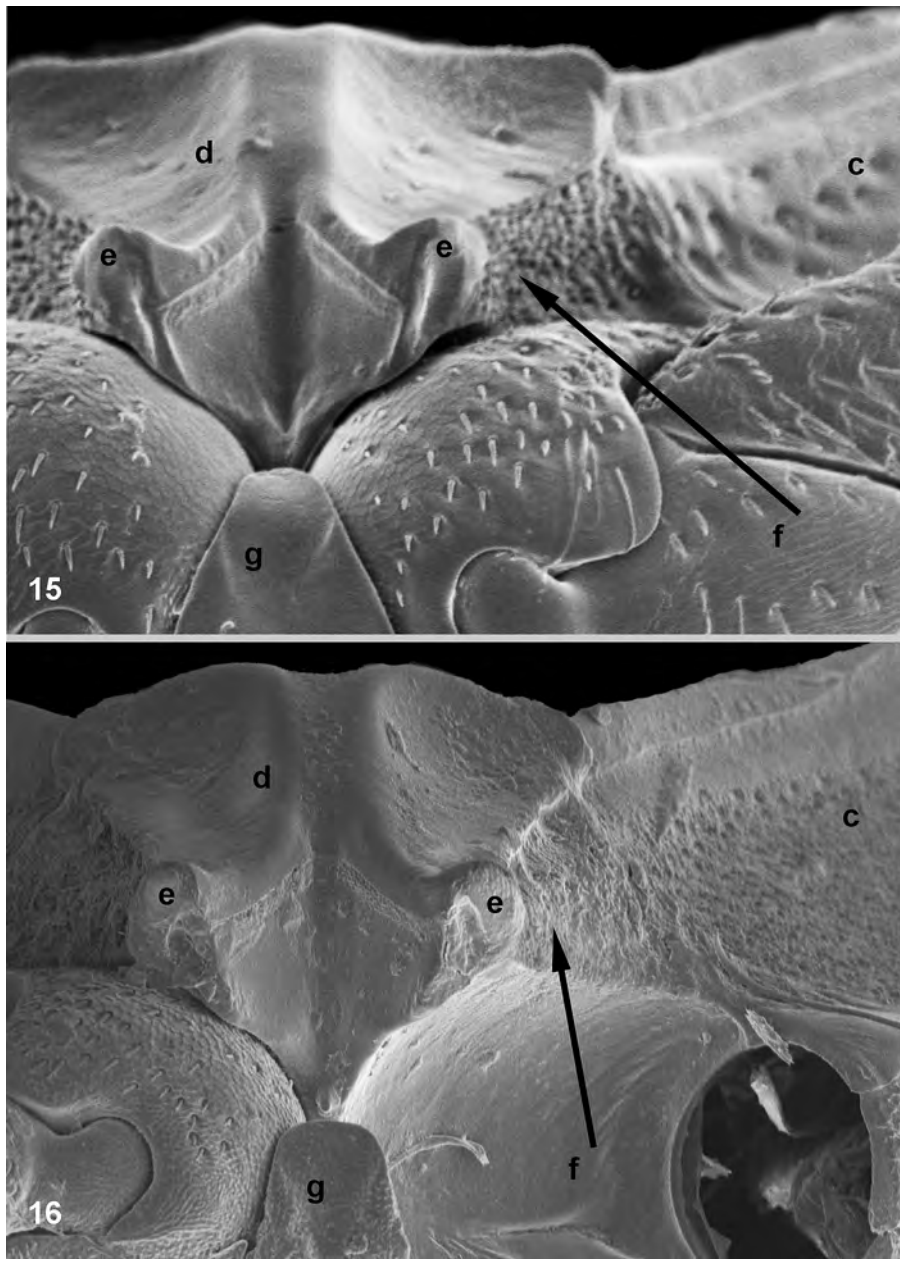
Figs 6-9: Punctation on metaventrite and metacoxal plate of: (**6**) *Scarodytes costatus* nov.sp. (holotype; left mid-leg removed); (**7**) *S. fuscitarsis* (male from Arbatax, Sardinia, Italy); (**8**) *S. halensis* (female from Oldenburg, Celle, Germany; left mid-leg removed); (**9**) *Nebrioporus carinatus* (male from Camporredondo, Lugo, Spain).



Figs 10-12: (**10**) "SHARP's T" – modified from figure 23 of plate VII in SHARP 1882; drawn by SHARP after a *Dytiscus marginalis* L. (meaning of letters a-d same as in Fig. 12); (**11**) *Scarodytes costatus* nov.sp. (paratype): mesocoxal processes; arrow pointing on weakly exposed interlaminary bridge; (**12**) *Nebrioporus carinatus*: frontal view on mesoventrite and mesoventral column (male from Tabladillo, León, Spain). Arrows point on: (**a**) mesepisternum, (**b**) mesepimeron, (**c**) SHARP's "portion of margin of middle coxal cavity", (**d**) frontal surfaces of mesoventral column ("facettes" of SHARP's "medisternum"), (**e**) tines if mesoventral ("mesosternal") fork, (**f**) lateral surfaces of mesoventral column, (**g**) anteromedial metaventral process, (**h**) metepisternum, (**i**) elytral epipleuron, (**j**) mesocoxae.



Figs 13-14: Details of mesoventral column in frontal view of (**13**) *Scarodytes fuscitarsis* (female from Arbatax, Sardinia, Italy); (**14**) *Nebrioporus carinatus* (male from Tabladillo, León, Spain); arrows point on lateral surfaces of mesoventral column, being parallel in *Scarodytes* and, thus, invisible in frontal view, but well visible in *Nebrioporus* because diverging backwards (lateral surfaces in Fig. 14 somewhat lightened); meaning of letters as in Fig. 12.



Figs 15-16: Details of mesoventral column in ventral view of (**15**) *Scarodytes halensis* (male from Oldenburg, Celle, Germany); (**16**) *Deronectes hispanicus* (male from N Jimena de la Frontera, Cádiz, Spain; left mid-leg disarticulated); meaning of letters as in Fig. 12.

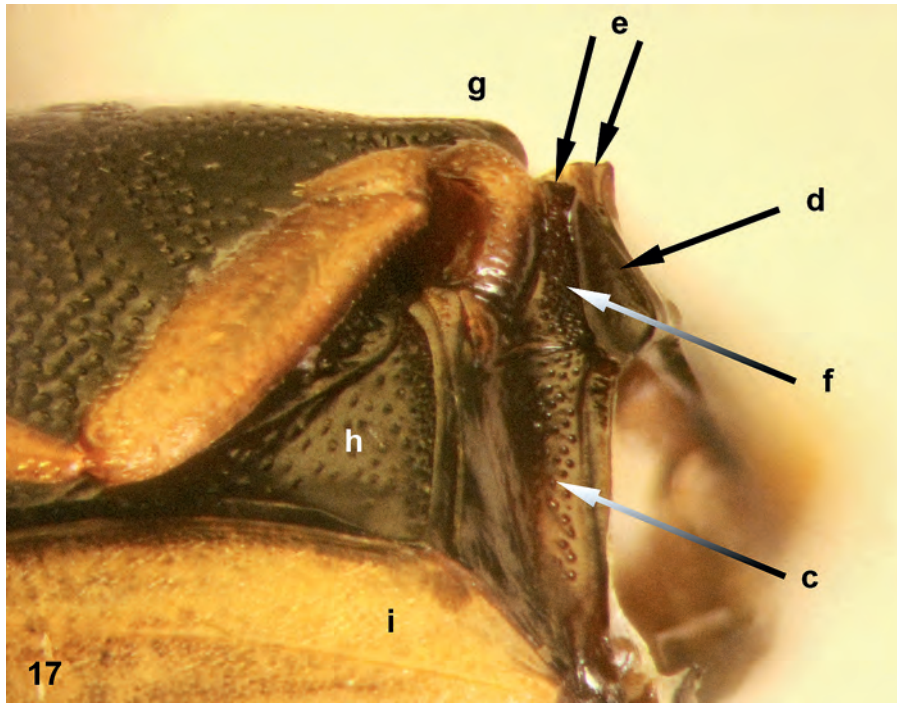
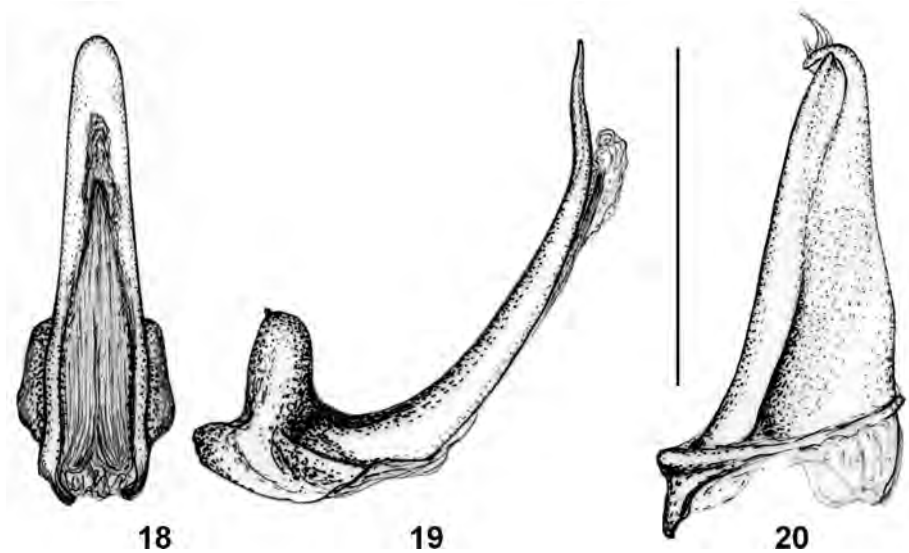


Fig. 17: Lateral view on anterior part of pterothorax of *Scarodytes fuscitarsis* (female from Arbatax, Sardinia, Italy); meaning of letters as in Fig. 12.



Figs 18-20: *Scarodytes costatus* nov.sp.: median lobe of aedeagus in ventral (**18**) and lateral (**19**) view; left paramere (**20**) (scale 0.5 mm).

Figs 21-22: Type locality of *Scarodytes costatus* nov.sp. – two rest pools of Hazarşah brook in August 2014.