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Satrapister nitens Bickhardt, 1912: redescription and tentative phylogenetic placement of a mysterious taxon (Coleoptera, Histeridae, Sapriniinae)

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Abstract

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The monotypic genus *Satrapister* Bickhardt, 1912 is redescribed and figured. Its tentative position in the recently performed phylogeny of the subfamily, inferred from a new analysis based on the available morphological characters is discussed. Lectotype of *Satrapister nitens* Bickhardt, 1912 is designated.

Key Words

Coleoptera

Histeridae

Sapriniinae

Satrapister

phylogeny

Introduction

Satrapister nitens Bickhardt, 1912 was described more than a hundred years ago by Bickhardt, one of the leading experts of the histerid taxonomy from the first half of the 20th century, as the type species of the monotypic genus *Satrapister* Bickhardt, 1912. The species was described based on two specimens collected by A. Reclaire in Göttingen (Germany) in guano, originating from Peru and became a mystery practically since its description, both for its uncertain origin, biology and morphology. Its taxonomic placement was only briefly discussed by Bickhardt (1912), he compared the newly described taxon *Satrapister* with the genera *Haeterius* Dejean, 1833 (which belongs to a different subfamily Haeteriinae Marseul, 1857) and *Saprinus* Erichson, 1834, based on their respective external morphologies. In the original description, Bickhardt (1912) did not place *Satrapister* into subfamily;

but later, in his catalogue of the family Histeridae (1916: 82), he placed it correctly into the subfamily Sapriniinae as the first genus of the subfamily. Mazur in his catalogues (1984, 1997, 2011) placed *Satrapister* between the genera *Myrmeosaprinus* Mazur, 1975 and *Euspilotus* Lewis, 1907 (Mazur 1984: 64); *Saprinus* and *Euspilotus* (1997: 232); and finally, between *Microsaprinus* Kryzhanovskij, 1976 and *Euspilotus* (2011: 189). *Satrapister*, together with *Auchmosaprinus* Wenzel, 1962 and *Paramyrmestes* Bruch, 1929 was one of the three Sapriniinae higher taxa that were not included in the phylogenetic treatment of the subfamily (Lackner 2014d) because of its unavailability. Recently I have had the opportunity to inspect *Auchmosaprinus* and *Satrapister*, so *Paramyrmestes* remains the last Sapriniinae genus or subgenus unknown to me. In this paper the taxon is redescribed based on the type material as well as three newly discovered specimens from Peru, and complement the redescription with habitus images

and drawings of the sensory organ of the antennal club and male genitalia. This work presents another contribution to my on-going revisionary work on the genera of the subfamily Sapriniinae (Lackner 2009a-c, 2010, 2011a,b; Lackner 2012; Lackner 2013a,b,c; Lackner and Gomy 2013; Lackner 2014a,b,c,d; Lackner 2015; Lackner and Tishechkin 2014; Tishechkin and Lackner 2012).

Material and methods

The lectotype specimen was soaked in water overnight, removed from its original mounting card, cleared from dust and remaining glue with 70% ethanol and mounted on a triangular point for observation. Other specimens were observed under binocular microscope. Colour images were made by F. Slamka (Bratislava, Slovakia). Measurements were made by ocular micrometer. Body part terminology follows that of Ôhara (1994) and Lackner (2010) and the following acronyms of museum collections are used throughout the text: MUSM – Universidad Mayor de San Marcos, Lima, Perú (Olga Bracamonte Guevara); NCB – National Centre for Biodiversity Naturalis, Leiden, the Netherlands (Hans Huijbregts); SENA-SA – Servicio Nacional de Sanidad Agraria, Lima, Perú (Nuñez Sacarias De Dioses Elizabeth Yolanda); ZMHUB – Museum für Naturkunde, Berlin, Germany (Bernd Jaeger). Separate lines of the same label are demarcated by a slash (/). Abbreviations of morphological measurements follow Ôhara (1994) and are used throughout the text as follows:

APW	width between anterior angles of pronotum
EL	length of elytron along elytral suture
EW	maximum width between outer margins of elytra
PEL	length between anterior angles of pronotum and apices of elytra
PPW	width between posterior angles of pronotum.

Analytical methods. Cladistic analyses were based on the external structures and male genitalia. In total, 95 morphological characters (see Lackner 2014d for details) of adults were scored (multistate coding) and analyzed. Adult morphological characters were treated as non-additive; inapplicable characters were assigned a gap value (‘–’) and treated as equivalent to missing data (‘?’). The total number of ingroup taxa was 73 (taxa used in Lackner 2014d + *S. nitens*); cladograms were rooted with exemplars of Dendrophilinae Reitter, 1909 (genus *Dendrophilus* Leach, 1817), Bacaniini Kryzhanovskij in Kryzhanovskij and Reichardt 1976 (genus *Bacanius* LeConte, 1853), Abraecinae MacLeay, 1819 (genus *Chaetabraeus* Portevin, 1929), and Anapleini Olexa, 1982 (genus *Anapleus* Horn, 1873). The taxa selected as outgroup representatives were selected based on the existing phylogenies of the Histeridae by Ślipiński and Mazur (1999) and Caterino and Vogler (2002), which suggest that representatives of

Dendrophilinae and Abraecinae are amongst the best contenders for the Sapriniinae sister groups. The most parsimonious trees (MPTs) were searched using PAUP 4.0B10 (Swofford 2001) with 1000 random addition replicates of tree bisection-reconnection branch swapping. All characters were unordered and equally weighted. Bootstrap (BS) values (Felsenstein 1985; Sanderson 1995) were calculated by resampling with 1000 replications using simple searches while holding one tree at each step and swapping on the best tree. Additional branch support was examined using decay indices (DIs; Bremer 1994), calculated by the program TreeRot (Sorenson 1999). Character states were optimized using MacClade 4.08 (Maddison and Maddison 2005); only the unambiguous optimizations are shown on the tree (Fig. 14A). The cladogram was graphically depicted using the FIGTREE program (Rambaut 2007) and subsequently redrawn using Adobe Illustrator CS5.

Results

Satrapister Bickhardt, 1912

Satrapister Bickhardt, 1912: 231. Type species *Satrapister nitens* Bickhardt, 1912: 232, by monotypy. *Satrapister*: Bickhardt (1926): 81, 82, table 4, fig. 27; Mazur (1984): 64; Mazur (1997): 232; Mazur (2011): 189.

Diagnosis. Very small elongate-oval non-metallic Sapriniinae beetle with sparsely punctate dorsum and reduced dorsal elytral striae. Venter of body with sparse microscopic setae; carinal prosternal striae very reduced or obsolete; lateral prosternal striae divergent anteriorly; prosternal foveae absent; apex of prosternal process with sulcus. Meso- and metaventrite almost impunctate; lateral disc of metaventrite + metepisternum punctuate and setose. Mandibles of unequal length, left mandible slightly longer than right. Eyes completely flattened, reduced, invisible from above. Sensory structures of antenna in form of a single stipe-shaped vesicle situated under round sensory area on internal distal part of the antennal club complemented by another round sensory area. Protibiae with 9-11 low teeth topped by rather long, curved thin amber denticles.

Differential diagnosis. As I am not familiar with most of the South American taxa of the species-rich genus *Euspilolus*, I hesitate to provide a clear-cut differential diagnosis of the genus *Satrapister*. It is, however, most readily distinguishable from the majority of the South American species of the subfamily that I am familiar with by its elongate-oval body form, reduced and flattened eyes and almost complete lack of elytral striation.

Biology. Unknown, the type specimens were found in guano originated from Peru; reduced eyes can indeed indicate its inquilinous habits. The other three specimens do not carry any biological data on their labels.

Distribution. Bickhardt (1912: 232) following the description of *S. nitens* in Latin gave ‘South America ?’ as

its terra typica, but explained further in the text in German that the two specimens he examined were found in Göttingen by Dr. A. Reclaire in ‘Peru-Guano’, and that was why he opted for South America as the continent of origin. The type locality ‘South America ?’ was repeated by Mazur (1984, 1997, 2011), followed by ‘Peru ?’. The three non-type specimens collected in the years before and after WWII originate from two tiny islands off the Peruvian coast: Isla Don Martín and Isla de Pescadores [=Isla Grande]. Both these islands serve as important refugia and nesting grounds for numerous species of seabirds and are known to contain large amounts of guano (Cushman 2014).

Remarks. Bickhardt (1912) described the type species of this genus based on two specimens: one of them was to be kept in his private collection (now ZMHUB) and the second one was to be kept at the private collection of Dr. H.J. Veth (later acquired by NCB), who had sent him the two type exemplars found in guano allegedly originating from Peru in Göttingen, Germany by Dr. A. Reclaire (see also above). During my visit of ZMHUB, I found one of the two specimens of *S. nitens* (a female) that had been designated a lectotype by G. Arriagada (Santiago de Chile, Chile); however, this designation has apparently never been published. Recently, I discovered the second specimen, kept in the collection of NCB; this was most likely Veth’s specimen. The specimen in ZMHUB is almost completely fallen apart and its body parts are glued on two separate mounting cards. The other specimen, housed in NCB was also observed to be badly damaged and very fragile. Judging from the state of the type specimens, I infer that they arrived to Europe from their alleged homeland (South America, Peru) already dead.

Satrapister nitens Bickhardt, 1912

Figs 1–13

Satrapister nitens Bickhardt, 1912: 232

Mazur (1984): 64; Mazur (1997): 232; Mazur (2011): 189.

Type material examined. Lectotype (designated here), ♂, glued on its side on a triangular mounting point, except for pretarsus all other tarsi missing, both antennae, left mandible missing, both hind legs missing, propygidium and pygidium dismembered, separated from the rest of the abdominal segments and glued to the mounting card separately from the specimen, right elytron wholly longitudinally cracked, with dismembered male genitalia glued also to the same mounting card as the specimen, with following labels: “in Peru guano” (written); followed by: “Type” (brick-red label, written); followed by: “*Satrapister / nitens / n.gen. n. sp. / Bickh*” (dark green, barely legible written label); followed by: “Coll. Veth” (printed); followed by: “Type” (red label, printed); followed by: “LECTOTYPE / *Satrapister nitens* / Bickhardt, 1912 / des. T. Lackner 2015” (red label, written) (NCB).



Figure 1. *Satrapister nitens* Bickhardt, 1912 SYNTYPE, dorsal view.



Figure 2. *Satrapister nitens* Bickhardt, 1912 LECTOTYPE, prosternum, mesoventrite + metaventrite.

Syntype, ♀, designated as lectotype by G. Arriagada in 1990, but apparently never published, body and head glued on a triangular point, with five legs, both mandibles, two antennal scapes and one antennal club dismembered and glued in Canada balsam on a separate mounting

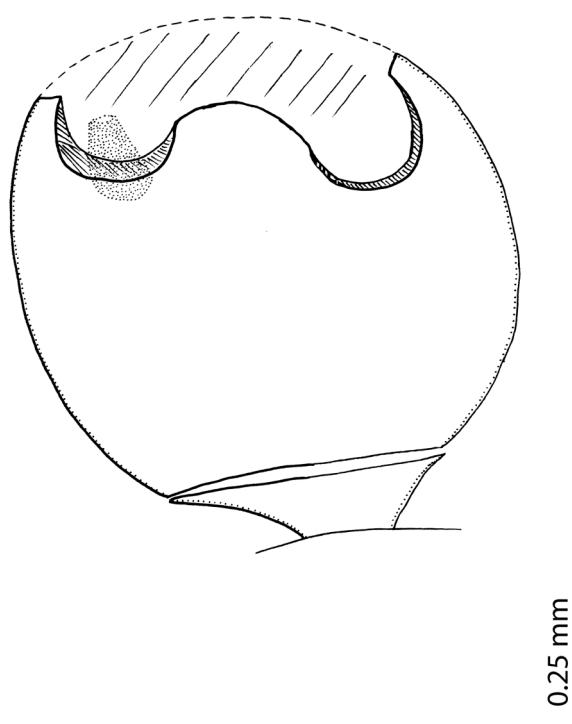


Figure 3. *Satrapister nitens* Bickhardt, 1912 SYNTYPE, sensory structures of the antenna.

card, with pygidium and dismembered female genitalia glued in Canada balsam on another mounting card under the former one, followed by: “in Peru guano” (written); followed by: “Type” (brick-red card, written); followed by: “*Satrapister / nitens* Bickh. / n.gen., n. sp.” (written); followed by: “*Satrapister / Bickh.*” (written); followed by: “*nitens / Bickh.*” (written); followed by: “Zool. Mus. / Berlin” (printed); followed by: “*Satrapister* ♀ / *nitens* Bickh. / Lectotype / G. ARRIAGADA DET 1990” (black/red framed written-printed label) (ZMHUB). **Note.** This species was described based on two specimens. Bickhardt (1912) apparently did not check the sex of specimens. Although Arriagada examined the specimen from ZMHUB and furnished it with a lectotype label, his designation has never been published. Since the specimen housed in ZMHUB is a badly damaged female and the second specimen in NCB is a male that is in somewhat better condition I designate the male from NCB as the lectotype here. The second specimen, housed in ZMHUB therefore bears the status of a syntype.

Additional material examined. PERU: 2 ♂♂, Isla Don Martín, 15.ii.1955, Coll. M. Peña (MUSM). 1 ♀, Isla de Pescadores [=Isla Grande], 5.viii.1934, collector illegible (SENASA).

Description. Body (Figs 1–2) PEL: 1.50–1.70 mm; APW: 0.625–0.65 mm; PPW: 1.00–1.125 mm; EW: 1.25 mm; EL: 1.00 mm; colour (including body appendages) light brown to castaneous, antennal club amber-coloured. Clypeus flat, with scattered punctuation; labrum with wide median depression, with two long labral setae arising from each labral pit; mandibles rather slender,

left mandible slightly longer than right, both mandibles pointed apically, sub-apical tooth on left mandible situated approximately in mandibular mid-length, obtuse; vague vestiges of frontal stria present anterad eyes, frontal + supraorbital striae otherwise absent; frontal disc flat, with scattered punctuation, punctures separated by several times their diameter, on posterior margin with distinct fovea medially; occipital stria fine, complete. Antennal scape slightly thickened, antennal club round, sensory structures of antennal club (Fig. 3) in form of one stipe-shaped vesicle situated under round sensory area on internal distal side of the antennal club dorsally, bridge-like connected with another sensory area. Antennomeres 1–8 with distinct setae. Eyes small (reduced?), flattened, invisible from above; surface above eyes on frontal lateral margins with distinct regular microscopic setae.

Pronotal hypomeron punctate, with distinct regular microscopic setae, lateral pronotal margins (Fig. 1) on basal two-thirds almost sub-parallel, on apical third narrowing, anterior pronotal angles obtuse. Pronotal disc laterally with sparse, rather deep elongate punctures separated by their own to several times their diameter; medially disc with scattered microscopic punctuation. Marginal pronotal stria thin, but carinate and complete; pronotal base with a vague row of tiny punctures. Scutellum small, triangular.

Elytral epipleuron with several irregular wrinkles and few punctures, otherwise smooth; marginal epipleural stria fine, complete, marginal elytral stria carinate and complete; apical elytral stria obliterated on half its length. Oblique humeral stria deeply impressed on basal elytral fourth; in one specimen a median fragment of inner sub-humeral stria as well as a basal fragments of elytral striae 1–2 present; in rest of specimens all other elytral striae, except for short basal fragment of fourth dorsal elytral stria that is basally connected to almost complete sutural elytral stria completely lacking. Elytral disc with scattered punctures separated by several times their diameter.

Propygidium and pygidium with punctuation similar to the elytra, but punctures deeper and denser, separated approximately twice their diameter.

Prosternal process (Fig. 2) on apical margin with distinct, rather long amber setae; marginal prosternal stria present as a median fragment; carinal prosternal striae very weak, usually present only between procoxae, next evanescent (in two specimens intermittent to almost complete); lateral prosternal striae widely divergent anteriorly and ending in apical sulcus; prosternal foveae absent; prosternal keel even, rounded, impunctate, alutaceous.

Mesoventrite (Fig. 2) sub-trapezoid, convex, sparsely punctate, marginal mesoventral stria thin, weak; meso-metaventral sutural stria absent; metaventrite almost smooth, only with several scattered punctures becoming denser along metaventral base; lateral metaventral stria straight, thin, vaguely impressed, shortened; lateral disc of metaventrite with dense deep, almost confluent punctures fringed with long amber setae; metepisternum with similar punctuation.

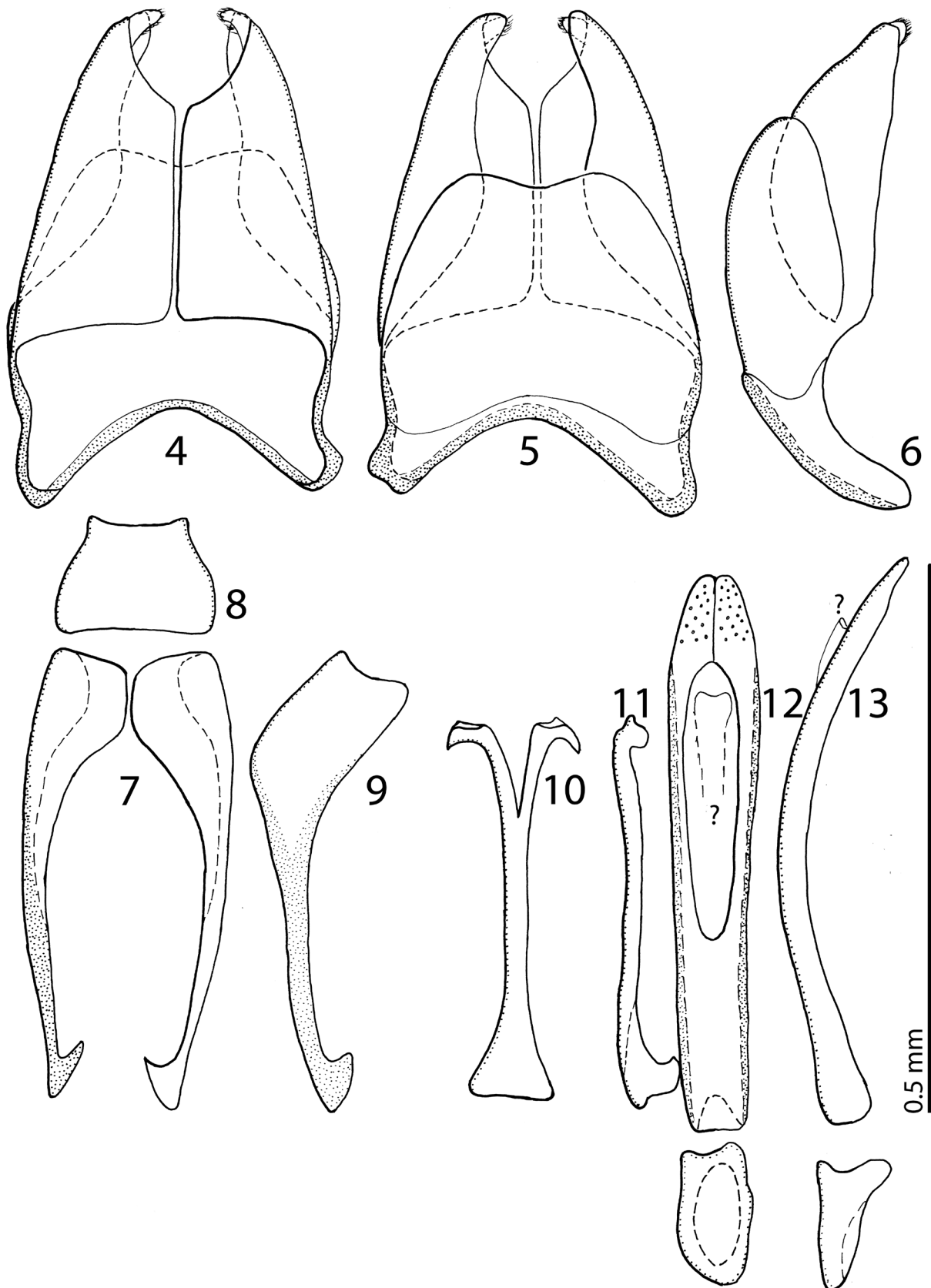
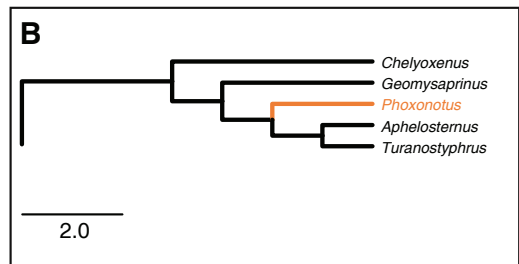


Figure 4–13. 4 *Satrapister nitens* Bickhardt, 1912 LECTOTYPE, eighth sternite and tergite, ventral view 5 ditto, dorsal view 6 ditto, lateral view 7 *Satrapister nitens* Bickhardt, 1912 LECTOTYPE, ninth tergite, dorsal view 8 *Satrapister nitens* Bickhardt, 1912 LECTOTYPE, tenth tergite, dorsal view 9 *Satrapister nitens* Bickhardt, 1912 LECTOTYPE, ninth tergite, lateral view 10 *Satrapister nitens* Bickhardt, 1912 LECTOTYPE, spiculum gastrale, ventral view 11 ditto, lateral view 12 *Satrapister nitens* Bickhardt, 1912 LECTOTYPE, aedeagus, dorsal view 13 ditto, lateral view



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First visible abdominal ventrite vaguely striate laterally, disc almost glabrous, only with scattered microscopic punctuation.

Legs: protibia slightly dilated, with 9–11 low teeth topped by rather long thin curved denticles diminishing in size in proximal direction, protarsal groove shallow, protibial spur short and stout, growing out from apical protibial margin, further characters of protibia not examined. Mesotibia on outer margin with a row of low teeth topped by long, slender amber-coloured denticles, setae of outer row dense and rather long; setae of median row finer and shorter; on anterior face of mesotibia another row of shorter dense amber denticles present, mesotibial spur stout and well-developed; metatibia slightly longer than mesotibia, denticles on outer metatibial margin more closely-set; metatarsal claws short, bent, about half-length of terminal metatarsal segment; other characters of legs not examined.

Male genitalia: eighth sternite (Figs 4–5) longitudinally divided medially, apically with tiny velum topped by several microscopic setae; eighth tergite inwardly arcuate apically; eighth sternite and tergite fused laterally (Fig. 6). Ninth tergite (Figs 7, 9) longitudinally separated medially; tenth tergite (Fig. 8) apically with lateral processes; spiculum gastrale (Fig. 10) apically separated into two arms; base distinctly triangular. Aedeagus (Fig. 12) with rather short phallobase, ratio phallobase: tegmen approximately 1:5; tegmen sub-parallel, faintly dilating apically; apex with pores and pseudo-pores; parameres fused apically and on their basal 2/5; aedeagus laterally curved ventrad (Fig. 13).

Cladistic analysis. Results of the tree reconstruction analyses are shown in Figure 14A. Heuristic search resulted in 1026 equally parsimonious trees of tree length (TL) = 582, CI = 0.33, RI = 0.66. The strict consensus of the equally parsimonious trees had the following characteristics: TL = 701, CI = 0.29, RI = 0.57. The strict consensus tree is mostly resolved, but bootstrapping resulted in low support values for most of the recovered branches.

Discussion

The genus *Satrapister* was, due to its unavailability not included in my phylogeny of the subfamily, which was based on the morphological characters of the adults alone (Lackner 2014d). Using the analytical methods of my previous work (Lackner 2014d; see also above) I coded the characters of *Satrapister* as well as male genitalia of another South American genus *Phoxonotus* Marseul, 1862 that were not available previously and performed the heuristic search. The analysis yielded a tree topology, which is in deeper branches largely congruent with my previous results, with the exception of the newly included *Satrapister*, naturally (Fig. 14A). The South American attaphilous genus *Phoxonotus* was recovered in my previous analysis (Lackner 2014d; see Fig. 14B of the present paper) as a member of a small monophyletic clade

of mostly inquiline, North American genera (with the exception of the Middle-Asian genus *Turanostyphrus* Tishechkin, 2005 whose type species is known only from a single specimen and whose mouthparts dissections were not possible to study and whose spiculum gastrale was not available for character coding). With the forthcoming revision of the genus *Phoxonotus* (Lackner, *in press*) I have had the possibility to examine numerous specimens of its type species, *P. tuberculatus* Marseul, 1862 and coded the male genitalia into the original matrix. Although the position of *P. tuberculatus* on the recent tree (Fig. 14A) is somewhat different from that of Lackner (2014d), it is newly recovered, together with Peruvian *Satrapister nitens*, Malagasy *Malagasyprinus caeruleatus* (Lewis, 1905) (unknown biology) as well as two Middle-Asian psammophilous taxa *Axelinus ghilarovi* Kryzhanovskij in Kryzhanovskij & Reichardt, 1976 and *Reichardtius duriculus* (Reitter, 1904) in a grade basal to a large clade of mainly psammophilous taxa with largely unresolved inter-relationships. The support for the clade including *P. tuberculatus* of Lackner (2014d) is low and based only on several homoplastic characters. Although this has been attributed to the lack of a male genital characters of *Phoxonotus* previously and the missing characters of the rare Middle-Asian *Turanostyphrus ignoratus* (Lackner 2014d: 548) the situation is no different even after inclusion of the male genitalia characters of *Phoxonotus*, and the support for the branches is low and based on mostly homoplastic characters again.

The position of the species *Satrapister nitens* on the cladogram, in the same grade as *P. tuberculatus* must, due to the low support of the most branches, be regarded as preliminary and tentative. Its morphological characters are a mix of plesiomorphic (e.g. absent supra-orbital striae) and apomorphic ones (e.g. the presence of only a single, stipe-shaped vesicle or the 8th sternite and tergite of male genitalia fused laterally).

Based on the reduced eyes as well as its presence in guano there is room for speculation that *S. nitens* is indeed an inquiline species. The incomplete biological data and lack of larval and/or molecular characters of this species considerably blur the picture of its exact allegiance with the rest of the subfamily.

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References

- Bickhardt H (1912) Neue Histeriden (Coleoptera). (14. Beitrag zur Kenntnis der Histeriden). Tijdschrift voor Entomologie 55: 217–233.
- Bickhardt H (1916) Histeridae. In: Wytsmann P (Ed.) Genera Insectorum, fasc. 166a. M. Nijhoff, La Haye, 1–112.
- Caterino MS, Vogler AP (2002) The phylogeny of Histeroidea (Coleoptera: Staphyliniformia). Cladistics 18: 394–415. doi: 10.1111/j.1096-0031.2002.tb00158.x
- Cushman GT (2014) Guano and the Opening of the Pacific World. A Global Ecological History. Cambridge University Press, 416 pp.
- Felsenstein J (1985) Phylogenies and the comparative method. American Naturalist 125: 1–15. doi: 10.1086/284325
- Lackner T (2009a) Revision of the genus *Saprinillus*, with description of a new species (Coleoptera: Histeridae). Folia Heyrovskyana Series A 16(4): 107–118.
- Lackner T (2009b) Revision of the genus *Zorius* (Coleoptera: Histeridae). Folia Heyrovskyana Series A 16(4): 119–129.
- Lackner T (2009c) Revision of the genus *Terametopon*, with description of new species (Coleoptera: Histeridae). Folia Heyrovskyana Series A 17(2): 43–72.
- Lackner T (2010) Review of the Palearctic genera of Saprininae (Coleoptera: Histeridae). Acta Entomologica Musei Nationalis Pragae 50 (Supplementum): 1–254.
- Lackner T (2011a) On the identity of *Chalcionellus orcinus* Reichardt, 1932 and *Chalcionellus libanicola* (Marseul, 1870) (Coleoptera: Histeridae). Acta Entomologica Musei Nationalis Pragae 51(2): 505–515.
- Lackner T (2011b) Revision of the genus *Alienocacculus* Kanaar 2008 (Coleoptera: Histeridae: Saprininae). Folia Heyrovskyana 19(1–4): 139–157.
- Lackner T (2012) Revision of the genus *Xenonychus* Wollaston, 1864. Acta Entomologica Musei Nationalis Pragae 52(1): 147–159.
- Lackner T (2013a) Revision of the genus *Ctenophilothis* Kryzhanovskij, 1987 (Coleoptera: Histeridae: Saprininae). Zootaxa 3691(2): 273–282. doi: 10.11646/zootaxa.3691.2.6
- Lackner T (2013b) Elevation of *Pilisaprinus* to full generic status with notes on the evolution of termitoxeny in the Saprininae (Coleoptera: Histeridae). Acta Entomologica Musei Nationalis Pragae 53(2): 623–632.
- Lackner T (2013c) *Afroprinus cavicola* gen. et sp. n. from the Afro-tropical region with notes on cave-dwelling Saprininae (Coleoptera, Histeridae). ZooKeys 294: 57–73. doi: 10.3897/zookeys.294.4800
- Lackner T, Gomy Y (2013) *Malagasyprinus*, a new genus of the Saprininae subfamily from Madagascar with description of two new species (Coleoptera: Histeridae: Saprininae) (First contribution to the knowledge of the Histeridae of Madagascar). ZooKeys 333: 55–76. doi: 10.3897/zookeys.333.5909
- Lackner T (2014a) Revision of the genus *Reichardtius* Kryzhanovskij, 1959 (Coleoptera, Histeridae, Saprininae). ZooKeys 379: 1–27. doi: 10.3897/zookeys.379.6457
- Lackner T (2014b) Revision of the genus *Hemisaprinus* Kryzhanovskij, 1976 (Coleoptera, Histeridae, Saprininae). ZooKeys 429: 101–130. doi: 10.3897/zookeys.429.7949
- Lackner T (2014c) Description of the male of *Ctenophilothis altus* (Lewis, 1885): supplement to the revision of the genus *Ctenophilothis* Kryzhanovskij, 1987 (Coleoptera: Histeridae: Saprininae). Deutsche Entomologische Zeitschrift 61(2): 121–122. doi: 10.3897/dez.61.8422
- Lackner T (2014d) Phylogeny of the Saprininae subfamily reveals interesting ecological shifts in the history of the subfamily (Coleoptera: Histeridae). Zoological Journal of the Linnean Society 172: 521–555. doi: 10.1111/zoj.12182
- Lackner T (2015) Revision of the genus *Exaesiopus* Reichardt, 1926. ZooKeys 479: 65–108. doi: 10.3897/zookeys.479.8738
- Maddison WP, Maddison DR (2011) Mesquite: a modular system for evolutionary analysis, Version 2.75, <http://mesquiteproject.org>
- Mazur S (1984) A world catalogue of Histeridae. Polskie Pismo Entomologiczne 54(3–4): 1–376.
- Mazur S (1997) A world catalogue of the Histeridae. Genus – International Journal of Invertebrate Taxonomy (supplement), 373 pp.
- Mazur S (2011) A concise catalogue of the Histeridae. Warsaw University of Life Sciences, SGGW Press, Warsaw, 332 pp.
- Ôhara M (1994) A revision of the superfamily Histeroidea of Japan (Coleoptera). Insecta Matsumurana (n.s.) 51: 1–283.
- Rambaut A (2007) FigTree v. 1.3.1. Tree Figure Drawing Tool. <http://tree.bio.ed.ac.uk/software/figtree/>
- Sanderson MJ (1995) Objections to bootstrapping phylogenies: a critique. Systematic Biology 44: 299–320. doi: 10.1093/sysbio/44.3.299
- Ślipiński SA, Mazur S (1999) *Epuracosoma*, a new genus of Histerinae and phylogeny of the family Histeridae. Annales Zoologici (Warszawa) 49: 209–230.
- Swofford DL (2001) PAUP*: phylogenetic analysis using parsimony (*and other methods), Version 4. Sinauer Associates, Sunderland, MA.

Descriptions of three new species and new records of Cerambycidae (Coleoptera) from America

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Abstract

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Three new species are described and figured: *Hemilissa birai* **sp. n.** (Piezocerini), from Brazil; *Estoloides (Estoloides) flavoscutellaris* **sp. n.** (Desmiphorini), from Ecuador; and *Esthlogena (Esthlogena) setosa* **sp. n.** (Pteropliini), from Ecuador. Twenty-three new records in Lamiinae are provided.

Key Words

Neotropical Region

New species

Taxonomy

Introduction

Introduction

Hemilissa Pascoe, 1858 was described for *Acanthoptera gummosa* Perty, 1832. Martins (1976) revised the genus, described three new species and provided a key to species. Martins (2003) provided an update revision of the genus that included ten species: *H. catapotia* Martins, 1976 (from Brazil and French Guiana); *H. cornuta* Bates, 1870 (from Bolivia, Brazil, French Guiana and Peru); *H. emblema* Martins, 1976 (from Bolivia and Venezuela); *H. fabulosa* Martins, 1985 (from Venezuela); *H. gummosa* (Perty, 1832) (from Bolivia, Brazil, Paraguay and Argentina); *H. opaca* Martins, 1976 (from Brazil Colombia, French Guiana, Guyana, and Venezuela); *H. quadrispinosa* Gounelle, 1913 (from Argentina, Bolivia, Brazil and Peru); *H. rufa* Melzer, 1934 (from Costa Rica); *H. sulcicollis* Bates, 1870 (from Bolivia, Brazil, Colombia, Costa Rica?, French Guiana, Guyana, and Peru); and *H. undulaticollis* Zajciw, 1960 (from Brazil).

Estoloides (Estoloides) Breuning, 1940 currently encompasses 24 species distributed in North, Central and South America (Monné 2015), and a single species in the United States of America. After the revision by Breuning (1974), seven species were described: five from North America and two from the Caribbean region.

Esthlogena (Esthlogena) Thomson, 1864 currently includes 20 species. Monné (2015) does not yet include *Esthlogena (Esthlogena) crassa* Martins et al., 2015, from Guatemala and Mexico. The new species described herein is the first record of the genus in Ecuador.

Material and methods

Photographs were taken with a Canon EOS Rebel T3i DSLR camera, Canon MP-E 65mm f/2.8 1-5X macro lens, controlled by Zerene Stacker AutoMontage software. Measurements were taken in “mm” using a micrometer

ocular Hensoldt/Wetzlar - Mess 10 in the Leica MZ6 stereomicroscope, also used in the study of the specimen.

The acronyms used in the text are as follows:

CAS	California Academy of Sciences, San Francisco, California, USA;
CSCA	California State Collection of Arthropods, Sacramento, California, USA;
EMEC	Essig Museum of Entomology, University of California, Berkeley, California, USA;
LGBC	Larry G. Bezark Collection, Sacramento, California, USA;
MSZP	Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil.

Results

Cerambycidae Piezocerini

Hemilissa birai sp. n.

<http://zoobank.org/1C3C6769-477E-4D52-A5F4-B93E5D1DC822>

Figures 1–4

Description. Male. Integument dorsally dark-brown, ventrally mostly reddish-brown with some areas darker; femoral club reddish-brown with apex dark-brown; tibiae with some areas reddish-brown; antennae mostly reddish-brown with brown and dark-brown areas.

Head. Frons moderately coarsely, densely, shallowly, confluent punctate; with short, sparse setae. Central area between antennal tubercles opaque, glabrous, shallowly, confluent punctate; with longitudinal, well-marked carina on each side, between antennal tubercle and coronal suture. Vertex lower than area between antennal tubercles, coarsely, abundantly punctate; glabrous. Area behind upper eye lobes with sculpture as on vertex, gradually smooth toward area behind lower eye lobe; with some long setae close to eyes. Area behind lower eye lobes with moderately coarse, sparse punctures, slightly denser on area close to apex of lobe; with some long setae close to eye. Apex of antennal tubercle notably horn-shaped. Coronal suture distinct from near clypeus to posterior level of antennal tubercles. Gula finely, transversely striate, more distinctly toward submentum. Submentum depressed, more distinctly toward anterior edge; finely, moderately abundantly punctate; with short, sparse setae. Area between submentum and lower eye lobes with sparse, very long setae. Mandibles with very long, sparse setae on outer surface. Distance between upper eye lobes 0.55 times length of scape; distance between lower eye lobes, in frontal view, 0.85 times length of scape. Antennae as long as 1.65 times elytral length; reaching elytral apex about apex of antennomere X. Scape coarsely, densely, confluent punctate throughout; with moderately long, sparse setae. Antennal formula based on antennomere III: scape = 0.86; pedicel = 0.18; IV = 0.88; V = 0.82; VI = 0.76; VII = 0.72; VIII = 0.60; IX = 0.62; X = 0.56; XI = 0.86.

Thorax. Prothorax slightly longitudinal, about 1.1 times longer than largest width; basal quarter distinctly constricted; slightly narrowed from basal constriction to anterior margin laterally. Pronotum coarsely alveolate, except for more distinctly smoother lateral sides of basal constriction; with long, thick, sparse setae throughout, interspersed with short, sparse setae. Lateral sides of prothorax with sculpture and setae as on pronotum. Basal half of prosternum coarsely, densely, confluent punctate (punctures smaller, shallower than on pronotum, mainly centrally); with long, sparse setae, interspersed with minute setae. Anterior half of prosternum transversely striate; with moderately long, sparse setae. Prosternal process obliquely inclined about level of middle of procoxae, transversely sulcate and flat at apex. Mesosternum moderately coarsely, densely, shallowly punctate centrally, distinctly smoother laterally. Mesosternal process slightly narrower than mesocoxal cavities, deeply emarginate at apex. Metepisterna with very short, abundant setae. Metasternum with very short, slightly conspicuous setae laterally, with long, sparse setae toward center, except for glabrous central area; coarsely, shallowly punctate near mesocoxal cavities, with fine, very sparse punctures on remaining surface, except for smooth central area. Scutellum with minute, sparse setae. Elytra coarsely, deeply, abundantly punctate on basal half, gradually finely punctate toward apex (basal punctures partially tuberculiform); with long, sparse setae throughout; apex with long spine at outer angle, rounded at sutural angle.

Abdomen. Ventrites with short setae interspersed with long setae; ventrite I, without central projection, about as long as II–III together; apex of ventrite V subrounded. **Legs.** Femoral peduncle longitudinally sulcate ventrally and dorsally. Tibiae distinctly carinate.

Dimensions (mm). Male. Total length (including mandibles), 15.10; prothoracic length, 3.10; anterior prothoracic width, 2.35; basal prothoracic width, 2.60; largest prothoracic width, 2.90; humeral width, 3.70; elytral length, 10.00.

Type material. Holotype female, from BRAZIL, *Rorônia*: 62 km SE Ariquemes, 7–18.XI.1995, W. J. Hanson col. (CAS).

Etymology. The new species is named after Ubirajara Martins de Souza (Bira) who made the full revision of Piezocerini in 1976, and the revision of South American species in 2003.

Remarks. *Hemilissa birai* sp. n. differs from *H. catapotia* Martins, 1976 as follows: larger size (15.1 mm); antennal tubercle horn-shaped; pronotum without smooth area at central region. *H. catapotia* is smaller in size (from about 6 to 10 mm), the antennal tubercle is not horn-shaped, and the pronotum has a smooth area on the central region. It differs from *H. cornuta* Bates, 1870 by the pronotum not pubescent (with large pubescent area in *H. cornuta*), and by the shiny elytra (opaque



Figures 1–4. *Hemilissa birai* sp. n., holotype male: 1 dorsal habitus 2 ventral habitus 3 lateral habitus 4 head, frontal view.

in *H. cornuta*). *Hemilissa birai* sp. n. can be separated from *H. opaca* Martins, 1976 by the shiny elytra (opaque in *H. opaca*) and with a single spine at the apex (bispinose in *H. opaca*), and by the antennal tubercles horn-shaped (not so in *H. opaca*). It differs from *H. quadrispinosa* Gounelle, 1913 by the shiny elytra (opaque in *H. quadrispinosa*), by the elytral apex with a single spine (bispinose in *H. quadrispinosa*), by the antennal tuber-

cle horn-shaped (not so in *H. quadrispinosa*), and by the pronotum not tuberculate (tuberculate in *H. quadrispinosa*). *Hemilissa birai* sp. n. differs from *H. undulaticollis* Zajciw, 1960 by the pronotum not longitudinally sulcate (sulcate in *H. undulaticollis*), and by the antennal tubercle horn-shaped (not so in *H. undulaticollis*).

Hemilissa birai can be included in the alternative of couplet “7”, from Martins (2003) (translated):

- 7(4) Central area of the pronotum without sculpture contrasting with lateral sides. Brazil (Rondônia)..... *H. birai* sp. n.
 – Central area of the pronotum with sculpture contrasting with lateral sides 7'
 7'(7) Prothorax slightly longer than wide (length, 1.4–2.0 mm; largest width, 1.3–1.7 mm) with sides slightly convex; center of pronotum without distinct longitudinal depression; punctures on base of the elytra not tuberculiform. French Guiana, Brazil (Roraima, Amazonas, Amapá, Pará, Mato Grosso) *H. catapotia* Martins, 1976
 – Prothorax longer than wide (length, 1.5–2.8 mm; largest width, 1.2–2.2 mm) with parallel side; center of pronotum with wide longitudinal depression; punctures on base of the elytra tuberculiform 8

Lamiinae

Desmiphorini

Estoloides (Estoloides) flavoscutellaris sp. n.

<http://zoobank.org/102F5807-BAA0-436D-9E11-B27D8DBA7454>

Figures 5–8

Description. Female. Integument dark-brown; apex of palpomeres yellowish. Pubescence dorsally mostly pale yellowish, interspersed with grayish-white pubescence, except for: distinctly more yellowish on head; more whitish on antennae, after antennomere IV; white on narrow basal ring at antennomeres IV–XI; yellow on scutellum; yellow on margins of tibiae (mainly after middle); whitish on most of tibiae. Pubescence ventrally mostly grayish, except for: more yellowish on prosternum; yellow on narrow distal band at ventrites. Elytral yellowish pubescence uneven, with irregular, denser patches.

Head. Frons moderately coarsely, abundantly punctate (punctures partially obliterated by pubescence); with long, sparse setae (distinctly longer close to lower eye lobes). Area between upper eye lobes coarsely, moderately sparsely punctate; with long, sparse setae (longer close to eyes). Area between posterior ocular edge and prothorax, finely punctate (punctures obliterated by pubescence). Pubescence behind eyes gradually narrowed toward gular region (nearly glabrous area close to prothorax gradually wider); finely, moderately abundantly punctate (punctures obliterated on pubescent region; punctures sparser toward prothorax); with coarse, sparse punctures close to eye (each puncture with long setae). Antennal tubercles with sculpture and setae as on frons. Coronal suture distinct from clypeus to anterior margin of prothorax. Gula shiny, smooth, glabrous. Submentum moderately finely, abundantly punctate; pubescent; anterior margin distinctly elevated. Genae pubescent (glabrous on apex); finely, abundantly punctate (smooth on apex). Basal half on outer side of mandibles pubescent interspersed with long setae. Distance between upper eye lobes 0.65 times length of scape; distance between lower eye lobes, in frontal view, equal to length of scape. Antennae as long as 1.45 times elytral length; reaching elytral apex at base of antennomere XI. Scape, pedicel and antennomere III with long setae ventrally; antennomere IV with moderately long, sparse setae ventrally. Antennal formula based on antennomere III: scape = 0.67; pedicel = 0.14; IV = 0.77; V = 0.54; VI = 0.47; VII = 0.41; VIII = 0.38; IX = 0.35; X = 0.35; XI = 0.31.

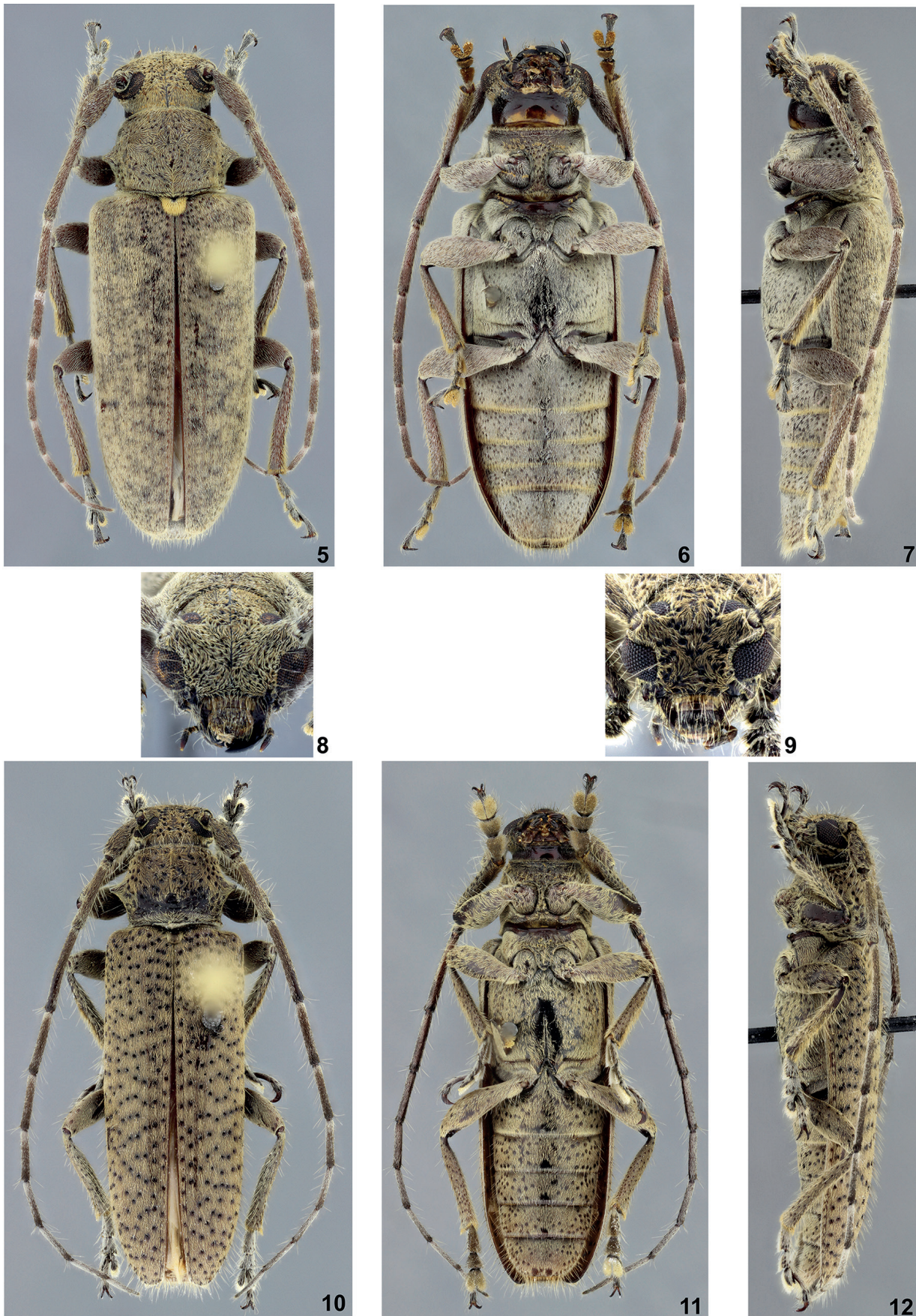
Thorax. Prothorax distinctly wider than long, distinctly wider at base than anterior margin; lateral tubercles large, conical, placed about middle. Pronotum coarsely, moderately abundantly punctate (punctures partially obliterated by pubescence); with three longitudinal, slightly distinct bands with yellowish pubescence: one narrow, placed centrally at basal quarter; two moderately wide, placed laterally from base to about anterior third; with three callosities: one centrally, longitudinal, on basal half; two laterally, subelliptical, transverse, on anterior half; with moderately long, sparse setae. Lateral sides of prothorax with sculpture and setae as on pronotum. Prosternum coarsely, moderately abundantly punctate centrally on basal half, smooth laterally and anteriorly. Prosternal process wide; coarsely, moderately abundantly punctate from base to posterior level of procoxae. Mesosternum shiny, centrally glabrous, except for some short central close to base of mesosternal process. Mesosternal process moderately coarsely punctate laterally and distally. Metasternum moderately coarsely, sparsely, shallowly punctate (punctures not obliterated by pubescence), except for sub smooth central region. Scutellum with glabrous, small area on center of base. Elytra moderately finely and sparsely punctate (part of punctures obliterated by pubescence); with short, yellow, decumbent, moderately abundant setae throughout; apex rounded.

Abdomen. Ventrites moderately coarsely, sparsely, shallowly punctate (punctures not obliterated by pubescence), except for smooth central area of ventrite V; with long, sparse, yellow setae. **Legs.** Femora moderately coarsely, sparsely punctate (punctures partially obliterated by pubescence).

Variability. Glabrous area of scutellum from small to large, from glabrous to with short, sparse setae.

Dimensions (mm). Female. Total length (including mandibles), 10.00–15.20; prothoracic length, 1.90–2.70; anterior prothoracic width, 1.95–2.90; basal prothoracic width, 2.30–3.30; largest prothoracic width, 2.90–4.30; humeral width, 3.25–5.05; elytral length, 7.10–10.70. The largest dimensions are those of the holotype.

Type material. Holotype female, from ECUADOR, *Manabi*: Vicinity of La Pila (200 m; 01.11198S / 080.58068W), 18-27.II.2006, F. T. Hovore and I. Swift col. (CAS). Paratypes – ECUADOR, *Manabi*: 50 KM S Montecristi, female, 10.III.2006, F. T. Hovore and I. Swift col. (MZSP); Vicinity of La Pila (200 m; 01.11198S / 080.58068W), 2 females, 18-27.II.2006, F. T. Hovore and I. Swift col. (LGBC).



Figures 5–12. 5–8 *Estoloides* (*Estoloides*) *flavoscutellaris*, holotype female: 5 dorsal habitus 6 ventral habitus 7 lateral habitus 8 head, frontal view 9–12 *Esthlogena* (*Esthlogena*) *setosa*, holotype female: 9 head, frontal view 10 dorsal habitus 11 ventral habitus 12 lateral habitus.

Etymology. This species is named for the distinct dense yellowish pubescence of the scutellum.

Remarks. *Estoloides (Estoloides) flavoscutellaris* sp. n. is similar to *E. (E.) aquilonius* Linsley & Chemsak, 1984, but differs as follows (female): prothorax wider (about 1.5 times wider than long); pronotum without narrow central glabrous area; elytra proportionally narrow; scutellar pubescence yellow. In *E. (E.) aquilonius* (see Bezark 2015) the prothorax is narrower (about 1.3 times wider than long), the pronotum has narrow central glabrous area, the elytra are proportionally wider, and the scutellar pubescence is whitish. It differs from *E. (E.) alboscuteellaris* Breuning, 1943 by the scutellar pubescence yellow (white in *E. (E.) alboscuteellaris*), by the dorsal pubescence distinctly lighter (darker in *E. (E.) alboscuteellaris*). It can be separated from *E. (E.) galapagoensis* (Blair, 1933) mainly by the elytral pubescence without irregular lines with pubescence contrasting with remaining surface (present in *E. (E.) galapagoensis* – see Bezark 2015). *Estoloides (E.) flavoscutellaris* sp. n. differs from *E. (E.) paralboscuteellaris* Breuning, 1971 by the scutellar pubescence yellow (white in *E. (E.) paralboscuteellaris*), and by the prothorax wider (more elongate in *E. (E.) paralboscuteellaris*).

Pteropliini

Esthlogena (Esthlogena) setosa sp. n.

<http://zoobank.org/A6491209-CC6E-4974-8142-6A9585372085>

Figures 9–12

Description. Female. Integument black; apex of palpi and ligula yellowish; anteclypeus reddish. Pubescence yellowish-brown; setae yellowish.

Head. Frons coarsely, deeply, abundantly punctate; with long, moderately sparse setae (longer close to eyes). Area between upper eye lobes coarsely, deeply, abundantly punctate; with long, moderately sparse setae. Area between posterior ocular edge and prothorax with some coarse punctures near posterior ocular edge, smooth toward prothorax; with long, sparse setae. Area behind upper eye lobes densely pubescent close to eye, gradually less dense toward prothorax; without punctures. Area behind lower eye lobes densely pubescent, coarsely punctate, with long, sparse setae on wide band close to eye; glabrous, smooth toward prothorax, except for narrow, longitudinal, finely punctate sulcus between those areas. Antennal tubercles with oblique band of moderately coarsely punctures from base to near apex; with long, sparse setae. Coronal suture not distinct. Gula shiny, smooth, glabrous. Submentum with moderately coarsely, shallowly, sparsely punctate; finely pubescent; with long, sparse setae. Genae pubescent; moderately coarsely, sparsely punctate; with long, sparse setae. Basal two-thirds on outer side of mandibles pubescent interspersed with long, sparse setae. Distance between upper eye lobes 0.6 times length of scape; distance between lower eye lobes, in frontal view, equal to 0.9 times length of scape.

Antennae as long as 1.55 times elytral length; reaching elytral apex at base of antennomere X. Scape with long, sparse setae throughout; antennomeres III–XI with long setae ventrally (sparser, shorter toward distal antennomeres); antennomeres III–XI with basal ring with white pubescence, gradually wider toward antennomere XI (almost covering this last one). Antennal formula based on antennomere III: scape = 0.74; pedicel = 0.15; IV = 1.33; V = 1.00; VI = 0.87; VII = 0.77; VIII = 0.72; IX = 0.69; X = 0.69; XI = 0.61.

Thorax. Prothorax about 1.5 times wider than long (including lateral tubercles), distinctly wider at base than anterior margin; lateral tubercles large, conical, placed about middle. Pronotum coarsely, moderately abundantly punctate, except on smooth callosities; with large, transverse, subglabrous band at basal half; remaining surface pubescent; with three callosities: one centrally, longitudinal, on basal half; two laterally, subelliptical, transverse, on anterior half; with moderately short, decumbent setae throughout; with long, sparse setae. Lateral sides of prothorax pubescent, coarsely, moderately abundantly punctate. Prosternum pubescent, coarsely, abundantly deeply punctate on basal half; coarsely, sparsely, shallowly punctate between basal half and anterior third; anterior third subsmooth, except for transverse, narrow carina; with long, sparse setae. Prosternal process narrowed near base, gradually enlarged toward posterior edge of procoxae, strongly enlarged toward apex; moderately coarsely, abundantly punctate on area between procoxae; pubescent; with long, sparse setae. Mesosternum pubescent, except on anterior center; coarsely, densely punctate, except for smooth anterior center; without tubercle. Mesosternal process gradually narrowed toward rounded apex. Metasternum pubescent; coarsely, moderately sparsely punctate, except for central region along metasternal suture; with long, sparse setae. Scutellum distinctly more pubescent laterally than centrally. Elytra coarsely, moderately abundantly punctate throughout; pubescent, interspersed with long, moderately abundant setae throughout; apex rounded.

Abdomen. Ventrites pubescent; coarsely, shallowly, moderately abundant punctate laterally, distinctly sparser centrally; with long, sparse setae; ventrite V with two small, subcircular glabrous areas near apex; apex truncate. **Legs.** Femora and tibiae pubescent, with moderately coarse, sparse punctures (denser on tibiae).

Dimensions (mm). Female. Total length (including mandibles), 12.5–9.8; prothoracic length, 2.0–1.9; anterior prothoracic width, 2.2–1.7; basal prothoracic width, 2.4–1.8; largest prothoracic width, 3.3–2.0; humeral width, 3.5–2.9; elytral length, 9.3–7.3.

Type material. Holotype female, from ECUADOR, Loja: 18.5 km N Gonzanama (48°08'08.5"S / 79°23'36.4"W), 22.II.2006, F. T. Hovore and I. Swift col. (CAS). Paratypes – 2 females, same data as holotype (LGBC), 1 female, same data as holotype (MZSP).

Etymology. This species is named for the abundant setae on the elytra, antennae and legs.

Remarks. *Esthlogena (Esthlogena) setosa* sp. n. is similar to *E. (E.) amaliae* Galileo & Martins, 2001 (see photo of the holotypes at Bezark 2015), but differs as follows: body wider and distinctly more setose (narrower and less setose in *E. (E.) amaliae*); elytral punctures finer (distinctly coarser in *E. (E.) amaliae*); and elytral apex rounded (obliquely truncate in *E. (E.) amaliae*). It can be separated from *E. (E.) chicacaoensis* Galileo & Martins, 2011 (see photo of the holotypes at Bezark 2015) by the elytral punctures finer (distinctly coarser and more concentrated at base in *E. (E.) chicacaoensis*), and by the elytral apex rounded (obliquely truncate in *E. (E.) chicacaoensis*). It can be separated from *E. (E.) dissimilis* Galileo & Martins, 2011 and *E. (E.) foveolata* Aurivillius, 1920 by the central pronotal pubescence not contrasting with pubescence on lateral and basal sides (contrasting in *E. (E.) dissimilis*), and by the smaller elytral punctures (distinctly larger in *E. (E.) dissimilis*). It differs from *E. (E.) guatemalena* Bates, 1885 (see photo of lectotype at Bezark 2015) mainly by the denser elytral punctures (distinctly sparser in *E. (E.) guatemalena*).

New records in Lamiinae

Atrypanius scitulus (Germar, 1924) (Acanthocinini) is recorded from Panama, **new country record**. Material examined – 1 specimen, Gamboa Pipeline Road, Soberiana National Park, Colon, Panama, 18 February 2014, 09°07'38.8"N, 79°42'53.4"W, 90 m, Larry G. Bezark col., beating, (LGBC). This species was described from Brazil. Currently it is known from eastern Brazil (BA-SP), Peru, Ecuador and French Guiana.

Bisaltus (Bisaltus) fuscomarmoratus Breuning, 1966 (Apomecynini) is recorded from Ecuador, **new country record**. Material examined – 3 specimens, 18.5 km N Gonzanama, Loja Province, Ecuador, 22 February 2006, F. T. Hovore & I. Swift col. (LGBC), determined by U. R. Martins. This species was described from Peru.

Esthlogena (Esthlogena) maculifrons Thomson, 1868 (Pteropliini) is recorded from Paraguay, **new country record**. Material examined – 1 male, Paraguay, Canindeyú, Corpus Christi (Guyra Keha), 12.XI.2010, Walt Gomes col. (LGBC). It was described from Brazil (without detailed location). Currently, this species is known from Brazil (Bahia, Rio de Janeiro, São Paulo) (Monné 2015).

Estola albovaria Breuning, 1940 (Desmiphorini) is recorded from Brazil (Amazonas), **new state record**. Material examined – 1 specimen, 62 km SE Ariquemes, Amazonas, Brazil, 7–18 November 1995, F. D. Parker col. (LGBC), determined by U. R. Martins. This species was described from French Guiana and is known also from Brazil (Rondônia).

Euryestola cribrata (Bates, 1881) (Calliini) is recorded from Belize, **new country record**. Material examined – 1 female, Belize, Cayo, Chiquibul National

Park (1976'; 3 miles S Millionario, 16°44.365'N / 89°00.719'W), 14–20.V.2007, F. G. Andrews col. (LGBC). This species was described from Guatemala. Currently it is known from Guatemala, Honduras and Mexico (Monné 2015).

Eutrichillus neomexicanus (Champlain & Knull, 1925) (Acanthocinini) is recorded from Utah, **new state record**. Material examined – 1 specimen, 6 mi NW junction, City Cr. Campground, Paiute Co, Utah, 23 July 2006, Blacklight, D. & J. Powell col. (EMEC). This species was described from New Mexico (USA), and is currently known from the southwestern USA (Arizona and Texas), and Mexico (Durango).

Jurua monachina (White, 1855) (Anisocerini) is recorded from Rondônia, Brazil, **new state record**. Material examined – 2 males, 62 km SE Ariquemes, Fazenda Rancho Grande, Rondônia, Brazil, 16–22 November 1991, E. M. Fisher col. (CSCA), and 22–31 October 1997, W. J. Hanson col. (LGBC). This species was described from Brazil. Currently it is known from Brazil (Amazonas) and Peru.

Leiopus marcelamonneae Audureau & Demez, 2015 (Acanthocinini) is recorded from Ecuador, **new country record**. Material examined – 2 specimens, West of Sarayaca, Nampa-Loreto Road km 55, Napo, Ecuador, 16 March 2001, F.T. Hovore col. (LGBC). This species was described from Peru, and was previously known only from the type material.

Leptostylus batesi Casey, 1913 (Acanthocinini) is recorded from Costa Rica, **new country record**. Material examined – 1 specimen, Turrialba, Costa Rica, 10 January 1973, V.M. Kirk col. (EMEC). This species was described from Panama, and is currently known from Nicaragua and Panama.

Leptostylus triangulifer Bates, 1872 (Acanthocinini) is recorded from Mexico, **new country record**. Material examined – 3 specimens, Estacion de Biologia, Los Tuxtla, Vera Cruz, Mexico, 15 May 1989, J. D. McCarty col. (EMEC, LGBC), 1 specimen Estación de Biologia, Los Tuxtla, Vera Cruz, Mexico, 11 May 1989, J. D. McCarty col. (EMEC). It was described from Nicaragua. This species is currently known from Honduras, and Guatemala to Costa Rica.

Lepturges (Chaeturges) definitus Tavakilian & Monné, 1989 (Acanthocinini) is recorded from Ecuador, **new country record**. Material examined – 1 specimen, km 1 Napo-Galeras Road, Napo Province, Ecuador, 25 August 2004, F. T. Hovore col. (LGBC). This species was described from French Guiana.

Lepturges (Lepturges) singularis Monné, 1976 (Acanthocinini) is recorded from Paraguay, **new country record**. Material examined – 1 specimen, Guyra Keha, Corpus Christi, Canindeyú, Paraguay, 18 October 2009, Walt Gomez col. (LGBC). This species was described from Brazil. It is currently known from Brazil (Rio de Janeiro to Rio Grande do Sul).

Nyssodrysternum insulorum Monné & Tavakilian, 2011 (Acanthocinini) is recorded from Costa Rica, **new**

country record. Material examined – 1 specimen La Selva, Heredia, Costa Rica, 22-25 January 1995, F. T. Hovore col. (CAS); 1 specimen vic. Rincon, Osa Peninsula, Puntarenas, Costa Rica, 28 July, 1981, F. T. Hovore col. (CAS). This species was described from Panama.

Oedopeza louisi Audureau, 2010 (Acanthoderini) is recorded from Costa Rica **new country record.** Material examined – 1 specimen, Santa Rosa National Park, Guanacaste, Costa Rica, 13 June 2002, Chemsak & Hovore col. (EMEC). This species was described from Nicaragua.

Oncideres aurantiaca Galileo & Martins, 2010 (Onciderini) is recorded from Guatemala, **new country record.** Material examined – 1 male, Rt. CA-14 Purulha hotel Ranchito del Quetzal, 1600 m, Department Baja Verapaz, Guatemala, 15°12.929'N, 90°13.149'W, 16 October 2012, R. Zack col., MV/BL light trap (LGBC). This species was described from Honduras.

Oncideres estebani Galileo & Martins, 2010 (Onciderini) is recorded from Guatemala, **new country record.** Material examined – 1 male, University del Valle de Guatemala, Research Station, nr Aldea Adelaida/Finca Panama Sta Barbara, Department Suchitepéquez, Guatemala, 1550 m, 14°32.881'N, 91°11.620'W, 11 August 2010, R. Zack col., MV/BL light trap (LGBC). This species was described from Alajuela, Costa Rica.

Palame crassimana Bates, 1864 (Acanthocinini) is recorded from Panama, **new country record.** Material examined – 2 males, 8-14 km N El Llano, Panama Province, Panama, 12 May 1991, F. T. Hovore col. (EMEC). It was described from Brazil. This species is currently known from Brazil (AP, AM, PA, MT), Bolivia, Ecuador, French Guiana, Guyana and Venezuela.

Plagiohammus imperator (Thomson, 1868) (Monochamini) is recorded from Nayarit, Mexico, **new state record.** Material examined – 1 specimen, Volcan Ceboruco, 5-15 km W Jala, Nayarit, Mexico, 15 October 2001, R. L. Penrose col. (CSCA). This species was described from Mexico, and known from the states of Mexico, Jalisco, Mexico, Michoacán, Guerrero, Chiapas, Oaxaca, and Puebla.

Stenolis gilvolineata Monné, 2011 (Acanthocinini) is recorded from Costa Rica, **new country record.** Material examined – 1 specimen La Selva, Heredia, Costa Rica, 22-25 January 1996, F. T. Hovore col. (LGBC). This species was described from Panama.

Stenolis multimaculata Monné, 2011 (Acanthocinini) is recorded from Guatemala, **new country record.** Material examined – 1 specimen, Parque Natural Ixpanpajul Rt. CA-13 nr Santa Ana, 345 m, Department Petén, Guatemala, 16°52.226'N, 89°49.383'W,

12 September 2009, R. Zack col. MV/BL light trap (LGBC). This species was described from Costa Rica and is currently known from Guanacaste & Puntarenas.

Taurolema hirsuticornis Chevrolat, 1861 (Mauesini) is recorded from Paraguay, **new country record.** Material examined – 1 specimen, Britez-cue, Corpus Christi, Canindeyú, Paraguay, 12 November 2010, Walter Gomez col. (LGBC). This species was described from Brazil, and is currently known from Brazil (Goiás, Minas Gerais to Rio Grande do Sul) and Argentina (Misiones).

Trypanidius irroratus Monné & Delfino, 1980 (Acanthocinini) is recorded from Ecuador **new country record.** Material examined – 1 specimen, 16 km E Mera, Pastaza, Ecuador, 16 June 2001, D. Curoe col. (EMEC). This species was described from Venezuela, and is currently known from Venezuela and Colombia.

Zeale dubia Galileo & Martins, 1997 (Hemilophini) is recorded from Peru, **new country record.** Material examined – 1 male, Peru, Cuzco, Valle del Rio Apumirac, XI.2011, L. G. Bezark col. (LGBC). This species was described from Bolivia. Currently it is known from Bolivia and Colombia (Monné 2015).

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References

- Breuning S (1974) Révision des Rhodopini américains. *Studia Entomologica* 17(1-4): 1-210.
- Bezark LG (2015) A photographic Catalog of the Cerambycidae of the New World. <https://apps2.cdfa.ca.gov/publicApps/plant/bycidDB/wdefault.asp?w=n> [accessed September 2015]
- Martins UR (1976) Sistemática e evolução da tribo Piezocerini (Coleoptera, Cerambycidae). *Arquivos de Zoologia*, 27(3-4): 165-370. doi: 10.11606/issn.2176-7793.v27i3-4p165-370
- Martins UR (2003) Tribo Piezocerini. In: Martins UR (Org.) *Cerambycidae Sul-Americanos* (Coleoptera). Taxonomia. Sociedade Brasileira de Entomologia, Curitiba, v. 6, 65-201.
- Monné MA (2015) Catalogue of the Cerambycidae (Coleoptera) of the Neotropical Region. Part II. Subfamily Lamiinae. <http://www.cerambyxcat.com/> [accessed August 2015]

Species diversity, chorology, and biogeography of the Steninae MacLeay, 1825 of Iran, with comparative notes on *Scopaeus* Erichson, 1839 (Coleoptera, Staphylinidae)

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<http://zoobank.org/70C12A81-00A7-46A3-8AF0-9FC20EB39AA6>

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Abstract

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The species diversity, chorology, and biogeography of the Steninae MacLeay, 1825 (Coleoptera: Staphylinidae) in Iran is described. A total of 68 species of *Stenus* Latreille, 1797 and one species of *Dianous* Leach, 1819 is recorded for this Middle Eastern country. *Dianous coerulescens korgei* Puthz, 2002, *Stenus bicornis* Puthz, 1972, *S. butrintensis* Smetana, 1959, *S. cindeloides* Schaller, 1783, *S. comma comma* Le Conte, 1863, and *S. hospes* Erichson, 1840 are recorded for the Iranian fauna for the first time. Records of *S. cordatoides* Puthz, 1972, *S. guttula* P. Müller 1821, *S. melanarius melanarius* Stephens, 1833, *S. planifrons planifrons* Rey, 1884, *S. pusillus* Stephens, 1833, and *S. umbriacus* Baudi di Selve, 1870 for Iran are, however, implausible or proved erroneous. Based on literature records and recent collecting data since 2004, the distribution of the stenine species in Iran is mapped, and their biogeographical relationships are discussed. As far as possible, the species are attributed to the commonly accepted distribution types in the Palaearctic Region after the theory of Pleistocene refuges of the arboreal biota. With the example of the Steninae and *Scopaeus* Erichson, 1839 (Staphylinidae: Paederinae), a cluster analysis is performed to examine the similarity of commonly accepted geographical units of Iran. The similar biogeographic pattern of the Steninae and *Scopaeus* reveal the high impact of Mediterranean elements on the fauna of Iran. The Hyrcanian subregion of the Caspian refuge is identified as the most significant center of origin of *Stenus* in Iran.

Introduction

The Steninae MacLeay, 1825 constitute a monophyletic group (Clarke and Grebennikov 2009: 354, 355; McKenna et al. 2014: 17) which is well characterized by bulging eyes and abdominal glands, which secrete a multifunctional hydrophobic substance for locomotion on the surface of water (Schierling et al. 2012). Steninae preferably dwell in humid or wet places such as banks of both running and standing waters, swamps, bogs, and wet grasslands (Schierling et al. 2012: 45). The subfamily presently comprises *Stenus* Latreille, 1797 with a world-

wide distribution and 2674 named species including fossil taxa (Puthz, unpublished) and the less speciose sister group *Dianous* Leach, 1819. *Stenus* is characterized by the eversible labium of the adults (Betz 1996: 15). It is protrusible for prey capture and allows the beetle to catch even prey which is able to escape rapidly such as Collembola, a frequent diet of *Stenus*. Kastcheev and Puthz (2011: 454) defined two morpho-ecological forms of *Stenus* species: “stratobionts” with a more compact body and short legs, which live in dense layers of vegetation litter, and “open-living species”, which prefer the banks of sandy, loamy or clayey shallows with sedges or bulrush.

Though the taxonomic diversity of the *Stenus* of Iran was relatively well known, the biogeography of the Iranian species still was to be investigated. Most of our knowledge on the *Stenus* species of Iran we owe to Puthz (e.g. 1972a, 1979), who described nine species from Iran mainly based on the samples of A. Senglet at the Muséum d'histoire naturelle, Geneva, which were collected between 1973 and 1975 in many provinces of Iran. Most of these species are endemics of the Hyrcanian subregion in the South Caspian mountain ranges and members of the *S. ochropus-ludyi-coarcticollis* group, which is the most speciose of the 26 species groups of *Stenus* reported from Iran. Recently, Puthz (2009) added two more endemics from this region from the same species group. Up to now, a total of 69 species of Steninae is confirmed to be distributed in Iran.

Iran is situated in the western Iranian Plateau and constitutes one of the largest countries of the Middle East. Some 47% of Iran is covered by natural grasslands, 31% by a variety of semiarid and arid environments, 14% by arable land, and 8% by woodlands (Yale et al. 2001: 24). The great variety of habitats includes salt marshes, deserts, and bare-rock mountains. The central plateau of Iran at an elevation of about 1000–1500 m above sea level receives 100–400 mm annual precipitation only, because it is surrounded by high mountain ranges. Two vast deserts, Dasht-e Kavir and Dasht-e Lut, occupy most of the northeast and east of the plateau, where the summer temperature exceeds 55 °C. Though most of Iran is arid, the green woodlands between the Caspian Sea and the northern slopes of the Elburz Mountains receive significantly more rain, some 1300–2000 mm or more per year. The average annual precipitation sums up to about 500–1000 mm in the Zagros Mountains, in the northwest of which the lowest winter temperature, -30 °C, was measured (Hangay et al. 2005: 1).

Due to its geographic location within the Middle Eastern transitional zone of the Palaearctic, the Oriental, and the Afrotropical Regions and its diverse geology and topography, Iran shows a significant biogeographic variety. Though the country is located in the Palaearctic Region, the fauna of southern Iran is significantly influenced by Afrotropical and Oriental faunal elements. Although the leading biogeographical concepts of Iran are based on phytogeography (e.g. Hedge and Wendelbo 1978, Parsa 1978, Zohary 1973), they also reflect the distribution pattern of animals. These concepts include three major phytogeographic regions in Iran: the Hyrcano-Euxine or Euxino-Hyrcanian Province of the Euro-Siberian Region, which includes the Elburz and Talish Mountains in the north of Iran, the southern Caucasus and the northern slopes of the Pontus Mountains in northeastern Turkey, the Irano-Turanian Region, a part of the Asian steppe zone, which occupies more than two-thirds of Iran, and the Saharo-Sindian Region in the south of Iran. According to many biogeographers, e.g. Naumann (1987), Afrotropical and Oriental faunal elements dispersed into this southern region of Iran.

A commonly accepted concept of the zoogeographical units of Iran has not yet been published. De Lattin (1949,

1951, 1957, 1967), however, identified glacial refuges of the arboreal and cremial faunas as the result of an analysis of the distribution pattern of Lepidoptera. He established the long accepted hypothesis that the postglacial dispersal events started at these refuges, which thus constitute the centres of origin for recent biogeographical patterns. Accordingly, he proposed distribution types for the arboreal and cremial faunas, which go back to the glacial refuges. Among the arboreal refuges proposed by de Lattin, the Caspian, Iranian, Sindian, Syrian, and Turkestanian refuges and the Mediterranean refuge have a great influence on the present distributional pattern of the fauna of the Middle East.

Despite of the unique geographical features of the country, we have insufficient information about the specific zoogeographical pattern and the degree of endemism of the Iranian fauna (Zehzad et al. 2002: 9). Nevertheless, a high degree of endemism is expected particularly in the isolated mountains within the steppes and deserts, where the gradual desiccation and aridization of the Iranian plateau in the Neogene with its maximum at the end of the Pleistocene (Ganji 1978: 154) led to the allopatric speciation of riparian species in relict freshwater systems (Frisch 2008: 285). We already know from many publications (e.g. Frisch 2006a, 2006b, 2008; Ganji 1978) that the South Caspian mountain ranges, the Zagros Mountains, and the high elevations in the central Iranian Plateau constitute centers of origin of many Iranian endemics.

In this contribution, we present the results of a research project of the first author on the diversity and biogeography of the Steninae in Iran. The aim of the study was to identify zoogeographical patterns of the stenine fauna of Iran and to compare them with the zoogeographical patterns of the strictly riparian staphylinid genus *Scopaeus* Erichson, 1839, research subject of the second author, to test whether they follow the same distributional patterns.

We compile the data on the distribution of the 68 *Stenus* species and one species of *Dianous* known from Iran so far, which include both previously unpublished, mostly recent records and plausible literature records, most of which were published in the last 44 years only. Finally, a cluster analysis with paired groups using Dice Similarity Coefficient was performed to gain a concept of the similarity of the *Stenus* fauna of defined geographical regions of Iran. It was compared with a cladogram for the *Scopaeus* species of Iran provided by the same method.

Material and methods

This study is mainly based on the results of recent field work of the authors from 2004 to 2011. The chorological data are compiled in the MS Excel 2007 supplementary file (supplementary material 1; 967 records). In this compilation, the locality labels of the specimens usually are not cited verbatim, but standardized and completed by adding the province name. Missing GPS – coordinates were subsequently taken from Taseo.com and are indicat-

ed by rectangular brackets to distinguish them from those measured at the exact collecting site.

The samples were identified by the first author and in difficult cases confirmed by Volker Puthz, the leading specialist of Steninae. Literature records were considered only if they were confirmed by examination of the reference specimens or are plausible, because they were published by well-known *Stenus* specialists. The dubious records of 19 species for Iran by Hadian et al. (2011: 3–4), Ghahari et al. (2009a: 1954, 2009b: 1964, 2009c: 661), Sakenin et al. (2008, 2010), and Samin et al. (2011a: 2–3, 2011b: 140–142, 2011c: 1238) we could not confirm, because our repeated attempts to contact the authors were unsuccessful.

The specimens referred to in this contribution are stored in Hayk Mirzayans Insect Museum, Tehran, except otherwise stated. Specimens collected by A. Senglet are kept in the Muséum d'histoire naturelle, Geneva and the private collection of Volker Puthz. The collections are abbreviated as follows (in alphabetical order):

APCE = Andreas Pütz private collection, Eisenhüttenstadt; HNHM = Hungarian Natural History Museum, Budapest; HMIM = Hayk Mirzayans Insect Museum, Tehran; LHCP = Lubomír Hromádka private collection, Prague; MNHB = Museum für Naturkunde Berlin; MHNG = Muséum d'histoire naturelle Geneva; MHNP = Muséum national d'histoire naturelle Paris; MZMC = Zoological Museum of the Moscow Lomonosov State University; NHMW = Naturhistorisches Museum Wien; NMEC = Naturkundemuseum Erfurt; NMPC = Národní Muzeum, Prague; SMNS = Staatliches Museum für Naturkunde Stuttgart; USNM = National Museum of Natural History, Smithsonian Institution, Washington; UZMH = Finnish Museum of Natural History, Helsinki; VPCS = Volker Puthz private collection, Schlitz; ZICP = Zoological Museum of the Zoological Institute of the Academy of Sciences, St. Petersburg.

The general information on the distribution of the species in the results section is taken from Schülke and Smetana (2015: 798–847) unless otherwise stated. The terminology of the Pleistocene glacial refuges follows de Lattin (1949, 1951, 1957, 1967). The dubious species reported by Hadian et al. (2011: 3–4), Ghahari et al. (2009a: 1954, 2009b: 1964, 2009c: 661), Sakenin et al. (2008, 2010), and Samin et al. (2011a: 2–3, b: 140–142, c: 1238) are discussed separately.

The subgeneric classification of *Stenus* has been subject to controversial discussions. According to Ryvkin (2011: 59), a comprehensive phylogenetic analysis is necessary to identify the monophyletic lineages within *Stenus*, which are blurred by a high amount of parallelism and do not reflect the phylogenetic relationships. In the first edition of the Catalogue of Palaearctic Coleoptera, Smetana (2004: 540–564) still followed the traditional subgeneric concept and distinguished *Hemistenus* Motschulsky, 1860, *Hypostenus* Rey, 1884, *Stenus* Latreille, 1797, *Metastenus* Ádám, 1987 (replacement name: *Metatesnus* Ádám, 2001), and *Tesnus* Rey, 1884 as valid subgenera of *Stenus*. Puthz (2008: 141–147) recently

replaced that artificial classification by 157 monophyletic species groups according to apomorphic characters of the aedeagus, spermatheca, and terminal abdominal sclerites. In the current edition of the Catalogue of Palaearctic Coleoptera, Schülke and Smetana (2015: 798–847) followed Puthz (2008: 141–147) and rejected the traditional subgenera. In this contribution, we follow this concept.

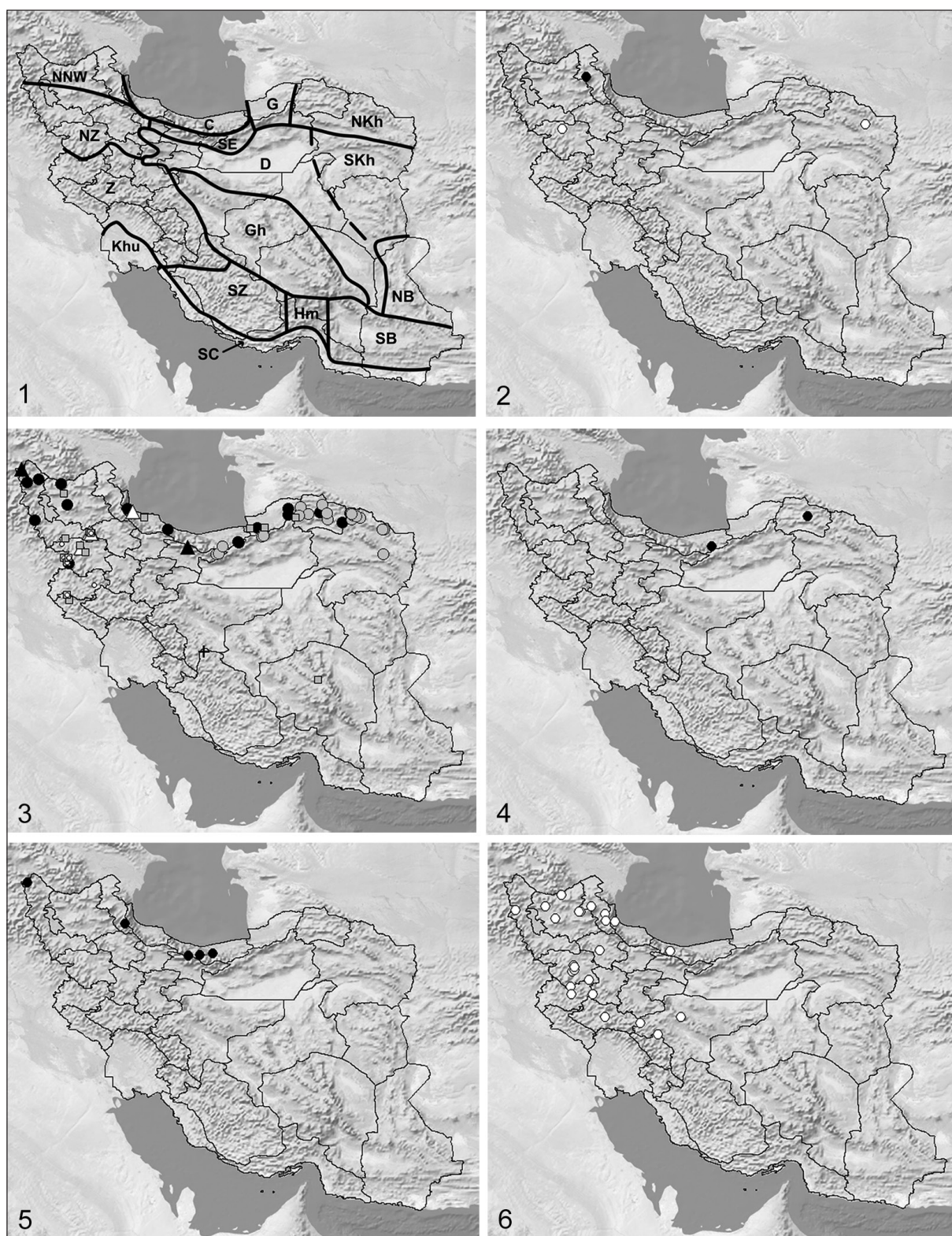
The distribution maps were prepared using the biodiversity software BIOOFFICE and do not include dubious literature records. The distributional patterns of all members of a particular species group are combined in one map.

The biogeographical cluster analysis was carried out using NTSYS (2.02) (Rohlf 1998). The qualitative input data are coded 1 for presence and 0 for absence of a species in a geographical unit. The complete distributional information for the Steninae analysis is presented in this contribution. The analyzed data of the genus *Scopaeus* were previously published by Frisch (2006a, 2006b, 2007a, 2007b, 2008, 2009, 2010, 2014) and Anlaş and Frisch (2014).

The underlying geographical subdivisions mainly follow Petrov (1955: 140–179), who distinguished the following seven “natural regions” of Iran: 1) North Iranian mountain region (Northwest Iran, South Caspian mountains, Turkmeno-Khorasanian mountains), 2) Caspian wet forest region, 3) Southwest Iranian mountain region (Poshte-Kuh or Kabir-Kuh Mountains, Zagros Mountains, Karun Plain, 4) Central Iranian mountain region (Ghohrud Mountains, Benan Mountains, Gavkhoni swamp), 5) South Iranian mountain region (east of Karun to Pakistan), 6) East Iranian mountain region (Jam and Kayen Mountains, Palangan mountain ranges, Serhed Plain), 7) highlands of Iranian Plateau (Kavir Desert, Lut Desert, Hamun-e Sistan salt marshes). Some geographical units of Petrov (1955) were, however, modified as follows based on significant differences of their stenine fauna: The northwestern part of the Northern Iranian mountain region is divided in two parts, Golestan is separated from the Caspian wet forest region, the Karun subregion of the Southwest Iranian mountain region, the North Baluchestan subregion of the East Iranian mountain region, and each of the subdivisions of the South Iranian mountain region are considered as separate regions.

The geographical subdivisions of Iran used in the biogeographical cluster analysis are illustrated in Fig. 1 and abbreviated as follows: C - Caspian wet forest region, D - deserts and salt marshes, G - Golestan region, Gh - Ghohrud Mountains, Hm - mountains of Hormozgan, Khu - Khuzestan Plain, NB - North Baluchestan Mountains, NKh - North Khorasan Mountains, NNW - northern part of North Zagros Mountains, NZ - North Zagros Mountains, SB - South Baluchestan Mountains, SC - coast of Persian Gulf and Oman Sea, SE - southern slopes of Elburz Mountains, SKh - southern Khorasan Mountains, SZ - southern Zagros Mountains in Fars, Z - Zagros Mountains.

Our expeditions between 2004 and 2011 covered most of Iran. While our samples from northern and western



Figures 1–6. Distribution of Steninae in Iran. **1.** Geographical subdivision of Iran modified after Petrov (1955) and **2–6** distribution data of Steninae: **2.** *Dianous* and the *Stenus alpicola* species group: ● *D. coeruleus korgei*, ○ *S. proprius*; **3.** *S. ater* species group: + *S. affaber*, ● *S. ater*, △ *S. hypoproditor*, ■ *S. intricatus zoufali*, ● *S. mongolicus*, ○ *S. nodipes*, ▲ *S. skoraszewskyi*; **4.** *S. brunnipes* species group: ● *S. b. brunnipes*; **5.** *S. canaliculatus* species group: ● *S. canaliculatus*; **6.** *S. cautus* species group: ○ *S. cautus*. Abbreviations: C - Caspian wet forest region, D - deserts and salt marshes, G - Golestan region, Gh - Ghohrud Mountains, Hm - mountains of Hormozgan, Khu - Khuzestan Plain, NB - North Baluchestan Mountains, NKh - North Khorasan Mountains, NNW - northern part of North Zagros Mountains, NZ - North Zagros Mountains, SB - South Baluchestan Mountains, SC - coast of Persian Gulf and Oman Sea, SE - southern slopes of Elburz Mountains, SKh - southern Khorasan Mountains, SZ - southern Zagros Mountains in Fars, Z - Zagros Mountains.

Iran must be looked upon as quite representative for these regions, the results from the mountains of southern Khorasan are poor and preliminary, because in this region we had a short collecting chance only. In view of the niche preferences of the *Steninae* species, however, we don't expect the existence of a rich *Stenus* fauna in the dry, salty lowlands of the coastal regions of the Persian Gulf and the Oman Sea.

Results

1. Species list, chorology and biogeographical characterization of the *Steninae* of Iran

In the following species chapters, we discuss the biogeography of the 69 species of *Steninae* known from Iran against the background of the Pleistocene glacial refuges (De Lattin 1949, 1951, 1957, 1967) based on the distributional data compiled in the supplementary file 1. This species list includes the first records of five species of *Stenus* and the genus *Dianous* for the Iranian fauna. The species are listed alphabetically in the species groups defined by Puthz (2008: 141–143), which are listed in alphabetical order as well. The distribution of the species is mapped in Figs 2–24.

Dianous Leach, 1819

Dianous coerulescens korgei Puthz, 2002

Fig. 2, Suppl. material 1

Chorology. *Dianous coerulescens*, widely distributed in the temperate West Palaearctic, is recorded as far east as Kazakhstan (Kastcheev and Puthz 2011: 438) and western Siberia (Schülke and Smetana 2015: 799). Judging from the distribution in the Caucasus and Turkey (Schülke and Smetana 2015: 799), the occurrence in northern Iran was expected. One male of *D. coerulescens*, which was collected in moss at a small waterfall in the northern slope of Mount Sabalan, represents the first record of both the genus and the species in Iran (Fig. 2). This southernmost finding of the polytypical species at 38°19'N belongs to *D. coerulescens korgei* Puthz, 2002, which was hitherto known only from the type locality near Trabzon, Northeast Turkey.

Biogeographical characterization. *Dianous coerulescens* cannot be assigned to any of de Lattin's (1951, 1957, 1967) southern Palaearctic glacial refuges.

Stenus Latreille, 1797

Stenus alpicola species group

Stenus proprius L. Benick, 1921

Fig. 2, Suppl. material 1

Chorology. *Stenus proprius* is recorded from Greece (Schülke and Smetana 2015: 837), northeastern Iran

(Puthz 2003: 93), and Central Asia (Kastcheev and Puthz 2011: 450). A second Iranian locality was recently discovered in the northwestern Zagros Mountains (Kordestan). Judging from the findings in the very northwest and northeast of Iran (Fig. 2), *S. proprius* is most probably distributed across the north of the country.

Biogeographical characterization. Although the species was found in Greece and is expected to occur in Anatolia, its main distribution in Central Asia concurs with the Turkestanian glacial refuge. Thus, *Stenus proprius* can be regarded as an expansive Turkestanian faunal element. Kastcheev and Puthz (2011: 454) described this species as Kazakhstan-Turanian. Hitherto, *S. proprius* is the only representative of the *S. alpicola* species group in Iran.

Stenus ater species group

Stenus affaber Baudi di Selve, 1848

Fig. 3, Suppl. material 1

Chorology. *Stenus affaber* is previously published for Lebanon, Syria, Turkey, Iran, and Kazakhstan. It is collected in the eastern Zagros Mountains, northern Fars (Fig. 3). The record from Kazakhstan is, however, dubious, because it is based on a female only identified as *S. cf. affaber* (Kastcheev and Puthz 2011: 439). The lack of records between Southwest Iran and Kazakhstan moreover does not support a Central Asian distribution.

Biogeographical characterization. Kastcheev and Puthz (2011: 454) consider *Stenus affaber* to be a species of Mediterranean origin. Judging from the distribution west (Levant), north (Anatolia), and east (Zagros Mountains) of the Mesopotamian plain, however, we assign this rarely collected species to the Syrian faunal element.

Stenus ater Mannerheim, 1830

Fig. 3, Suppl. material 1

Chorology. *Stenus ater* is widespread in the West Palaearctic and recorded as far east as European Russia, Azerbaijan, and North Iran, where it reaches its eastern limit of distribution in the Turkmeno-Khorasanian Mountains at about 58°06'E (Fig. 3). Records from Kazakhstan (Smetana 2004: 554), which were adopted by Schülke and Smetana (2015: 806), mainly refer to other species and are not reliable (Kastcheev and Puthz 2011: 454). In Iran, *S. ater* is the most widespread member of the *S. ater* group. Towards the east, it is replaced by its close relative *S. mongolicus*. The two species occur sympatrically in the eastern Elburz and the Turkmeno-Khorasanian Mountains (Fig. 3). Ghahari et al. (2009b: 1964) recently published *S. ater* for Behshahr, Mazandaran, a record which is in accord with the distribution pattern of the species.

Biogeographical characterization. Judging from the vast distribution in the Mediterranean, we consider *Stenus ater* to be an expansive Holomediterranean faunal element.

***Stenus hypoproditor* Puthz, 1965**

Fig. 3, Suppl. material 1

Chorology. *Stenus hypoproditor* is distributed from the northeastern Mediterranean, Southeast Europe, Turkey, and Iran as far east as Kazakhstan, Uzbekistan, and Kyrgyzstan. In Iran, it is known from the northwest (Fig. 3) only. The find in the northwestern Zagros Mountains at about 36°59'N constitutes the southernmost record of this species. Further to the south, *S. hypoproditor* is replaced by the allopatric relative *S. nodipes*.

Biogeographical characterization. Kastcheev and Puthz (2011: 454) consider *Stenus hypoproditor* to be a Mediterranean species. According to the Pleistocene refuge theory, it can be regarded as an expansive Pontomediterranean faunal element.

***Stenus intricatus zoufali* Fleischer, 1909**

Fig. 3, Suppl. material 1

Chorology. *Stenus intricatus zoufali* is distributed from southeastern Central Europe and the Balkans across Anatolia, Transcaucasia, and Iran as far east as Central Asia and Afghanistan (Kastcheev and Puthz 2011: 445). In Iran, the species is distributed in the north, but the record in the southeast at about 30°17'N (Kerman), the southernmost collecting site of the *S. ater* group, suggests the distribution in most of the country (Fig. 3).

Biogeographical characterization. Kastcheev and Puthz (2011: 454) describe *Stenus intricatus zoufali* as a Mediterranean species. Judging from the distribution in the southeastern Mediterranean, we consider it to be an expansive Pontomediterranean faunal element.

***Stenus mongolicus* Eppelsheim, 1889**

Fig. 3, Suppl. material 1

Chorology. *Stenus mongolicus* is widely distributed in Asia and the Middle East from China, Mongolia, and East Siberia as far south as Indian Kashmir, Pakistan, Afghanistan, and Iran and westwards to Anatolia and Caucasia. In Iran, the species is restricted to the Elburz and Turkmeno-Khorasanian Mountains in the northeast and recorded as far south as 35°42'N in Razavi Khorasan (Fig. 3). Recent records from the lowlands of Ivanaky, Semnan Province (Hadian et al. 2011: 4), and from rice fields and grassland in Lahijan, Gilan (Ghahari et al. 2009c: 661) need confirmation.

Biogeographical characterization. Kastcheev and Puthz (2011: 454) consider *Stenus mongolicus* as a Kazakhstan-Turanian species. Judging from its Central Asian distribution centre, *S. mongolicus* can be regarded as a Turkestanian faunal element, which expanded westward.

***Stenus nodipes* Puthz, 1972**

Fig. 3, Suppl. material 1

Chorology. Described from Bulgaria (Puthz 1972b: 250), *Stenus nodipes* is common from the Balkans throughout Turkey and Syria eastwards to Armenia and Iran (Puthz 2009: 34). In Iran, the species is known only from a comparatively small area in the northwestern Zagros Mountains between southern West Azarbaijan and northern Ilam (Fig. 3).

Biogeographical characterization. Due to its distribution in Southeast Europe, Anatolia, and the Caucasus region, we consider *Stenus nodipes* to be an expansive Pontomediterranean species.

***Stenus skoraszewskyi* Korge, 1971**

Fig. 3, Suppl. material 1

Chorology. *Stenus skoraszewskyi* was described from Kars, northeastern Turkey (Korge 1971: 21), and also recorded for Armenia and Iran, where it was found in the very northwest of West Azarbaijan and in the Central Elburz near Tehran, the southeasternmost record of the rare species at about 36°N 51°E (Fig. 3).

Biogeographical characterization. These few, scattered localities in the Irano-Anatolian highlands and the Elburz do not sufficiently describe the distribution pattern of *Stenus skoraszewskyi*, which is why we preliminarily term it as an Irano-Anatolian species.

Stenus brunnipes* species group**Stenus brunnipes brunnipes* Stephens, 1833**

Fig. 4, Suppl. material 1

Chorology. The nominotypical subspecies of *Stenus brunnipes* is widely distributed in the West Palaearctic eastwards to Iran and Turkmenistan. In Iran, the subspecies seems to be restricted to the northern mountain ranges, where it was found in the eastern Elburz and the Turkmeno-Khorasanian mountains (Fig. 4).

Biogeographical characterization. Puthz (2012a: 288) considers *Stenus b. brunnipes* to be Holomediterranean and we follow this hypothesis.

Stenus canaliculatus* species group**Stenus canaliculatus* Gyllenhal, 1827**

Fig. 5, Suppl. material 1

Chorology. The Holarctic *Stenus canaliculatus* is widely distributed across the temperate and northern Palaearctic as far east as Russian Far East and China. In Iran, the species is confined to the temperate north (West Azarbaijan, Ardabil, Mazandaran; Fig. 5). Thus, the record from Fars (Samin et al. 2011a: 2, 2011c: 1238), far south of the confirmed distribution, is implausible.

Biogeographical characterization. *Stenus canaliculatus*, a faunal element of the temperate Holarctic, cannot be assigned to any of de Lattin's (1951, 1957, 1967) southern Palaearctic glacial refuges.

Stenus cautus species group

Stenus cautus Erichson, 1839

Fig. 6, Suppl. material 1

Chorology. *Stenus cautus* is widely distributed across the temperate and northern Palaearctic from France to the Russian Far East. The first record for Iran was published by Puthz (2012a: 304). As far as known presently, the species reaches its southern limit of distribution in the northwest of Iran (Fig. 6), where it was found as far south as Chadegan (Esfahan Province).

Biogeographical characterization. No biogeographical assigning is possible for this trans-Palaearctic species.

Stenus circularis species group

Stenus planifrons robustus L. Benick, 1914

Fig. 7, Suppl. material 1

Chorology. The distribution of the polytypical *Stenus planifrons* reaches from Germany and Switzerland over the Balkans, Anatolia, the Levant, and the Ukraine eastwards to South Russia, Caucasia, Iran, and Turkmenistan. In Iran, the species is represented by the southeastern subspecies *S. p. robustus*, which is distributed in Cyprus, Lebanon, Israel, Syria, Anatolia, Iraq, and northern Iran as far east as Turkmenistan.

Biogeographical characterization. Due to this arched areal north, west, and east of the Mesopotamian plain, the evolutionary origin of the subspecies goes back to the Syrian Pleistocene refuge. In Iran, *Stenus p. robustus* reaches its southern and eastern distribution limit in the southern Zagros Mountains (29°40'N) and the Turkmeno-Khorasanian mountain ranges (59°54'E) (Fig. 7).

Bionomics. This cold resistant taxon was found in altitudes up to 3250 m.

Stenus clavicornis species group

Stenus caspius Puthz, 1972

Fig. 8, Suppl. material 1

Chorology. Described from the Talish Mountains (Puthz 1972d: 127), *Stenus caspius* has its main distribution in Transcaucasia and the South Caspian mountain ranges from Georgia as far east as the Turkmeno-Khorasanian mountains. It apparently is the most common *Stenus* in the Hyrcanian zone in the northern slopes of the Talish and Elburz Mountains, but it was also found outside of this biogeographical unit in West Azarbaijan, the northern Zagros Mountains, and south of the Elburz (Fig. 8).

Biogeographical characterization. Judging from this distribution pattern, *Stenus caspius* is a typical expansive Caspian faunal element.

Stenus providus providus Erichson, 1839

Fig. 8, Suppl. material 1

Chorology. The nominotypical subspecies of *Stenus providus* is widespread in the West Palaearctic as far east as Kazakhstan (Kastcheev and Puthz 2011: 450). The first record for Iran in this work is missing in the current Catalogue of Palaearctic Coleoptera (Schülke and Smetana 2015: 837). In Iran, *S. p. providus* is distributed in the South Caspian mountains and the very north of the Zagros Mountains (Fig. 8). In the Hyrcanian zone, the species is replaced by its close, allopatric relative *S. caspius*, but in high elevations of the northern slopes of the Elburz Mountains there is a narrow zone of sympatry.

Biogeographical characterization. Judging from the distribution in all of the arboreal Mediterranean, *Stenus providus* is to be attributed to the Holomediterranean distribution type. Kastcheev and Puthz (2011: 454) already described it as a Mediterranean species.

Stenus comma species group

Stenus aereus Solsky, 1871

Fig. 9, Suppl. material 1

Chorology. *Stenus aereus* is distributed in Caucasia, the Middle East, Central Asia, and West Siberia. In Iran, it apparently is a rare species, which we did not succeed to collect. The record from West Azarbaijan published by Samin et al. (2011b: 140) is plausible in view of the record from East Azarbaijan (Fig. 9), but needs confirmation.

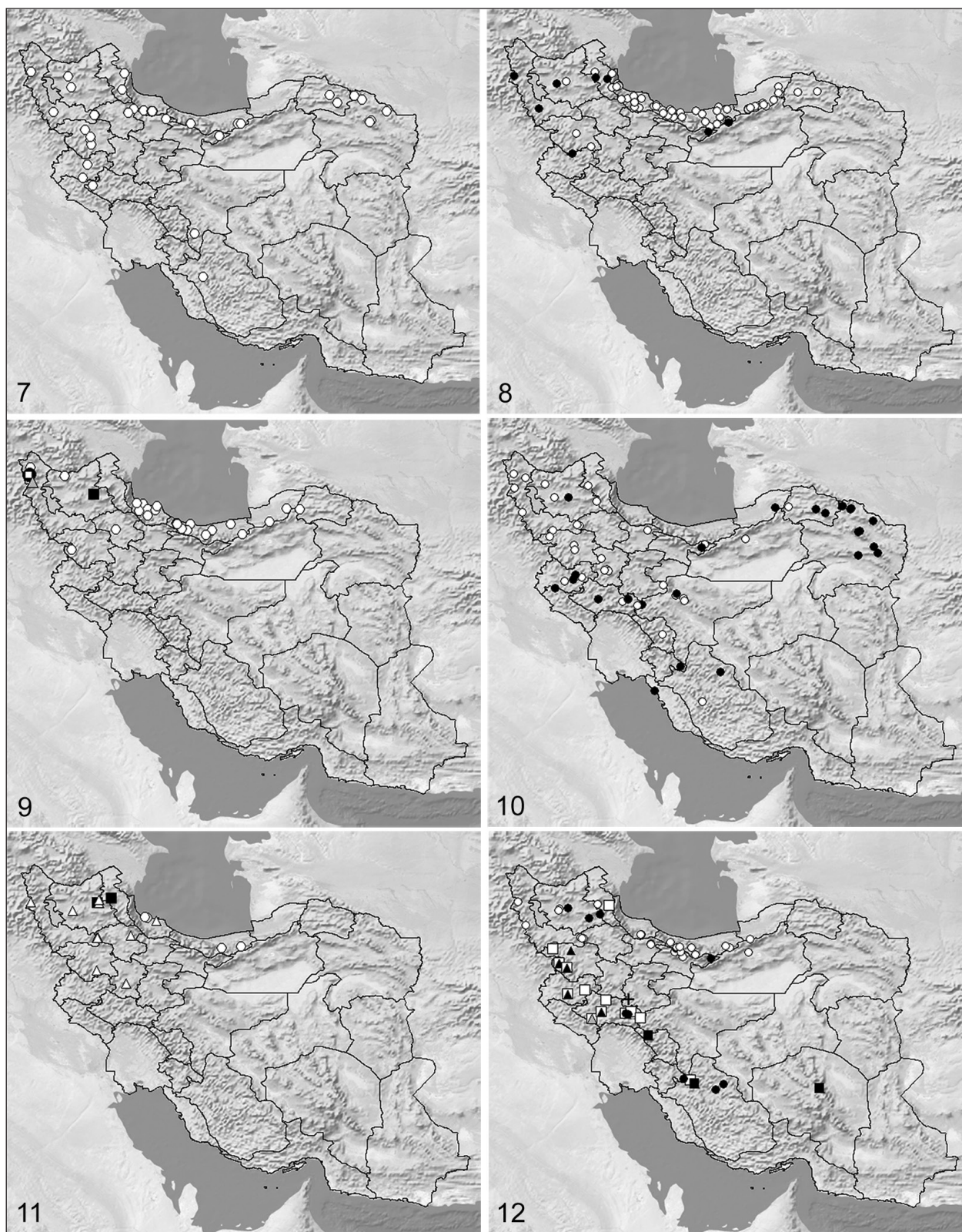
Biogeographical characterization. Kastcheev and Puthz (2011: 454) term *Stenus aereus* a Kazakhstan-Turanian species. According to the hypothesis of Pleistocene refuges, we consider it to be an expansive Turkestanian faunal element, which dispersed towards the Mediterranean.

Stenus asiaticus Bernhauer, 1940

Fig. 9, Suppl. material 1

Chorology. The Middle Eastern *Stenus asiaticus* is recorded for Georgia, Turkey, Syria, Iraq, Iran, and Turkmenistan. In Iran, it is the most widespread member of the *S. comma* species group and distributed in the South Caspian mountains and the northern Zagros Mountains (Fig. 9).

Biogeographical characterization. It is difficult, to assign *Stenus asiaticus* to a particular distribution type judging from the total distribution. In view of the high abundance of records in the Hyrcanian zone in the northern slopes of the Elburz Mountains and the distribution in Transcaucasia, the regions which constitute the Caspian refuge, we consider *S. asiaticus* to be an expansive Caspian faunal element.



Figures 7–12. Distribution of Steninae in Iran. 7. *Stenus circularis* species group: ○ *S. planifrons robustus*; 8. *Stenus clavicornis* species group: ○ *S. caspius*, ● *S. p. providus*; 9. *Stenus comma* species group: ■ *S. aereus*, ○ *S. asiaticus*, ● *S. bicornis*, ▲ *S. biguttatus*, □ *S. c. comma*; 10. *Stenus cordatus* species group: ○ *S. araxis*, ● *S. turk*; 11. *Stenus crassus* and *S. fornicatus* species groups: ■ *S. crassus*, △ *S. formicetorum*, ○ *S. fornicatus*; 12. *Stenus glacialis* species group: + *S. armeniacus*, ▲ *S. hospes*, ■ *S. limicola*, ○ *S. medus*, ▲ *S. parciur*, □ *S. persicus*, ● *S. schah*.

***Stenus bicornis* Puthz, 1972**

Fig. 9, Suppl. material 1

Chorology. Described from Macedonia and Turkey (Puthz 1972c: 170), *Stenus bicornis* is distributed in the Balkans and Anatolia. The recent records in the very northwest of Iran (Fig. 9) are the first for the Iranian fauna and represent the easternmost known localities of this species.

Biogeographical characterization. Due to its distribution in the northeastern Mediterranean, *Stenus bicornis* can be regarded as a Pontomediterranean species.

***Stenus biguttatus* (Linnaeus, 1758)**

Fig. 9, Suppl. material 1

Chorology. *Stenus biguttatus* is widely distributed across the northern Palaearctic eastwards to Russian Far East and Japan (Kastcheev and Puthz 2011: 440). In Iran, the species seems to be rare and restricted to the northwest, where we collected it just once (Fig. 9). The dubious records from Rasht and Fouman published by Samin et al. (2011a: 2, 2011c: 1238) were not adopted by Schülke and Smetana (2015: 808).

Biogeographical characterization. The enormous area of distribution of *Stenus biguttatus* cannot be attributed to a particular Pleistocene refuge and distribution type, respectively.

***Stenus comma comma* Le Conte, 1863**

Fig. 9, Suppl. material 1

Chorology. The Holarctic *Stenus comma* is widespread across the temperate and northern Palaearctic as far east as Russian Far East, China, and Japan. In Iran, the northern species seems to be confined to the temperate northwest. Our find in West Azarbaijan constitutes the first country record of *S. c. comma* for Iran (Fig. 9).

Biogeographical characterization. The wide distribution of this species cannot be explained by the Pleistocene refuge theory.

Stenus cordatus* species group**Stenus araxis* Ryvkin, 1990**

Fig. 10, Suppl. material 1

Chorology. *Stenus araxis* was described from Armenia (Ryvkin 1990: 213) and already recorded for Iran (Schülke and Smetana 2015: 805), where it is distributed from the northwest throughout the Iranian highlands as far east as 53°13'E in North Khorasan and as far south as 29°06'N in Central Fars (Fig. 10). Particularly in the Zagros Mountains, we usually collected *S. araxis* in high abundance.

Biogeographical characterization. The distribution pattern of *Stenus araxis* definitely matches the Iranian glacial refuge.

***Stenus turk* Puthz, 1972**

Fig. 10, Suppl. material 1

Chorology. *Stenus turk* is recorded from Azerbaijan, Georgia, Ukraine, Turkey, Iran, and Central Asia. Both Iranian representatives of the *S. cordatus* species group, *S. araxis* and *S. turk*, reach their southern distributional limit in Iran and occur sympatrically in the Zagros and Elburz Mountains (Fig. 10). Recent Iranian records of *S. turk* were mostly collected in the Khorasan provinces in the northeast, which concurs with the wide distribution of this species in Central Asia.

Biogeographical characterization. Kastcheev and Puthz (2011: 454) described *Stenus turk* as Kazakhstan-Turanian species. Judging from its distribution pattern in Central Asia, this species represents the Turkestanian faunal element.

Stenus crassus* species group**Stenus crassus* Stephens, 1833**

Fig. 11, Suppl. material 1

Chorology. *Stenus crassus* is widely distributed across the temperate and northern West Palaearctic eastwards to Russia, Kazakhstan, and Mongolia (Kastcheev and Puthz 2011: 443). The species reaches its southernmost limit of distribution in the very north of western Iran (Fig. 11). In view of this distribution pattern, the record by Ghahari et al. (2009a: 1954) from Kaleybar in East Azarbaijan, which is the first record for Iran, can be correct.

Biogeographical characterization. The distribution pattern of *Stenus crassus* cannot be explained by the theory of Pleistocene refuges.

***Stenus formicetorum* Mannerheim, 1843**

Fig. 11, Suppl. material 1

Chorology. The Holarctic *Stenus formicetorum* is widely distributed in the temperate and northern Palaearctic as far east as Russian Far East and as far south as Afghanistan and northwestern Iran (Fig. 11).

Biogeographical characterization. The wide distribution in the northern and temperate Palaearctic cannot be attributed to a particular Pleistocene refuge.

Stenus fornicatus* species group**Stenus fornicatus* Stephens, 1833**

Fig. 11, Suppl. material 1

Chorology. Unlike other members of the *Stenus fornicatus* species group which are endemic to the eastern parts of the Palaearctic, *S. fornicatus* is widely distributed in the West Palaearctic including the Mediterranean and reaches East Siberia. In Iran, the species is hitherto

known from the Hyrcanian zone of the northern slopes of the South Caspian mountain ranges only (Fig. 11).

Biogeographical characterization. Due to the wide distribution of this species in the Mediterranean, Puthz (2012a: 288) considered *Stenus fornicatus* to be a Holo-mediterranean species. Here we follow this interpretation.

Stenus glacialis species group

Stenus armeniacus Puthz, 1967

Fig. 12, Suppl. material 1

Chorology. *Stenus armeniacus* was described from Yerevan, Armenia (Puthz 1967: 248), and later recorded from the Kopet Dag in Turkmenistan and the eastern Zagros Mountains (Arak) in Iran (Puthz 1973: 292). Only recently, Puthz (2012b: 153) published first records of this species from southern Turkey and revealed that the record from Turkmenistan is based on a misidentification. The record from Arak represents the southernmost collection site (Fig. 12). This species is rare and we didn't succeed in collecting it.

Biogeographical characterization. In view of the widely scattered localities in the Irano-Anatolian highlands we propose an Irano-Anatolian type of distribution for *Stenus armeniacus*.

Stenus hospes Erichson, 1840

Fig. 12, Suppl. material 1

Chorology. *Stenus hospes* is widely distributed in the Mediterranean Region from France and Italy across the Balkans as far east as Anatolia, the Levant, and Caucasia. The recent records from the Zagros Mountains (Fig. 12) constitute the first for the Iranian fauna and considerably extend the known distribution to the southeast.

Biogeographical characterization. Judging from its distribution pattern, *Stenus hospes* can be regarded as a Pontomediterranean species.

Stenus limicola Korge, 1967

Fig. 12, Suppl. material 1

Chorology. Described from the Erzincan Province in the east of Turkey (Korge 1967: 251), *Stenus limicola* was later recorded for Iran (Smetana 2004: 544) and the north of Iraq (Puthz 2010: 61). We collected *S. limicola* in the Zagros Mountains and Kerman (Fig. 12). The gap of records between eastern Turkey (Tunceli Province; Anlaş 2009: 280) and the Central Zagros Mountains most probably is a collecting artifact.

Biogeographical characterization. Owing to the sparse records of *Stenus limicola*, it is not possible to explain its Irano-Anatolian distribution pattern with de Latin's hypothesis.

Bionomics. Because descriptions of many species of the *Stenus glacialis* group were based on single specimens and the species never collected again, Assing (2003:711)

assumed they inhabit unknown subterranean habitats and are found only by chance. *Stenus limicola* seems to be restricted to high elevations. In Iran, we collected it between 2860 and 3000 m.

Stenus medus Puthz, 1981

Fig. 12, Suppl. material 1

Chorology. *Stenus medus*, described from Armenia, Azerbaijan, and northern Iran (Puthz 1981: 702), is widely distributed in Transcaucasia, Turkey, and northern and northwestern Iran between 44°00'E (Orumieh) and 53°00'E (Shahmirzad) (Fig. 12).

Biogeographical characterization. Due to its distribution in Transcaucasia and its high abundance in the Hyrcanian zone in the northern slopes of the Elburz Mountains, *Stenus medus* is a typical expansive Caspian faunal element.

Stenus parciior Bernhauer, 1929

Fig. 12, Suppl. material 1

Chorology. Unlike the other representatives of the *Stenus glacialis* species group in Iran, *S. parciior* is widely distributed throughout the Balkans, Anatolia, Cyprus, Lebanon, and Iran as far east as Uzbekistan. The record from Pol-e Dokhtar in the southwestern Zagros Mountains (Puthz 2008: 171) at less than 1000 m elevation constitutes the easternmost record of this species (Fig. 12).

Biogeographical characterization. The distribution of *Stenus parciior* in the eastern Mediterranean and the Middle East corresponds to the expansive Pontomediterranean faunal element.

Stenus persicus Puthz, 1981

Fig. 12, Suppl. material 1

Chorology. *Stenus persicus* seems to be endemic to Azerbaijan and western Iran (Fig. 12). Besides a find in the Ardabil Province, we repeatedly collected it in the Zagros Mountains from Kordestan southwards to northern Fars, usually in higher elevations and sympatrically with relatives of the *S. glacialis* species group such as *S. hospes* and *S. schah*.

Biogeographical characterization. Judging from the distribution pattern in the Zagros Mountains and Northwest Iran (Ardabil Province), *Stenus persicus* can be regarded as an Iranian faunal element.

Stenus schah Puthz, 1981

Fig. 12, Suppl. material 1

Chorology. As far as known presently, *Stenus schah* is endemic to Iran. The new records, which are the first after the description, revealed its wider distribution in the Zagros Mountains.

Biogeographical characterization. The distribution pattern in both the Zagros and Elburz Mountains (Fig. 12) exactly correspond to the Iranian glacial refuge, which is why *Stenus schah* is an Iranian faunal element.

Stenus guttula species group

Stenus erythrocnemus Eppelsheim, 1884

Fig. 13, Suppl. material 1

Chorology. *Stenus erythrocnemus* is a Middle Eastern species, which is distributed from Anatolia and Caucasica across the Iranian Plateau eastwards to Kyrgyzstan, Tadzhikistan, Afghanistan, and Pakistan. *Stenus erythrocnemus* has a vast distribution in the mountain ranges of Iran (Fig. 13).

Biogeographical characterization. Because the majority of records originated from the highlands of Iran (Assing 2005: 307), we consider *Stenus erythrocnemus* to be an expansive Iranian faunal element, which dispersed northwestwards to Anatolia and Caucasica and eastwards to Central Asia and the Hindu Kush.

Stenus maculiger Weise, 1875

Fig. 13, Suppl. material 1

Chorology. *Stenus maculiger* is widely distributed in the Northeast Mediterranean and eastern Europe eastwards to South Russia and Iran. The first records for Iran were published from Ghaemshahr in Mazandaran (Ghahari et al. 2009b: 1964) and Jangal-e Abr in the Semnan Province (Hadian et al. 2011: 4). However, we doubt these records, because we were unable to find this species in the South Caspian mountains. Our collections in Northwest Iran must be regarded as the first confirmed country records (Fig. 13). The locality in the Ardabil Province moreover constitutes the easternmost collecting site of the species.

Biogeographical characterization. Judging from the distribution pattern, *Stenus maculiger* belongs to the expansive Pontomediterranean faunal element.

Stenus hopffgarteni species group

Stenus fuscicornis Erichson, 1840

Fig. 14, Suppl. material 1

Chorology. *Stenus fuscicornis* is widely distributed throughout most of Europe and the Mediterranean including the Maghreb countries and Turkey. The first record for Iran was published by Puthz (2012a: 312). In Iran, we discovered the species in a relatively small area in the western Elburz and the Talish Mountains (Fig. 14). Unlike most members of the *S. hopffgarteni* species group which are European endemics, *S. fuscicornis* is the only representative of the species group in the Middle East.

In Iran, the species obviously reaches its eastern limit of distribution.

Biogeographical characterization. *Stenus fuscicornis* is a Holomediterranean species according to Puthz (2012a: 312).

Stenus humilis species group

Stenus callidus Baudi di Selve, 1848

Fig. 15, Suppl. material 1

Chorology. *Stenus callidus* exists in the Balkans, Caucasica, and the Middle East. According to Puthz (2008: 157), the record for Kyrgyzstan in Smetana (2004: 555), which was adopted by Schülke and Smetana (2015: 810), is based on a misidentification and probably refers to *S. cephalenicus*. *Stenus callidus* is the second widespread species of the genus (Fig. 15) in Iran. It was recorded in all of the northwest, in the northern Qohrud Range, and in the Elburz as far east as 53°38'E in eastern Mazandaran. Most frequently, however, it was collected in the Zagros Mountains. The records from southeastern Iran at about 56°E in the provinces of Hormozgan and Kerman considerably extend the range of this species towards east.

Biogeographical characterization. Due to its vast distribution in the eastern Mediterranean, Anatolia (Puthz 2008: 153), and Iran, *Stenus callidus* can be considered as an expansive Pontomediterranean species.

Stenus impressus species group

Stenus heinzianus Puthz, 1970

Fig. 16, Suppl. material 1

Chorology. *Stenus heinzianus* was described from Damash in Gilan, Iran (Puthz 1970a: 223), and subsequently recorded from Azerbaijan and Afghanistan. In Iran, it is abundant in the entire Hyrcanian zone from northern Gilan as far east as Golestan (Fig. 16).

Biogeographical characterization. Judging from this distribution pattern, *Stenus heinzianus* is an expansive Caspian faunal element.

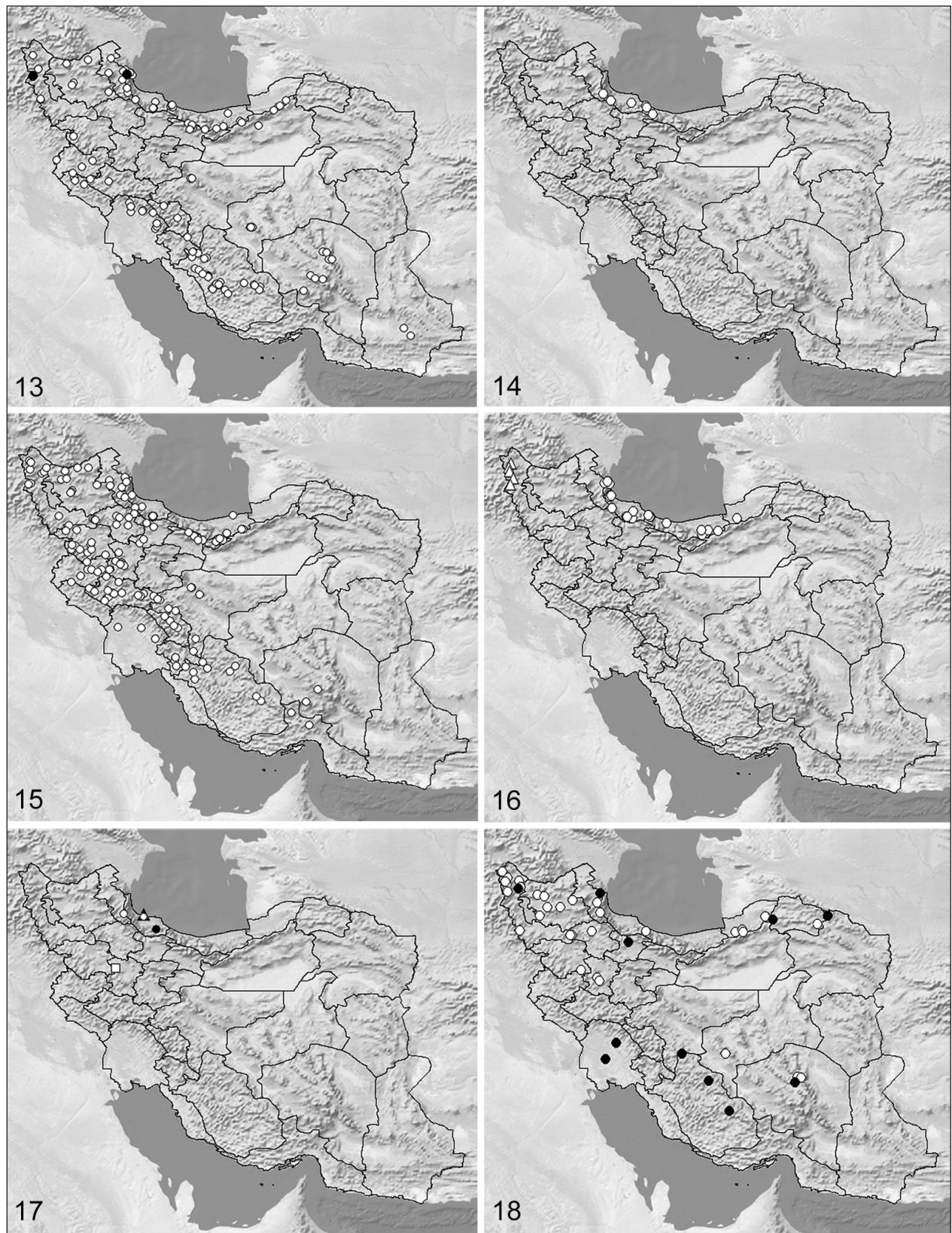
Stenus incanus species group

Stenus taurus Serri & Frisch, 2013

Fig. 16, Suppl. material 1

Chorology. *Stenus taurus* was described only recently from westerly facing slopes of mountain ranges close to the Turkish border in West Azarbaijan (Serri and Frisch 2013: 99–103; Fig. 16).

Biogeographical characterization. It is difficult to assign *Stenus taurus* to a particular distribution type, because its total distribution is still unknown. However, we expect it to be endemic to the Irano-Anatolian highlands.



Figures 13–18. Distribution of Steninae in Iran. **13.** *Stenus guttula* species group: ○ *S. erythrocnemus*, ● *S. maculiger*; **14.** *Stenus hopffgarteni* species group: ○ *S. fuscicornis*; **15.** *Stenus humilis* species group: ○ *S. callidus*; **16.** *Stenus impressus* and *S. incanus* species groups: ○ *S. heinzianus*, △ *S. taurus*; **17.** *Stenus latifrons* and *S. melanarius* species groups: ▲ *S. latifrons*, ○ *S. incrassatus*, □ *S. morio*, ● *S. peripherus*; **18.** *Stenus melanopus* species group: ○ *S. atratulus*, ● *S. piscator*.

***Stenus latifrons* species group**

The *Stenus latifrons* species group is here proposed for *S. latifrons* based on the deviant morphology of the paraglossae following a recommendation of V. Puthz (pers. comm., 2015).

***Stenus latifrons* Erichson, 1839**

Fig. 17, Suppl. material 1

Chorology. *Stenus latifrons* is widely distributed across Europe from the Balkans and Italy northwards to Scandinavia. Towards the east, the species reaches Turkey, Caucasasia, and Iran. A recent record from Kazakhstan (Kastcheev and Puthz 2011: 447) is based on a single female. In Iran, the species is known from the Caspian plain in Gilan (Fig. 17).

Biogeographical characterization. Kastcheev and Puthz (2011: 454) consider *Stenus latifrons* to be a Mediterranean species. In view of the absence in the western Mediterranean, we follow Puthz (2012a: 287) and attribute the species to the Pontomediterranean type of distribution.

Stenus melanarius* species group**Stenus incrassatus* Erichson, 1839**

Fig. 17, Suppl. material 1

Chorology. *Stenus incrassatus* is widely distributed in the northern and temperate Palaearctic from Ireland to China and Russian Far East. In Iran, we collected *S. incrassatus* only in the Talish Mountains (Fig. 17) from sea level up to 1850 m.

Biogeographical characterization. The vast range of the trans-Palaearctic species cannot be attributed to a particular Pleistocene refuge in the West Palaearctic and Middle East, respectively.

***Stenus morio* Gravenhorst, 1806**

Fig. 17, Suppl. material 1

Chorology. *Stenus morio* is a Holarctic species with a trans-Palaearctic distribution. The first records for Iran (West and East Azarbaijan) were published only recently by Ghahari et al. (2009b: 1964). However, we were not given the opportunity to see the underlying specimens. Like other members of the *S. melanarius* group, *S. morio* seems to be rare in Iran and restricted to the northwest of the country, because we collected it in the northern Zagros (Hamedan Province) only (Fig. 17).

Biogeographical characterization. The trans-Palaearctic distribution of *Stenus morio* can not be explained by particular Pleistocene refuges.

***Stenus peripherus* Korge, 1971**

Fig. 17, Suppl. material 1

Chorology. *Stenus peripherus* was described as a subspecies of *S. melanarius* from Turkey (Korge 1971: 24), but only recently raised to species rank by Puthz (2008: 149). The species is distributed in eastern Turkey, Armenia, and Iran, where it reaches its southernmost known limit of distribution in the southern Talish at 36°54'N, 49°59'E (Fig. 17).

Biogeographical characterization. The few localities hitherto known suggest an expanded Caspian distribution for *Stenus peripherus*.

Stenus melanopus* species group**Stenus atratulus* Erichson, 1839**

Fig. 18, Suppl. material 1

Chorology. The West Palaearctic *Stenus atratulus* is widely distributed throughout Europe, the Mediterranean including the Maghreb countries Algeria and Tunisia, and Turkey eastwards to Iran, where it is most abundant in the northwest (Fig. 18), from where it dispersed across the South Caspian mountains as far east as the Koppeh Dag at about 58°E in North Khorasan, the easternmost confirmed locality of the species. Interestingly, *S. atratulus* was not found in the Zagros Mountains south of Hamedan Province, but it occurs in the dryer Qohrud Range, where we recorded it at Shir Kuh and in the mountains of Kerman (Fig. 18).

Biogeographical characterization. Due to its Mediterranean distribution centre, we classify *Stenus atratulus* as a Holomediterranean species following Puthz (2012a: 78).

***Stenus piscator* Saulcy, 1864**

Fig. 18, Suppl. material 1

Chorology. *Stenus piscator* is distributed from the eastern Mediterranean (Turkey, Cyprus, Levant) across Anatolia and northern Mesopotamia as far north as Transcaucasia and eastwards to Iran and Turkmenistan. In Iran, the species has a disjunct distribution pattern (Fig. 18) and is recorded for the Talish, the Turkmeno-Khorasanian mountains, the southern Zagros, the plain of Khuzestan, and Kerman. *Stenus piscator* reaches its easternmost known locality in the Koppeh Dag at about 58°30'E.

Biogeographical characterization. The arched distribution pattern west, north, and east of Mesopotamia characterizes *Stenus piscator* as an expansive Syrian faunal element.

Stenus mendicus* species group**Stenus alienigenus* Puthz, 1964**

Fig. 19, Suppl. material 1

Chorology. Described as a subspecies of *Stenus mendicus* from Israel (Puthz 1964: 229), *S. alienigenus* is distributed in the Levant (Lebanon, Israel and Syria) and Iran, where it seems to be restricted to the northern Zagros Mountains (Fig. 19).

Biogeographical characterization. Due to its distribution in the arboreal regions west and east of the Mesopotamian plain, we consider *Stenus alienigenus* as a Syrian faunal element.

***Stenus ignotus* Eppelsheim, 1890**

Fig. 19, Suppl. material 1

Chorology. *Stenus ignotus* was described from the Talish Mountains near Lenkoran, Azerbaijan (Eppelsheim 1890: 226). Its area of distribution reaches from Italy and the Balkans over Anatolia, Syria, Iraq, Caucasia, and Iran eastwards to Central Asia. In Iran, *S. ignotus* is distributed in the very northwest, the northern Zagros Mountains, and the South Caspian mountains, where we recorded it as far east as about 53°30'E in eastern Mazandaran (Fig. 19).

Biogeographical characterization. Judging from the wide distribution in the northeastern Mediterranean, *Stenus ignotus* belongs to the Pontomediterranean type of distribution.

***Stenus orientis* Puthz, 1967**

Fig. 19, Suppl. material 1

Chorology. *Stenus orientis* is restricted to the Levant, Iraq, and western Iran, where it is recorded in the South Caspian mountains as far east as about 53°30'E (eastern Mazandaran) and in the Zagros Mountains southwards to 29°24'N (Central Fars) (Fig. 19).

Biogeographical characterization. Due to this arched distribution around the northern Mesopotamian plain, we consider *Stenus orientis* as a Syrian faunal element.

***Stenus ochropus-ludyi-coarcticollis* species group**

Biogeographical characterization. Except for *Stenus ochropus*, the Iranian species of the *S. ochropus* – *ludyi* – *coarcticollis* species group are endemic to the Hyrcanian forest zone, the South Caspian subunit of the Caspian glacial refuge (Fig. 20). Their vertical distribution concurs with that forest zone, where they were found from the Caspian plain up to about 1500 m in the mountains. Thus, these species represent the Hyrcanian faunal element within the Caspian type of distribution sensu De Lattin (1951: 208–210, 1957: 388, 1967: 322).

***Stenus barbarae* Hromadka, 1979**

Fig. 20, Suppl. material 1

Chorology. *Stenus barbarae* was described from the Talish Mountains in Gilan, Iran (Hromadka 1979: 183). The new record close to the type locality is the first after the description. As far as known presently, *S. barbarae* is endemic to some north-facing valleys in the southern Talish at about 37°N, 49°E (Fig. 20).

***Stenus confrater* Eppelsheim, 1890**

Fig. 20, Suppl. material 1

Chorology. *Stenus confrater* is endemic to the northern Talish Mountains in Iran and Azerbaijan (Fig. 20). In Gilan, it was collected at an elevation of 30 m only in the foothills of the Talish Mountains. In higher elevations, the species seems to be replaced by its close relatives *S. barbarae* and *S. darius*.

***Stenus darius* Puthz, 2009**

Fig. 20, Suppl. material 1

Chorology. As far as known presently, *Stenus darius* is endemic to the northeast-facing freshwater system of the Masuleh Valley in the southern Talish Mountains at about 37°N, 49°E (Fig. 20).

***Stenus derwisch* Puthz, 1981**

Fig. 20, Suppl. material 1

Chorology. *Stenus derwisch* is a Hyrcanian endemic, which is comparatively widespread in the South Caspian mountains (Fig. 20). The species is hitherto recorded from the very north of Gilan at 38°13'N, 48°53'E (As-tara) eastwards to Central Mazandaran at about 52°20'E (Amol).

***Stenus guilanensis* Puthz, 1979**

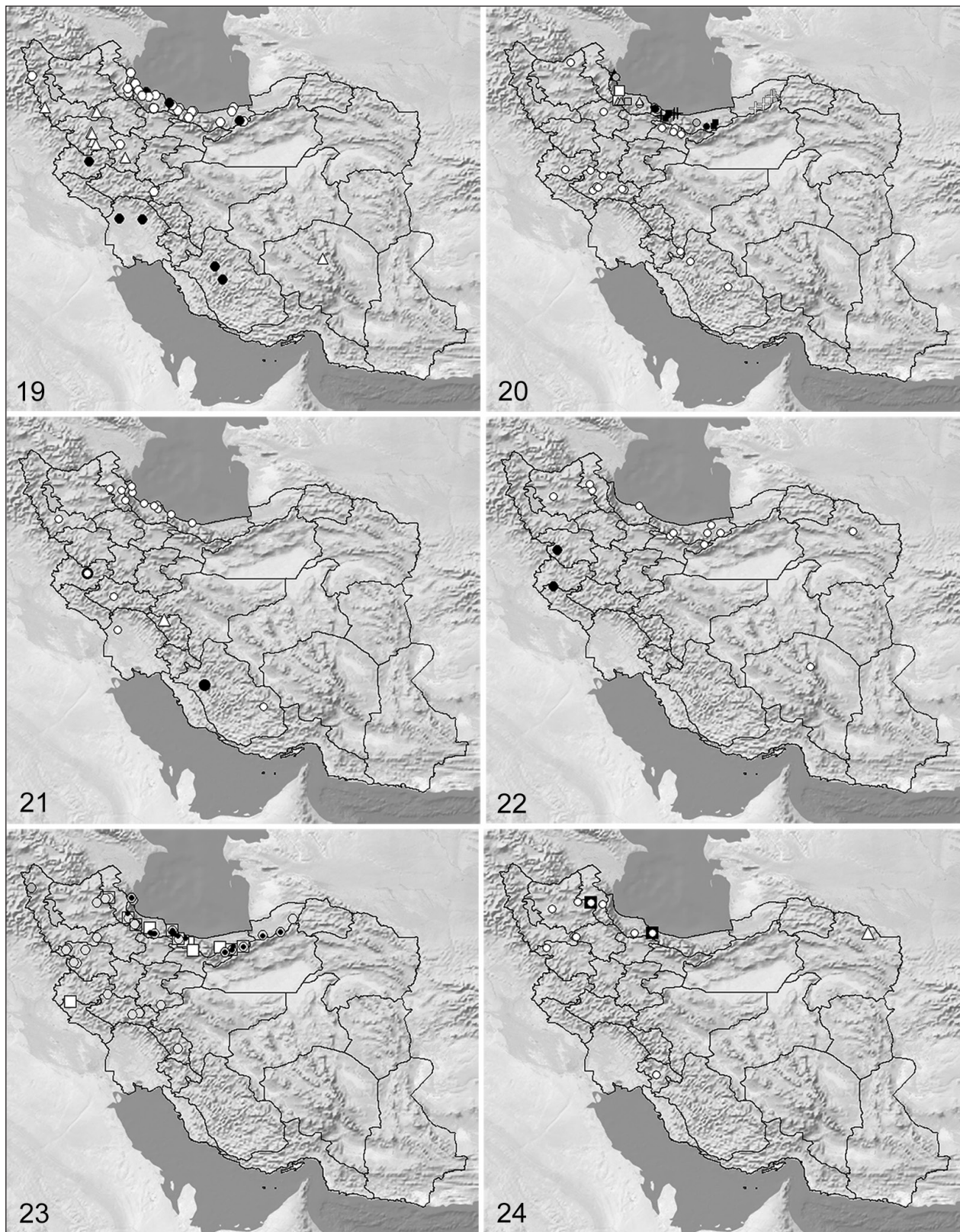
Fig. 20, Suppl. material 1

Chorology. *Stenus guilanensis* was described from Lahijan, Gilan (Puthz 1979: 57). The Hyrcanian endemic is hitherto known only from the type locality in the north-westernmost foothills of the Elburz (Fig. 20).

***Stenus kambyes* Puthz, 2009**

Fig. 20, Suppl. material 1

Chorology. *Stenus kambyes* is presently known only from the type locality in the southernmost Talish Mountains, Gilan (Fig. 20), and certainly endemic to the Hyrcanian district.



Figures 19–24. Distribution of Steninae in Iran. 19. *Stenus mendicus* species group: \triangle *S. alienigenus*, \circ *S. ignotus*, \bullet *S. orientis*; 20. *Stenus ochropus-ludyi-coarcticollis* species group: \blacksquare *S. barbarae*, \blacktriangle *S. confrater*, \triangle *S. darius*, \bullet *S. derwisch*, \triangle *S. guilanensis*, \blacksquare *S. kambyes*, \bullet *S. martensi*, \circ *S. ochropus*, \blacksquare *S. pieperi*, $+$ *S. resili*, \oplus *S. wittmeri*; 21. *Stenus pallitarsis* species group: \bullet *S. arabicus*, \triangle *S. butrintensis*, \circ *S. claritarsis*; 22. *Stenus picipes* species group: \circ *S. ganglbaueri*, \bullet *S. picipes*; 23. *Stenus pusillus* species group: \blacksquare *S. lenkoranus*, \bullet *S. machulkai*, \bullet *S. viti*; 24. *Stenus similis* species group: \triangle *S. bernhauerianus*, \blacksquare *S. cicindeloides*, \circ *S. similis*.

***Stenus martensi* Puthz, 1983**

Fig. 20, Suppl. material 1

Chorology. Including the new records from western Mazandaran, the first after the description, *Stenus martensi* is endemic to the Hyrcanian forest zone of the Elburz, where it was collected between 50°34'E (Ram-sar) and 52°49'E (Alasht) in altitudes up to 1450 m (Fig. 20).

***Stenus ochropus* Kiesenwetter, 1858**

Fig. 20, Suppl. material 1

Chorology. *Stenus ochropus* is the most widespread member of the *ochropus-ludyi-coarcticollis* species group. The West Palaearctic species is distributed from Europe, except for the Iberian Peninsula, as far east as Central Asia including Anatolia, the Levant, Caucasasia, and Iran, where it is recorded from the northwest as far east as Tehran and southwards to 29°09'N in Fars (Fig. 20).

Biogeographical characterization. Judging from its wide distribution in the northeastern Mediterranean, we follow Puthz (2012a: 313), who classified *Stenus ochropus* as an expansive Pontomediterranean species.

***Stenus pieperi* Puthz, 1983**

Fig. 20, Suppl. material 1

Chorology. *Stenus pieperi* was described from Alamdeh, West Mazandaran (Puthz 1983: 353). Our recent records further east, which are the first after the description, indicate that the species is endemic to the Hyrcanian forest zone of the Elburz Mountains from about 50°30'E eastwards to about 53°10'E (Fig. 20).

***Stenus resslı* Puthz, 1979**

Fig. 20, Suppl. material 1

Chorology. *Stenus resslı* was described from the northern foothills of the Elburz in the Caspian plain south and east of Chalus (Puthz 1979: 54). We rediscovered it somewhat further to the west south of Tonekabon. Seemingly, *S. resslı* is endemic to a small area in the Hyrcanian forest belt of western Mazandaran (Fig. 20).

***Stenus wittmeri* Puthz, 1972**

Fig. 20, Suppl. material 1

Chorology. *Stenus wittmeri*, described from Minudasht, Golestan (Puthz 1972a: 123), is the easternmost representative of the *S. ochropus-ludyi-coarcticollis* species group in Iran. The species is endemic to the Hyrcanian forest belt of the eastern Elburz (Fig. 20).

Stenus pallitarsis* species group**Stenus arabicus* Sauley, 1864**

Fig. 21, Suppl. material 1

Chorology. The Middle Eastern *Stenus arabicus* is recorded from Lebanon, Israel, Jordan, Syria, Turkey, and Iran as far north as Armenia. The record from China in Smetana (2004: 552), which was repeated by Schülke and Smetana (2015: 805), is a lapsus (V. Puthz, pers. comm.). We collected the species in two widely separate localities in the Zagros Mountains (Fig. 21).

Biogeographical characterization. Due to its arched distribution in arboreal regions around northern Mesopotamia, *Stenus arabicus* can be considered as a Syrian faunal element.

***Stenus butrintensis* Smetana, 1959**

Fig. 21, Suppl. material 1

Chorology. The West Palaearctic *Stenus butrintensis* was previously known from western Europe as far east as Turkey. The record for Spain in Smetana (2004: 552), adopted by Schülke and Smetana (2015: 810), is a lapsus (Puthz 2012a: 310). The first record of *S. butrintensis* for Iran in the Central Zagros considerably extends the known limit of distribution to the southeast (Fig. 21).

Biogeographical characterization. Due to its wide distribution in the northeastern Mediterranean, we adopt Puthz' (2012a: 310) classification as a Pontomediterranean species.

***Stenus claritarsis* Puthz, 1971**

Fig. 21, Suppl. material 1

Chorology. Described from Lenkoran, Azerbaijan (Puthz 1971: 100), *Stenus claritarsis* is distributed from eastern Europe (Austria, northern Balkans, Ukraine, South Russia) across Caucasasia and Iran eastwards to Central Asia. In Iran, the species is widespread in the South Caspian mountains, where we collected it as far east as 51°29'E in western Mazandaran and in the Zagros Mountains southwards to 28°45'N in southeastern Fars. It was also found in the plain of Khuzestan (Fig. 21).

Biogeographical characterization. Puthz (2012a: 312) proposed a Ponto-Mediterranean distribution for *Stenus claritarsis*, which is unlikely in view of the lack of records in all of the eastern Mediterranean. The distribution across Transcaucasia and the South Caspian mountains points to an expansive Caspian faunal element.

Stenus picipes* species group**Stenus ganglbaueri* Bernhauer, 1905**

Fig. 22, Suppl. material 1

Chorology. *Stenus ganglbaueri* is distributed from Italy and the Balkans across Ukraine, Anatolia, the Levant, Syria, Caucasia, and Iran eastwards to Turkmenistan. The species is widespread in northern Iran as far east as the Binalud Mountains (Fig. 22), but a find in Kerman Province, which considerably extends the known range of *S. ganglbaueri* to the south, suggests a much wider distribution in the western Iranian Plateau.

Biogeographical characterization. Due to its distribution in the southeastern Mediterranean, we consider *Stenus ganglbaueri* to be a Pontomediterranean faunal element.

***Stenus picipes* Stephens, 1833**

Fig. 22, Suppl. material 1

Chorology. *Stenus picipes* is widespread in the temperate West Palaearctic as far east as western Russia, Anatolia, the Levant (Lebanon, Jordan, Syria), and Iran. The records from the northwestern Zagros Mountains (Puthz 2010: 61), the first for Iran, mark the southeastern distributional limit of this species (Fig. 22). The specimens from Iran belong to the type form *S. p. picipes*, which differs from *S. p. brevipennis* Thomson, 1851 by broader elytra with well developed humeral angels. These sympatric morphs are formally treated as subspecies in recent catalogues (Schülke and Smetana 2015: 835, 836) and key books (Puthz 2012a: 309).

Biogeographical characterization. The wide area of distribution of *Stenus picipes* can not be attributed to particular Pleistocene refugia of the arboreal, which is why no biogeographical assigning is possible for this West Palaearctic species.

Stenus pusillus* species group**Stenus lenkoranus* Puthz, 1970**

Fig. 23, Suppl. material 1

Chorology. *Stenus lenkoranus* was described as a subspecies of *S. nanus* Stephens, 1833 (Puthz 1970b: 211), but later raised to species rank (Ryvkin 1990: 158). The species is hitherto known from Azerbaijan and Iran only. The first records for Iran originate from the South Caspian mountains, Mt Sabalan in West Azarbaijan, and the northwestern Zagros in Ilam (Fig. 23).

Biogeographical characterization. We propose an expansive Caspian distribution for *Stenus lenkoranus*.

***Stenus machulkai* Hromadka, 1977**

Fig. 23, Suppl. material 1

Chorology. *Stenus machulkai*, described from the Araxes Valley (Hromadka 1977: 4), is known from Caucasia (Azerbaijan, Armenia, Georgia), Lebanon, Turkey, and Iran. The species is widely distributed in the northwest of the country, the northern and central Zagros, and the South Caspian mountains, where it is recorded as far east as 55°46'E (Fig. 23).

Biogeographical characterization. Judging from its existence in the northeastern Mediterranean, *Stenus machulkai* can be attributed to the Pontomediterranean type of distribution.

***Stenus viti* Puthz, 1977**

Fig. 23, Suppl. material 1

Chorology. *Stenus viti*, endemic to the northern slopes of the South Caspian mountains and presently known from Iran only, is recorded from northern Gilan at 48°49'E (Astara) throughout Mazandaran eastwards to Golestan at 55°14'E (Ramian) (Fig. 23).

Biogeographical characterization. This species is a Hyrcanian faunal element sensu De Lattin (1951: 208–210, 1957: 388, 1967: 322).

Stenus similis* species group**Stenus bernhauerianus* Jakobson, 1909**

Fig. 24, Suppl. material 1

Chorology. Described from Aulie Ata (Taraz) in southern Kazakhstan, the Central Asian *Stenus bernhauerianus* was also recorded from Kyrgyzstan and the Koppeh-Dagh (Fig. 24) in the northeast of Iran (Puthz 2010: 60).

Biogeographical characterization. Due to its distribution pattern, this rare species can be regarded as a Turkestanian faunal element.

***Stenus cicindeloides* Schaller, 1783**

Fig. 24, Suppl. material 1

Chorology. The Euro-Siberian *Stenus cicindeloides* has a trans-Palaearctic distribution from the British Isles east to Japan. The species is here for the first time reported for Iran from Ardabil and Mazandaran in the northwest of the country (Fig. 24).

Biogeographical characterization. It is not possible to assign the distribution pattern of *Stenus cicindeloides* to any of de Lattin's (1951, 1957, 1967) southern Palaearctic glacial refuges.

***Stenus similis* Herbst, 1784**

Fig. 24, Suppl. material 1

Chorology. *Stenus similis* is widely distributed throughout the West Palaearctic eastwards to Kazakhstan and Mongolia. The species exists in northwestern Iran and was recorded as far south as 30°44'N in the Zagros Mountains (Fig. 24).

Biogeographical characterization. Judging from the existence in all of the arboreal Mediterranean, *Stenus similis* belongs to the Holomediterranean type of distribution.

Dubious and erroneous records of *Stenus* species from Iran

The following *Stenus* species were for the first time reported for Iran by Ghahari et al. (2009 a, b, c), Hadian et al. (2011), Sakenin et al. (2008, 2010), and Samin et al. (2011a, b, c). Below we discuss the plausibility of these records, because we were not given the opportunity to examine the reference specimens. Therefore we don't accept these species as members of the Iranian fauna and did not include them in the biogeographical analysis below. All of these dubious records require confirmation by the examination of the reference specimens considering the obvious misidentifications of Iranian *Scopaeus* species in these works (see Anlaş and Frisch 2014: 159, 160, 164, 165; Frisch 2010: 184, 194, 199).

***Stenus aceris* Stephens, 1833**

Records. East Azarbaijan: Arasbaran, 8.2005 (Samin et al. 2011a: 2). **West Azarbaijan:** Maku, 9.2007 (Samin et al. 2011c: 1238).

Remarks. The distribution of the widespread Holomediterranean *Stenus aceris* is confirmed as far east as Cyprus, Lebanon, and Turkey. The existence in northwestern Iran is doubtful.

***Stenus assequens assequens* Rey, 1884**

Record. Gilan (Samin et al. 2011 b: 140).

Remarks. The Palaearctic distribution of the Holarctic *Stenus a. assequens* reaches from Western Europe and the arboreal North Africa eastwards to the Russian Far East and China. Puthz (1977: 111) wrote that he received a single female from Nav Valley, Gilan, but this record was not adopted by Schülke and Smetana (2015: 806). Owing to the existence of *S. a. assequens* in Caucasus, Turkey, and Central Asia, the above record for Gilan could be correct.

***Stenus binotatus* Ljungh, 1804**

Records. West Azarbaijan: Mahabad, 9.2003 (Ghahari et al. 2009a: 3). **Semnan:** Jangal-e Abr, 4.-5.2011 (Hadian et al. 2011: 3).

Remarks. *Stenus binotatus* is widely distributed across the Palaearctic from the British Isles to East Sibe-

ria. According to Kastscheev and Puthz (2011: 440), the record for Kazakhstan in Smetana (2004: 552), which was not repeated by Schülke and Smetana (2015: 808), is based on a misidentification. In view of the distribution in Caucasus and Turkey, the existence of *S. binotatus* in Iran is conceivable.

***Stenus circularis* Gravenhorst, 1802**

Records. Golestan: Kordkoy, 6.2005 (Ghahari et al. 2009b: 1964). **Semnan:** Shahrud, 4.2009 (Hadian et al. 2011: 4).

Remarks. *Stenus circularis* is widely distributed throughout Europe and western Asia as far east as Turkey, Caucasus, West Siberia, and Central Asia. In view of this West Palaearctic distribution pattern the above records could be correct.

***Stenus cordatoides* Puthz, 1972**

Remarks. Samin et al. (2011b: 141) erroneously misinterpreted Puthz (1972a: 125, 1972b: 280), who mentioned "*Stenus cordatoides* variant A" from Esfahan Province, which the same author later described as *S. turk* (Puthz 1972: 178). Therefore the Pontomediterranean *S. cordatoides*, which is distributed in the Balkans, Turkey, and the Levant, does not belong to the Iranian fauna. Schülke and Smetana (2015: 813) do not cite the species for Iran.

***Stenus cyaneus* Baudi di Selve, 1848**

Record. East Azarbaijan: Arasbaran (Sakenin et al. 2008).

Remarks. *Stenus cyaneus* is distributed in Lebanon, Israel, Jordan, Syria, and Turkey. Sakenin et al. (2008) recorded the species for Iran as *S. glacialis cyaneus*, because until recently it was considered as a subspecies of the Central and Southeast European *S. glacialis* Heer, 1839. The existence of *S. cyaneus* in Iran is conceivable.

***Stenus guttula* P. Müller 1821**

Record. Sistan & Baluchestan (Samin et al. 2011b: 141).

Remarks. This record was adopted from Scheerpeltz (1961: 4), though it already turned out to be based on a misidentification (Herman 2001: 2208). Consequently, the Holomediterranean *S. guttula*, which is widely distributed in Europe and the Mediterranean, but also recorded for Egypt (Sinai) and Yemen, does not exist in Iran.

***Stenus melanarius melanarius* Stephens, 1833**

Remarks. Samin et al. (2011b: 141) cited *Stenus m. melanarius* for Iran referring to the catalogues of Herman (2001: 2276) and Smetana (2004: 559). The underlying specimens represent *S. peripherus* Korge, 1971 (Puthz, pers. comm.). Thus, the trans-Palaearctic *S. melanarius* is not yet recorded for the fauna of Iran. This erroneous record is, however, cited by Schülke and Smetana (2015: 828) again.

***Stenus melanopus* Marsham, 1802**

Records. **Razavi Khorasan:** Mashad, 3.2006 (Samin et al. 2011c: 1238). **South Khorasan:** Birjand, 6.2001 (Samin et al. 2011a: 3).

Remarks. The Holarctic *Stenus melanopus* is widely distributed throughout the western Palaearctic eastwards to China. The cited records from Northeast Iran are dubious as well as an old record from “Perse méridionale” (Fauvel 1873: 256), because, except for Turkey, the species is unknown from the Middle East and Central Asia.

***Stenus paludicola* Kiesenwetter, 1858**

Records. **Ardabil:** Ardabil, 6.2004 (Ghahari et al. 2009a: 1954). **Semnan:** Shahrud, 11.2010 (Hadian et al. 2011: 4).

Remarks. The area of distribution of the Pontomediterranean *Stenus paludicola* stretches over the Balkans, Anatolia, and the Levant. The existence in northwestern Iran is imaginable.

***Stenus pallitarsis* Stephens, 1833**

Records. **Gilan:** Rasht (Jarrige 1971: 498; cited by Samin et al. 2011b: 142).

Remarks. The area of distribution of *Stenus pallitarsis* stretches over the arboreal Palaearctic eastwards to East Siberia and China. In view of the distribution in Caucasia, Turkey, and Central Asia, the existence in Iran is conceivable.

***Stenus picipennis* Erichson, 1840**

Record. **Iran** (Schülke and Smetana 2015: 835).

Remarks. *Stenus picipennis* is widely distributed in Europe and the Mediterranean, but unknown from Turkey, the Levant, and Caucasia. In view of this distribution pattern the record for Iran in the current edition of the Catalogue of Palaearctic Coleoptera far east of the area of distribution of *S. picipennis* appears doubtful. The underlying reference for this country record, which was not yet cited in the first edition of the catalogue (Smetana 2004: 552), is unknown to us.

***Stenus planifrons planifrons* Rey, 1884**

Record. **Semnan** (Sakenin et al. 2010: 13).

Remarks. The nominotypical form of *Stenus planifrons* has a Pontomediterranean distribution in south-eastern Europe and Turkey. Considering the allopatry of subspecies, the record from Semnan is implausible, because the collecting site is situated deeply within the area of distribution of *S. planifrons robustus* in northwestern Iran and the South Caspian mountains (Fig. 7).

***Stenus pseudofossulatus* Scheerpeltz, 1960**

Record. **East Azarbaijan:** Arasbaran (Sakenin et al. 2008).

Remarks. This species was described from Afghanistan (Scheerpeltz 1960: 74) and since then never recorded again. Its existence in East Azarbaijan is doubtful.

***Stenus pusillus* Stephens, 1833**

Records. **Esfahan:** Lenjan, 8.2000 (Ghahari et al. 2009b: 1964). **Semnan:** Garmsar, 3.2011 (Hadian et al. 2011: 4).

Remarks. *Stenus pusillus* is widely distributed across Europe and the arboreal North Africa (Morocco). As the species was never recorded for western Asia and the Middle East, respectively, the presence in Iran is implausible.

***Stenus solutus* Erichson, 1840**

Records. **Fars:** Kazerun, 10.2002 (Samin et al. 2011a: 3); Shiraz, 5.2008 (Samin et al. 2011c: 1238).

Remarks. The area of distribution of the West Palaearctic *Stenus solutus* stretches from the British Isles as far east as Anatolia and Azerbaijan. Its existence in South Iran is doubtful.

***Stenus stigmula* Erichson, 1840**

Records. **East Azarbaijan:** Kaleybar, 8.2006 (Ghahari et al. 2009a: 1954). **Semnan:** Jangal-e Abr, 4.2011 (Hadian et al. 2011).

Remarks. In view of the confirmed distribution of the Pontomediterranean *Stenus stigmula* in Turkey and Transcaucasia, the records from northwestern Iran are plausible.

***Stenus subaeneus* Erichson, 1840**

Records. **Ardabil:** Meshkinshahr, 6.2007 (Samin et al. 2011c: 1238). **East Azarbaijan:** Arasbaran, 8.2005 (Samin et al. 2011a: 3).

Remarks. *Stenus subaeneus* is widely distributed throughout the arboreal Mediterranean and Europe as far east as Lebanon, Syria, and Turkey. The records from northwestern Iran are questionable.

***Stenus turbulentus* Bondroit, 1912**

Records. **Semnan** (Sakenin et al. 2010).

Remarks. *Stenus turbulentus* has a restricted distribution in Greece, Turkey, Cyprus, and Israel. The existence of this species in North Iran is doubtful.

***Stenus umbricus* Baudi di Selve, 1870**

Records. **Khuzestan:** Ahvaz, 4.2007 (Samin et al. 2011c: 1238); Dezful, 5.2003 (Samin et al. 2011a: 3).

Remarks: In view of the restricted distribution of *Stenus umbricus* in France (Corse), Switzerland, and Italy, the record from Khuzestan is certainly based on a misidentification and here rejected.

Table 1. Faunal elements of the subfamily Steninae and genus *Scopaeus* in Iran with species numbers and percentage of species in each group.

Steninae			Scopaeus		
faunal element	species number	%	faunal element	species number	%
Pontomediterranean	14	20.29	Iranian	10	33.33
Hyrcanian	11	15.94	Irano-Anatolian	5	16.67
Caspian	7	10.14	Syrian	3	10
Holomediterranean	6	8.69	Holomediterranean	2	6.67
Syrian	6	8.69	Pontomediterranean	2	6.67
Trans-Palaeartic	5	7.25	Caspian	2	6.67
Turkestanian	5	7.25	Hyrcanian	2	6.67
Iranian	4	5.80	Trans-Palaeartic	1	3.33
Holarctic	4	5.80	Palaeotropic	1	3.33
Irano-Anatolian	4	5.80	South Iranian	1	3.33
West Palaeartic	3	4.35	Sindian	1	3.33
Palaeotropic	0	0	West Palaeartic	0	0
Sindian	0	0	Holarctic	0	0
South Iranian	0	0	Turkestanian	0	0
Species number	69	100	Species number	30	100

2. Biogeographical analysis of the *Stenus* and *Scopaeus* fauna of Iran

As a result of this study, a total of 69 species of Steninae is recorded for Iran, the following of which represent new country records: *Dianous coerulescens korgei*, *Stenus bicornis*, *S. butrintensis*, *S. cicindeloides*, *S. c. comma*, and *S. hospes*.

As shown in Table 1, the distribution of 76.8% of the Iranian Steninae species can be interpreted by the glacial refuge hypothesis (28.98% faunal elements of polycentric Holomediterranean glacial refuge, 26.08% of Caspian refuge including Hyrcanian subregion, 8.7% of Syrian refuge, 7.25% of Turkestanian refuge and 5.8% of Iranian refuge). The Irano-Anatolian type of distribution comprises 5.8% of the species. About 17.4% of the Steninae of Iran are more widely distributed and show West Palaeartic, trans-Palaeartic, and Holarctic distribution pattern. Almost the same percentage (73%) of the *Scopaeus* species in Iran shows a distribution pattern which is in accord with the glacial refuge theory: 33% are faunal elements of the Iranian glacial refuge, 13% elements of the Holomediterranean refuge, 13% Caspian elements, 10% Syrian elements and 3.3% Sindian faunal elements. The distribution pattern of 26% of the *Scopaeus* known to occur in Iran cannot be interpreted by the glacial refuge hypothesis, 17% of which are endemic to restricted areas within the Irano-Anatolian highlands.

The results obtained from the biogeographical analysis of the distributional pattern of the subfamily Steninae in Iran are shown in Tables 2, 3 and Fig. 25. No records of *Stenus* were available from the arid plains of the Iranian highlands and North Baluchestan. From the 69 species included in the data matrix, 40 species (57.97%) occur in the Caspian wet forest region. This area in the Caspian

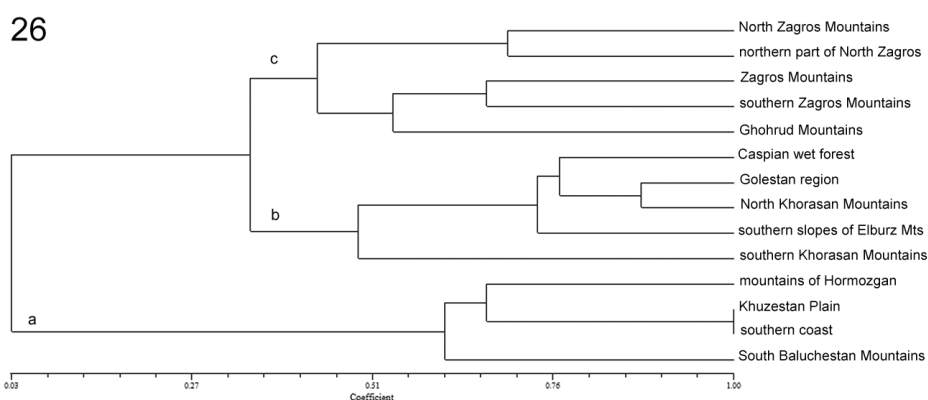
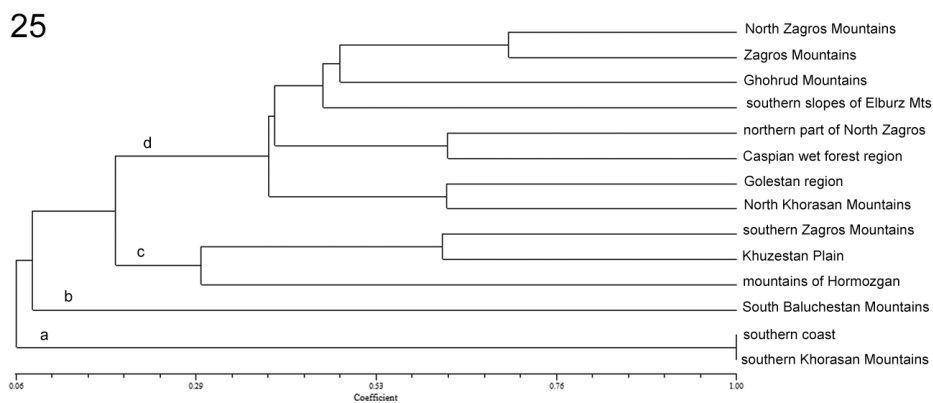
plain and the adjacent forest zone of the northern slopes of the Elburz and Talish Mountains, which is known as the Hyrcanian district of the Hyrcano-Euxine subregion of the Euro-Siberian temperate forest belt, bears the highest diversity of *Stenus* species in Iran including eleven endemics. De Lattin (1951: 208–211, 1957: 388, 1967: 322) considered this region as the eastern part of the Caspian glacial refuge in the Pleistocene. With 35 species, the northern part of the Northwest Iranian mountain region (NNW) is the second speciose region (Table 2). This area mainly matches the Iranian part of the Lesser Caucasus. The valleys and northeastern mountain slopes in this area constitute the Caucasian part of the Caspian glacial refuge proposed by de Lattin (1951, 1957). The least speciose region is the coast of the Persian Gulf and the Oman Sea in South Iran. As shown in Fig. 25, the low similarity among the northern and southern regions suggests the relative isolation and independency of their faunas. The analysis yields four different biogeographical clades (Fig. 25).

The clade a “southern Coast + South Khorasan region” is, however, likely to be an artifact, because the close similarity between these regions is caused by only one common species, *S. turk*, and not by a joint biogeographical history or habitat resemblance.

South Baluchestan, clade b, comprises *S. erythronemus* only. It is an outlier to the clusters with higher species numbers. Considering the arid character of this region, the existence of a rich *Stenus* fauna in South Baluchestan is not probable. Obviously, the diversity of the Steninae in Iran decreases considerably towards the eremial south and southeast owing to the increase of aridity and salinity of freshwater ecosystems.

The clade c comprises the mountains of Hormozgan, the southern Zagros Mountains in Fars, and the Khuzestan Plain with a total of nine species (13%). Southern Zagros Mountains and Khuzestan Plain show a high similarity (about 60%) with Hormozgan as an outlier with less similarity to them. It seems that appropriate habitats for *Stenus* species diminish towards the east and south, because the number of permanent water bodies decreases and their salinity rises.

The northern clade, d, constitutes the largest cluster of biogeographical regions of Iran. It comprises the northern, western, and central parts of the country, which reveal the least similarity with the southern clusters. It is made up of two sister clades. The first consists of Golestan and North Khorasan with 20 species and about 60% similarity. The next comprises the central and northern Zagros (37 species) with the Ghohrud Mountains and the southern Elburz as outliers with 40 species and is the sister clade to the other, which includes the Hyrcanian (Caspian) wet forest region of the Talish and the Elburz Mountains and the northwestern part of the Iranian mountain ranges with 52 species (about 75% of the Iranian Steninae). This significantly higher diversity impressively reflects the strong impact of the Pleistocene refuges proposed for these regions by de Lattin (1957, 1967). Before we conducted the cluster analysis, we suspected that the species composition of the



Figures 25–26. Cladograms of Dice similarity values between geographical subdivisions of Iran. An average linkage cluster analysis (UPGMA) was used to test cluster similarities. Different clades are indicated by small letters. **25.** Steninae fauna; **26.** *Scopaeus* fauna.

Table 2. Qualitative listing of Steninae species collected in Iran. See Material and methods section for abbreviations of the geographical subdivisions.

Species/ Regions	NZ	NNW	C	G	SE	NKh	Z	SZ	Gh	Hm	SB	Khu	SC	SKh
<i>Stenus aereus</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. affaber</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. alienigenus</i>	1	0	0	0	0	0	1	0	1	0	0	0	0	0
<i>S. arabicus</i>	0	0	0	0	0	0	1	1	0	0	0	0	0	0
<i>S. araxis</i>	1	1	0	1	1	1	1	1	1	0	0	0	0	0
<i>S. armeniacus</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. asiaticus</i>	1	1	1	1	0	1	0	0	0	0	0	0	0	0
<i>S. ater</i>	1	1	1	1	0	1	0	0	0	0	0	0	0	0
<i>S. atratulus</i>	1	1	1	1	0	1	1	0	1	0	0	0	0	0
<i>S. barbarae</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. bernhauerianus</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>S. bicornis</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. biguttatus</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. brunripes</i>	0	0	1	1	0	1	0	0	0	0	0	0	0	0
<i>S. butrintensis</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. callidus</i>	1	1	1	0	1	0	1	1	1	1	0	1	0	0
<i>S. canaliculatus</i>	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. caspius</i>	1	1	1	1	0	1	0	0	0	0	0	0	0	0
<i>S. cautus</i>	1	1	1	0	0	0	1	0	1	0	0	0	0	0
<i>S. cicindeloides</i>	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. claritarsis</i>	1	1	1	0	0	0	1	1	0	0	0	1	0	0

Species/ Regions	NZ	NNW	C	G	SE	NKh	Z	SZ	Gh	Hm	SB	Khu	SC	SKh
<i>S. comma comma</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. confrater</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. crassus</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. darius</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. derwisch</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. erythrocnemus</i>	1	1	1	1	1	0	1	1	1	0	1	0	0	0
<i>S. formicetorum</i>	1	1	1	0	0	0	1	0	0	0	0	0	0	0
<i>S. formicatus</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. fuscicornis</i>	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. ganglbaueri</i>	0	1	1	0	1	1	0	0	1	0	0	0	0	0
<i>S. guilanensis</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. heinzianus</i>	0	1	1	1	0	0	0	0	0	0	0	0	0	0
<i>S. hospes</i>	1	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. hypoproditor</i>	1	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. ignotus</i>	0	1	1	0	0	0	1	0	0	0	0	0	0	0
<i>S. incrassatus</i>	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. intricatus zoufali</i>	1	1	1	1	0	1	1	0	1	0	0	0	0	0
<i>S. kambyzes</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. latifrons</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. lenkoranus</i>	0	1	1	0	1	0	1	0	0	0	0	0	0	0
<i>S. limicola</i>	0	0	0	0	0	0	1	0	1	0	0	0	0	0
<i>S. machulkai</i>	1	1	1	1	0	0	1	0	0	0	0	0	0	0
<i>S. maculiger</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. martensi</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. medus</i>	1	1	1	1	1	0	0	0	0	0	0	0	0	0
<i>S. mongolicus</i>	0	0	1	1	1	1	0	0	0	0	0	0	0	0
<i>S. morio</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. nodipes</i>	1	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. ochropus</i>	1	1	0	0	1	0	1	1	0	0	0	0	0	0
<i>S. orientis</i>	0	0	1	0	0	0	1	1	0	0	0	1	0	0
<i>S. parciar</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. peripherus</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. persicus</i>	1	1	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. picipes</i>	1	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. pieperi</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. piscator</i>	1	0	0	0	1	1	1	1	1	0	0	1	0	0
<i>S. planifrons robustus</i>	1	1	1	0	1	1	1	1	0	0	0	0	0	0
<i>S. proprius</i>	1	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>S. providus providus</i>	1	1	1	0	1	0	0	0	0	0	0	0	0	0
<i>S. resli</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. schah</i>	1	0	0	0	1	0	1	0	0	0	0	0	0	0
<i>S. similis</i>	1	1	1	0	0	0	1	0	0	0	0	0	0	0
<i>S. skoraszewskyi</i>	0	1	0	0	1	0	0	0	0	0	0	0	0	0
<i>S. taurus</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. turk</i>	1	0	0	1	1	1	1	0	1	0	0	0	1	1
<i>S. viti</i>	0	0	1	1	0	0	0	0	0	0	0	0	0	0
<i>S. wittmeri</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Dianous coerulescens</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Species number	27	35	40	15	14	14	30	9	11	1	1	4	1	1
Percentage	39.13	50.72	57.97	21.74	20.29	20.29	43.49	13.04	15.94	1.45	1.45	5.80	1.45	1.45

Golestan region would be similar to that of the Caspian region as the Caspian wet forest reaches Gorgan, though it gradually becomes dryer there towards the east. Surprisingly, these geographical units appear in two different biogeographical clades, which reflect the low faunal similarity of less than 40%. Golestan is grouped with North Khorasan, while the Caspian region and the Northwest Iranian

mountains (similarity 60%) constitute a cluster with the southern slope of the Elburz, the northern and Central Zagros and the Ghohrud Mountains (similarity <45%). Thus, the composition of the stenine fauna of Iranian Caucasia is very similar to that of the northern slopes of the Elburz Mountains. This result strongly supports the Caspian glacial refuge of de Lattin (1951: 208–210, 1957: 388).

Table 3. Number of Steninae faunal elements in each geographical unit. See Material and methods section for abbreviations of the geographical subdivisions.

	NZ	NNW	C	G	SE	NKh	Z	SZ	Gh	Hm	SB	Khu	Sc	SKh
Pontomediterranean	7	8	7	2	3	2	9	2	3	1	0	1	0	0
Hyrceanian	0	0	10	2	0	0	0	0	0	0	0	0	0	0
Caspian	4	6	7	4	3	2	2	1	0	0	0	1	0	0
Holomediterranean	3	4	6	3	1	3	1	0	1	0	0	0	0	0
Turkestanian	2	1	1	2	2	4	1	0	1	0	0	0	1	1
Trans-Palaeartic	2	5	4	0	0	0	2	0	1	0	0	0	0	0
Syrian	3	1	2	0	2	2	6	4	2	0	0	2	0	0
Iranian	4	3	1	2	3	1	4	2	2	0	1	0	0	0
Holarctic	1	3	2	0	0	0	2	0	0	0	0	0	0	0
West Palaeartic	1	2	0	0	0	0	1	0	0	0	0	0	0	0
Irano-Anatolian	0	2	0	0	0	0	2	0	1	0	0	0	0	0
Species number	27	35	40	15	14	14	30	9	11	1	1	4	1	1

Table 4. Qualitative listing of *Scopaeus* species collected in Iran. See Material and methods section for abbreviations of the geographical subdivisions.

Species/ Regions	NZ	NNW	C	G	SE	NKh	Z	SZ	Gh	Hm	SB	Khu	SC	SKh
<i>Scopaeus alborzensis</i>	0	0	1	1	1	1	0	0	0	0	0	0	0	0
<i>S. azerbaijani</i>	0	0	1	1	0	1	0	0	0	0	0	0	0	0
<i>S. borumandi</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. cameroni</i>	1	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>S. chalcodactylus</i>	1	1	1	1	1	1	1	0	1	0	0	0	0	0
<i>S. debilis</i>	1	1	0	1	1	1	1	1	1	0	0	0	0	1
<i>S. ebneri</i>	1	1	0	0	1	0	1	1	1	0	0	0	0	0
<i>S. farsensis</i>	0	0	0	0	0	0	1	1	1	0	0	0	0	0
<i>S. femursetosus</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. filiformis</i>	0	0	0	0	0	0	0	1	0	1	1	1	1	0
<i>S. gracilis</i>	1	1	1	1	1	1	1	1	1	0	0	0	0	1
<i>S. hyrcanus</i>	0	0	1	1	0	0	0	0	0	0	0	0	0	0
<i>S. iranensis</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. kermanensis</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>S. khnזורiani</i>	1	1	0	0	0	0	1	1	0	0	0	0	0	0
<i>S. kurdistanus</i>	1	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. laevigatus</i>	0	1	0	0	0	1	0	0	0	0	0	0	0	1
<i>S. mariae</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. minimus</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. mutatus</i>	0	1	1	1	1	1	0	0	0	0	0	0	0	0
<i>S. pakistanensis</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>S. persicus</i>	1	0	0	0	0	0	1	1	0	0	0	0	0	0
<i>S. qohrudensis</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>S. schillhammeri</i>	1	1	1	0	1	0	0	0	0	0	0	0	0	0
<i>S. serriae</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>S. signifer</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>S. similis minor</i>	0	0	1	1	1	1	0	0	0	0	0	0	0	1
<i>S. stramineus</i>	0	0	0	0	0	0	0	1	1	1	0	0	0	0
<i>S. ulughdaghensis</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. zagrosensis</i>	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Species number	12	11	9	8	8	8	11	10	8	2	2	1	1	4
Percentage	40	36.67	30	26.67	26.67	26.67	36.67	33.33	36.67	6.67	6.67	3.33	3.33	13.33

The results of the cluster analysis of the Iranian species of *Scopaeus* are provided in Table 5 and Fig. 26. Like in *Stenus*, no species were found in the central Deserts and North Baluchestan. While the riparian species are not expected to occur in the deserts, the lack of records from

North Baluchestan is a collecting artifact. The most speciose region is North Zagros with 12 species (40% of Iranian *Scopaeus*), which belong to the Mediterranean type of distribution or are Irano-Anatolian endemics. Like in *Stenus*, the clades a and b + c represent the southern and

Table 5. Number of *Scopaeus* faunal elements in each geographical unit. See Material and methods section for abbreviations of the geographical subdivisions.

	NZ	NNW	C	G	SE	NKh	Z	SZ	Gh	Hm	SB	Khu	Sc	SKh
Iranian	1	0	2	2	2	2	6	3	3	0	0	0	0	1
Irano-Anatolian	4	3	1	0	1	0	1	1	0	0	0	0	0	0
Syrian	2	2	0	0	1	0	1	2	1	0	0	0	0	0
Caspian	1	2	2	2	2	2	1	0	1	0	0	0	0	0
Hyrceanian	0	0	2	2	0	1	0	0	0	0	0	0	0	0
Holomediterranean	2	2	1	2	2	2	2	2	2	0	0	0	0	2
Pontomediterranean	2	1	1	0	0	0	0	0	0	0	0	0	0	0
Sindian	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Paleotropic	0	0	0	0	0	0	0	1	0	1	1	1	1	0
Trans-Palaeartic	0	1	0	0	0	1	0	0	0	0	0	0	0	1
South Iran and Oman	0	0	0	0	0	0	0	1	1	1	0	0	0	0
Species number	12	11	9	8	8	8	11	10	8	2	2	1	1	4

northern regions of Iran with well separated *Scopaeus* species spectra. The southern cluster (a) of consists of Hormozgan, Khuzestan Plain, and southern Coast with South Baluchestan as outlier. Though the close affinity between Khuzestan Plain and southern Coast is expected, we believe that more collecting activity will bring new insights to their actual biogeographical relationships. These southern regions are the least speciose areas. As in *Stenus*, the *Scopaeus* fauna shows a gradient of decreasing species diversity towards the increasingly eremial east and south – a fact which can be easily explained by the strong adaptation of both genera to humid and riparian habitats.

The northern cluster, b + c, with 25 species the most speciose clade in the *Scopaeus* cladogram, is composed of two major subgroups.

The first (clade b) comprises the South Caspian and Turkmeno-Khorasanian mountain ranges. South Khorasan constitutes the outlier of the remaining geographical units of this clade. The southern Elburz is the outlier of the Caspian or Hyrcanian Region, Golestan, and North Khorasan. The two latter units reveal a significant faunal similarity (>85%), which is even higher than the considerable similarity of 60% in the Steninae.

The second subgroup (clade c) comprises Northwest Iran, the Zagros, and the Qohrud Mountains. It is made up of two sister clades with significant faunal similarity, a northern one comprising the Northwest and the adjacent North Zagros and a southern one with the Central and South Zagros and their outlier Ghohrud Mountains. The *Scopaeus* fauna shows a higher similarity between the northern, central, and southern parts of the Zagros compared to the *Stenus* fauna with a high similarity of the South Zagros and the southern regions of Khuzestan and Hormozgan.

Discussion

The present study confirms previous findings (e.g. Aiydov and Frisch 2014: 75; de Lattin 1949, 1951; Frisch 2010:

189–196; Naumann 1987) and contributes additional evidence that the distributional pattern of many species in Iran can be interpreted by the Pleistocene refugial centers in the West Palearctic. As shown in Table 1, about 78% of the Steninae and 73% of the *Scopaeus* species of Iran are endemic to these refuges or dispersed out of them after the last glacial period.

The results reveal that the composition of the Steninae fauna in Iran is most strongly influenced by faunal elements of the Mediterranean refuge (Table 3). Like the tropics, the Mediterranean Basin is considered as one of the world's biodiversity hotspots (Ribera et al. 2004: 179). Most of the Mediterranean *Stenus* species in Iran dispersed from the Pontomediterranean subrefuge in the northeastern Mediterranean. Mediterranean species are distributed in most of the investigated geographical units of Iran and have the strongest influence on the fauna of the Zagros Mountains. The northwest-southeast trending Zagros chains, a part of the Alpine-Himalayan orogenic system (Mouthereau 2011: 728) and the Irano-Anatolian mountain barrier, extend from the East Anatolian fault in eastern Turkey to southern Iran and prevent the dispersal of many Steninae species towards the east both as a barrier and owing to their Mediterranean climate. The Mediterranean influence on the Iranian fauna of *Scopaeus* is lower compared to the Steninae, but nevertheless the pervasive effect of Mediterranean species cannot be denied in most geographical units. The *Scopaeus* fauna of Iran is rather characterized by a high percentage of endemics, which are restricted to particular mountain ranges mainly in the Zagros Mountains. Like in *Scopaeus*, Mediterranean faunal elements notably influenced the stenine fauna of the Hyrcanian region and northern Khorasan (Table 3, 4). The similarity of the species composition of the Steninae fauna of the Zagros, the Ghohrud Mountains, and the southern slopes of the Elburz (see Fig. 25) is mainly caused by Mediterranean and Iranian faunal elements. Likewise, the similarity of the *Scopaeus* fauna of the central and southern Zagros Mountains and the Ghohrud Mountains is caused by the same Mediterranean species,

though the latter mountain range also includes *Scopaeus* species with an endemic Iranian distribution.

The second most frequent biogeographical element of the Iranian Steninae is the Caspian faunal element with a percentage of about 27%. Compared to the more widespread Holo-Caspian species (10.14%), which dispersed from the Caspian refuge from the Crimea to the southern shore of the Caspian Sea, however, the Hyrcanian faunal element with about 16% of the species has a greater impact on the stenine fauna of Iran. The Hyrcanian faunal elements originate from the Hyrcanian forest zone in the South Caspian plain and the northern slopes of the South Caspian mountains, the eastern subunit of the Caspian refuge. According to Frisch (2006: 262), the Hyrcanian subregion is a unique speciation center judging from the high numbers of endemics. Our results actually prove that it moreover constitutes the most significant center of origin for *Stenus* in Iran. The Caspian faunal elements constitute the main causative factor for the high similarity between Iranian Caucasia and the Hyrcanian region (more than 60%), and moreover strongly affect the *Stenus* fauna of the Golestan region and the northern Zagros Mountains. Although the Caspian *Scopaeus* have a considerably lower impact on the species diversity of the Iranian fauna (about 13%) compared to *Stenus*, some of them are relatively widespread and dispersed over geographical units of Iran adjacent to the Hyrcanian zone. *Scopaeus chalcodactylus* Kolenati even spread southwards to the mountains of Kerman.

Besides the Mediterranean and Caspian species, the widespread Holarctic, trans-Palaearctic, and West Palaearctic species (about 18% of the Iranian fauna) also have a great impact on the composition of the Steninae fauna of Iran, mostly in the more humid, temperate north and northwest of the country due to suitable habitats. On the contrary, the percentage of trans-Palaearctic species is much lower in the Iranian *Scopaeus* fauna (Table 1).

The Syrian and Iranian refuges have their greatest influence on the Steninae fauna in the central, southern, and northern Zagros Mountains and almost the same effect on the *Scopaeus* fauna of these regions.

We employed the geographical units of Iran after Petrov (1955) for our biogeographical analysis in order to have a tested base to compare our results with those of other recent works, which are based on the same subdivisions (e.g. Dubatolov and Zahiri 2005, Matov et al. 2008). We did without comparing our results, however, to cladistic biogeographical contributions which employed different geographical subdivisions of Iran, e.g. Burckhardt and Lauterer (1993). Although the studies of Dubatolov and Zahiri (2005) and Matov et al. (2008) were carried out on Lepidoptera, the results were not compatible with each other in many aspects probably due to the different habitat and niche preferences of the studied insects. Our results correspond with each of those studies in some aspects. For example, the heliothine faunas in the southern Caucasus and the Hyrcanian region show high resemblance (Matov et al. 2008: 32), a result

which matches the close affinity between the Steninae faunas of Iranian Caucasia and the Hyrcanian region in our study, both of which are subdivisions of the Caspian glacial refuge sensu de Lattin (1967: 322).

As the results obtained by Dubatolov and Zahiri (2005: 509), our cluster analysis yields a high similarity (more than 50%) between the faunal composition of Gorgan and North Khorasan, which seems to be caused by a similar composition of Mediterranean, Caspian, Turkestanian, and Iranian species.

The distribution patterns of the stenine fauna of Iran as well as their zoogeographical relationships and degree of endemism were unknown prior to this study. With the example of these riparian rove beetles we demonstrated, that the Mediterranean Pleistocene refuge performs a huge influence on the recent fauna of this country – a result we did not expect in view of the geographical position of Iran within the Middle East and at the interface of the Palaearctic, Afrotropical, and Oriental zoogeographical regions. Our interesting results significantly contribute to a better knowledge of the biogeography of Iran and highlight the great importance of the Mediterranean for the understanding of the biogeography of the entire Middle East and beyond.

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References

- Aiydov AA, Frisch J (2014) *Scopaeus chalcodactylus* Kolenati, 1846 (Coleoptera: Staphylinidae), a new species of rove beetles for the fauna of Russia. Caucasian Entomological Bulletin 10(1): 73–76.

- Anlaş S (2009) Distributional checklist of the Staphylinidae (Coleoptera) of Turkey, with new and additional records. *Linzer biologische Beiträge* 41(1): 215–342.
- Anlaş S, Frisch J (2014) On the Scopaeina Mulsant & Rey of the Middle East: A new species from Turkey and new biogeographic data (Coleoptera, Staphylinidae: Paederinae). *Soil Organisms* 86(3): 153–167.
- Assing V (2003) A new species of the *Stenus glacialis* group from the northeastern Iberian Peninsula (Coleoptera: Staphylinidae, Steninae). *Linzer biologische Beiträge* 35(2): 711–716.
- Assing V (2005) On the Taxonomy and Biogeography of *Stenus* (s. str.) *erythrocnemus* Eppelsheim and related species (Insecta: Coleoptera: Staphylinidae). *Bonner zoologische Beiträge* 53: 303–310.
- Betz O (1996) Function and evolution of the adhesion-capture apparatus of *Stenus* species (Coleoptera, Staphylinidae). *Zoomorphology* 116: 15–34. doi: 10.1007/BF02526926
- Burckhardt D, Lauterer P (1993) The jumping plant-lice of Iran (Homoptera, Psyllodea). *Revue Suisse de Zoologie* 100(4): 829–898. doi: 10.5962/bhl.part.79887
- Clarke DJ, Grebennikov VV (2009) Monophyly of Euaesthetinae (Coleoptera: Staphylinidae): phylogenetic evidence from adults and larvae, review of austral genera, and new larval descriptions. *Systematic Entomology* 34: 346–397. doi: 10.1111/j.1365-3113.2009.00472.x
- Dubatolov VV, Zahiri R (2005) Tiger-moths of Iran (Lepidoptera: Arctidae: Arctiinae). *Atalanta* 36: 481–525.
- Eppelsheim E (1890) Neue Staphylinen aus den Kaukasusländern. *Wiener Entomologische Zeitung* 9: 161–172, 217–229.
- Fauvel A (1873) Faune Gallo-Rhénane ou species des insectes qui habitent la France, la Belgique, la Hollande, le Luxembourg, la prusse Rhénane, la Nassau et la Valais avec tableaux synoptiques et planches gravées. Le Blanc-Hardel, Caen, 215–390.
- Frisch J (2006a) The genus *Scopaeus* (Coleoptera, Staphylinidae, Paederinae) in Iran, with description of new species from the Zagros Mountains. *Deutsche Entomologische Zeitschrift* 53(1): 5–22. doi: 10.1002/mmnd.200600002
- Frisch J (2006b) *Scopaeus hyrcanus* sp. n. from the Elburz- and Talish Mountains in Iran (Coleoptera, Staphylinidae, Paederinae). *Deutsche Entomologische Zeitschrift* 53(2): 264–270. doi: 10.1002/mmnd.200600023
- Frisch J (2007a) *Scopaeus farsensis* sp. n. from South Iran, with remarks on *S. chalcodactylus* (Kolenati, 1846) (Coleoptera, Staphylinidae: Paederinae). *Deutsche Entomologische Zeitschrift* 54(1): 79–88. doi: 10.1002/mmnd.200700008
- Frisch J (2007b) A review of the *Scopaeus gracilis* species group (Coleoptera, Staphylinidae: Paederinae), with description of new species from Sardinia, southern Africa and Middle East. *Deutsche Entomologische Zeitschrift* 54(2): 195–218. doi: 10.1002/mmnd.200700019
- Frisch J (2008) A new species of *Scopaeus* Erichson, 1839 (Staphylinidae, Paederinae) from the Qohrud Mountains in Iran. *Deutsche Entomologische Zeitschrift* 55(2): 285–289. doi: 10.1002/mmnd.200800029
- Frisch J (2009) A revision of the *Scopaeus mutatus* species group (Staphylinidae: Paederinae), with description of new species from Anatolia and the Caucasus. *Deutsche Entomologische Zeitschrift* 56(2): 271–287. doi: 10.1002/mmnd.200900024
- Frisch J (2010) On the taxonomy and biogeography of West Palaearctic *Scopaeina* Mulsant & Rey (Staphylinidae, Paederinae) with emphasis on the Middle East. *Deutsche Entomologische Zeitschrift* 57(2): 159–202. doi: 10.1002/mmnd.201000016
- Frisch J (2014) A revision of the Central Asian *Scopaeus similis* species group (Staphylinidae, Paederinae). *Soil Organisms* 86(3): 199–220.
- Ganji MH (1978) Post-Glacial Climatic Changes on the Iranian Plateau. In: Brice WC (Ed.) *The Environmental History of the Near and Middle East since the Last Ice Age*. Academic Press, London, New York, San Francisco, 149–163.
- Ghahari H, Anlas S, Sakenin H, Ostovan H, Havaskary M (2009a) Biodiversity of rove beetles (Coleoptera: Staphylinodea: Staphylinidae) from the Arasbaran biosphere reserve and vicinity, northwestern Iran. *Linzer biologische Beiträge* 41(2): 1949–1958.
- Ghahari H, Anlas S, Sakenin H, Ostovan H, Tabari M (2009b) A contribution to the rove beetles (Coleoptera: Staphylinodea: Staphylinidae) of Iranian rice fields and surrounding grasslands. *Linzer biologische Beiträge* 41(2): 1959–1968.
- Ghahari H, Havaskari M, Tabari M, Ostovan H, Sakenin H, Satar A (2009c) An annotated catalogue of Orthoptera (Insecta) and their natural enemies from Iranian rice fields and surrounding grasslands. *Linzer biologische Beiträge* 41(1): 639–672.
- Hadian A, Naderian H, Rastegar J, Makhan D, Ghahari H (2011) A study on the rove beetles (Coleoptera: Staphylinidae) from Semnan province, Iran. *Calodema* 177: 1–5.
- Hangay G, Nadai L, Szekely K (2005) Report on Hungarian entomological expeditions to Iran. *Folia Historico Naturalia Musei Matraensis* 29: 7–18.
- Hedge I, Wendelbo P (1978) Patterns of distribution and endemism in Iran. *Notes from the Royal Botanic Garden (Edinburgh)* 36(2): 441–464.
- Herman LH (2001) Catalogue of the Staphylinidae (Insecta: Coleoptera). 1758 to the end of the second millennium. IV. Staphylinidae group (Part I) Euaesthetinae, Leptotyphlinae, Megalopsidiinae, Oxyporinae, Pseudopsinae, Solieriinae, Steninae. *Bulletin of the American Museum of Natural History* 265: 1807–2440.
- Hromadka L (1977) Vier neue Paläarktische *Stenus*-Arten (Coleoptera, Staphylinidae). *Annotationes Zoologicae et Botanicae* 120: 1–8.
- Hromadka L (1979) Zwei neue paläarktische *Stenus*-Arten (Coleoptera, Staphylinidae). *Reichenbachia* 17(22): 183–187.
- Jarrige J (1971) Contribution a la faune de l' Iran 21. Coléoptères brachelytra. *Annales de la Société Entomologique de France (NS)* 7(2): 483–502.
- Kastcheev VA, Puthz V (2011) Contribution to the knowledge of the fauna of Steninae (Coleoptera, Staphylinidae) of the [sic!] Kazakhstan. 319th Contribution to the Knowledge of Steninae. *Entomofauna* 32: 437–460.
- Korge H (1967) [New species]. In: Puthz V (Ed.) *Über Stenus (Parastenus) alpicola* Fauvel und andere abweichend gebaute paläarktische *Parastenus*-Arten (Col., Staphylinidae). *Annales Entomologici Fennici* 33(3): 251–253.
- Korge H (1971) Beiträge zur Kenntnis der Koleopterenfauna Kleinasien. *Annotationes Zoologicae et Botanicae* 67: 1–68.
- de Lattin G (1949) Beiträge zur Zoogeographie des Mittelmeergebietes. In: Remane A, Thienemann A (Eds) *Verhandlungen der Deutschen Zoologischen Gesellschaft* (21–26.05.1956, Hamburg). Geest & Portig, Leipzig, 143–150.
- de Lattin G (1951) Über die Zoogeographischen Verhältnisse Vorderasiens. In: Herre W (Ed.) *Verhandlungen der Deutschen Zoologen vom*

1. bis 5. August 1950 in Marburg. Zoologischer Anzeiger (Suppl.) 15: 206–214.
- de Lattin G (1957) Die Ausbreitungszentren der holarktischen Landtierwelt. In: Pflugfelder O (Ed.) Verhandlungen der Deutschen Zoologischen Gesellschaft (21–26.05.1956, Hamburg). Zoologischer Anzeiger 20(Suppl.): 380–410.
- de Lattin G (1967) Grundriss der Zoogeographie. Jena, 602 pp.
- Mc Kenna DD, Farrell BD, Caterino MS, Farnum CW, Hawks DC, Maddison DR, Seago AE, Short AEZ, Newton AF, Thayer MK (2014) Phylogeny and evolution of Staphyliniformia and Scarabaeiformia: forest litter as a stepping stone for diversification of non-phytophagous beetles. Systematic Entomology (2014): 1–26. doi: 10.1111/syen.12093
- Matov A, Zahiri R, Holloway JD (2008) The Heliethinae of Iran (Lepidoptera: Noctuidae). Zootaxa 1763: 1–37.
- Mouthereau F (2011) Timing of uplift in the Zagros belt/Iranian plateau and accommodation of late Cenozoic Arabia–Eurasia convergence. Geology Magazine 148(5–6). doi: 10.1017/S0016756811000306
- Naumann C (1987) Distribution Patterns of *Zygaena* Moths in the Near and Middle East (Insecta, Lepidoptera, Zygaenidae). In: Krupp F, Schneider W, Kinzelbach R (Eds) Proceedings of the Symposium on the Fauna and Zoogeography of the Middle East. Beihefte zum Tübinger Atlas des vorderen Orients, Reihe A (Naturwissenschaften) 28: 200–212.
- Parsa A (1978) Flora of Iran 1. Ministry of Science and Education, Tehran, 506 pp.
- Petrov MP (1955) Iran (fundamental essay). Moscow, 184 pp. [In Russian]
- Puthz V (1964) Zwei neue paläarktische *Stenus*-Arten (Col., Staphylinidae). Annales Entomologici Fennici 30(4): 226–232.
- Puthz V (1967) Über *Stenus* (*Parastenus*) *alpicola* Fauvel und andere abweichend gebaute paläarktische *Parastenus*-Arten (Col., Staphylinidae). Annales Entomologici Fennici 33(3): 226–256.
- Puthz V (1970a) *Stenus* (*Parastenus*) *heinzianus* n. sp. aus dem Iran (Coleoptera, Staphylinidae) 67. Beitrag zur Kenntnis der Steninen. Reichenbachia 13: 223–226.
- Puthz V (1970b) Über die Gruppe des *Stenus pusillus* Stephens (Col., Staphylinidae). Annales Entomologici Fennici 36(4): 202–212.
- Puthz V (1971) Kritische Faunistik der bisher aus Mitteleuropa bekannten *Stenus*-Arten nebst systematischen Bemerkungen und Neubeschreibungen (Coleoptera, Staphylinidae). Entomologische Blätter für Biologie und Systematik der Käfer 67(2): 74–121.
- Puthz V (1972a) Ein neuer *Parastenus* aus dem Iran sowie Bemerkungen über zwei alte kaukasische *Parastenen* (Coleoptera, Staphylinidae). 115. Beitrag zur Kenntnis der Steninen. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 45: 123–126.
- Puthz V (1972b) Zur Staphylinidenfauna des Balkans: die bisher aus Jugoslawien und angrenzenden Ländern bekannten Steninen (Coleoptera, Staphylinidae). Wissenschaftliche Mitteilungen des Bosnisch-herzegonischen Landesmuseums 1(c): 239–292. [1971]
- Puthz V (1972c) Zur Staphylinidenfauna des Balkans: die bisher aus Jugoslawien und angrenzenden Ländern bekannten Steninen (Coleoptera, Staphylinidae). Wissenschaftliche Mitteilungen des Bosnisch-herzegonischen Landesmuseums 2(c): 167–179.
- Puthz V (1972d) Über zwei *Stenus*-Arten aus der *clavicornis*-Gruppe (Col., Staph.). Entomologische Blätter für Biologie und Systematik der Käfer 68(2): 124–128.
- Puthz V (1973) Über einige alte und neue Steninen aus der Sowjetunion. (Coleoptera, Staphylinidae). 114. Beitrag zur Kenntnis der Steninen. Reichenbachia 14: 291–296.
- Puthz V (1977) Neue westpaläarktische *Stenus*-Arten, aus dem Genfer Museum (Coleoptera: Staphylinidae). 159. Beitrag zur Kenntnis der Steninen. Revue Suisse de Zoologie 84: 109–117. doi: 10.5962/bhl.part.91374
- Puthz V (1979) Drei neue *Stenus*-Arten aus dem nördlichen Iran (Coleoptera, Staphylinidae). 168. Beitrag zur Kenntnis der Steninen. Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 31: 54–58.
- Puthz V (1981) Neue westpaläarktische *Stenus*, vorwiegend aus dem Genfer Museum (Coleoptera: Staphylinidae). 183. Beitrag zur Kenntnis der Steninen. Revue Suisse de Zoologie 83: 693–706. doi: 10.5962/bhl.part.82401
- Puthz V (1983) Einige *Stenus*-Arten aus dem Kaukasus und Elburs (Insecta: Coleoptera: Staphylinidae). 190. Beitrag zur Kenntnis der Steninen. Senckenbergiana biologica 63: 347–362.
- Puthz V (2002) Beiträge zur Kenntnis der Steninen CCLXXVII. Über *Dianous coerulescens* Gyllenhal, 1810 (Staphylinidae, Coleoptera). Philippia 10(2): 141–146.
- Puthz V (2003) *Stenus alpicola* Fauvel und seine Nahverwandten (Coleoptera, Staphylinidae). 274. Beitrag zur Kenntnis der Steninen. Entomologische Blätter für Biologie und Systematik der Käfer 98: 89–110.
- Puthz V (2008) *Stenus* Latreille und die segensreiche Himmelstochter (Coleoptera, Staphylinidae). Linzer biologische Beiträge 40(1): 137–230.
- Puthz V (2009) Neue und alte paläarktische *Stenus*-Arten (Col., Staphylinidae). 305. Beitrag zur Kenntnis der Steninen. Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 61: 29–50.
- Puthz V (2010) Neuer Beitrag über paläarktische Steninen (Coleoptera, Staphylinidae). 314. Beitrag zur Kenntnis der Steninen. Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 62: 59–74.
- Puthz V (2012a) Steninae. In: Freude H, Harde KW, Lohse A (Eds) Die Käfer Mitteleuropas (Band 4). Zweite Auflage, 286–317.
- Puthz V (2012b) Über einige paläarktische *Stenus*-Arten (Coleoptera, Staphylinidae). 326. Beitrag zur Kenntnis der Steninen. Entomologische Blätter und Coleoptera 108: 151–158.
- Ribera I, Vogler A (2004) Speciation of Iberian diving beetles in Pleistocene refugia (Coleoptera, Dytiscidae). Molecular Ecology 13: 179–193. doi: 10.1046/j.1365-294X.2003.02035.x
- Rohlf FJ (1998) NTSYSpc, version 2.02g. Exter Software. Applied Biosystematics Inc.
- Ryvkin AB (1990) Stafilinidy podsemeistva Steninae (Coleoptera, Staphylinidae) Kavkaza i sopredel'nykh territorii. In: Striganova B (Ed.) Fauna nazemnykh bespozvonochnykh Kavkaza – Sbornik Nauchnykh Trudov. Akademiia Nauka SSSR, Moskva, 137–234.
- Ryvkin AB (2011) Contributions to the knowledge of *Stenus* (*Nestus*) species of the *crassus* group (Insecta: Coleoptera: Staphylinidae: Steninae). 1. Four new species from the Russian Far East with taxonomic notes. Baltic Journal of Coleopterology 11(1): 57–72.
- Sakenin H, Ghahari H, Ostovan H, Imani S, Samin N (2010) Faunistic note on rove beetles (Coleoptera: Staphylinidae) from Semnan Province, Iran. International Society for Southeast Asian Agricultural Sciences, 2009 International Congress, January 11–15, 2010, Pattaya, Thailand, Abstract, 188.

- Sakenin Chelav H, Imani S, Shirdel F, Samin N, Havaskary M (2008) Identification of Pentatomidae (Heteroptera) and their host plants in central and eastern Mazandaran Province and introducing of many dominant natural enemies. *Journal of Plant & Ecosystem* 15: 37–51.
- Samin N, Zhou H, Ezzatpanah S (2011a) A contribution to the Staphylinine group of rove beetles (Coleoptera: Staphylinidae: Staphylinidae) from Iran. *Calodema* 141: 1–9.
- Samin N, Zhou H, Imani S (2011b) Iranian rove beetles (Coleoptera: Staphylinidae: Staphylinidae). *Amurian Zoological Journal* 3(2): 128–162.
- Samin N, Zhou H, Imani S, Rastegar J (2011c) A contribution to the knowledge of Iranian Staphylinidae (Coleoptera: Staphylinidae). *Arch. Biol. Sci., Belgrade* 63(4): 1235–1243.
- Scheerpeltz O (1960) Die von Prof. Dr. A. Gilli während seines Aufenthaltes in Afghanistan 1949/1951 aufgesammelten Staphyliniden (Col. Staph.). *Koleopterologische Rundschau* 37–38: 67–81.
- Scheerpeltz O (1961) Die von den Herren W. Richter und Dr. F. Schäufele in den Jahren 1954 und 1956 im Südiran aufgefundenen Staphyliniden (Col.). *Stuttgarter Beiträge zur Naturkunde* 50: 1–31.
- Schierling A, Seifert K, Sinterhauf SR, Rieß JB, Rupprecht JC, Dettner K (2012) The multifunctional pygidial gland secretion of the Steninae (Coleoptera: Staphylinidae): ecological significance and evolution. *Chemoecology* 23: 45–57. doi: 10.1007/s00049-012-0118-6
- Schülke M, Smetana A (2015) Staphylinidae [Omaliinae – Scydmaeninae]. In: Löbl I, Löbl D (Eds) *Catalogue of Palaearctic Coleoptera* (Vol. 2/1). Brill, Leiden, Boston, 304–900.
- Serri S, Frisch J (2013) New species of the *Stenus incanus* group from Iran, with remarks on *S. laetificus* Ryvkin (Staphylinidae: Steninae). *Deutsche Entomologische Zeitschrift* 60(1): 99–103.
- Smetana A (2004) Steninae. In: Löbl I, Smetana A (Eds) *Catalogue of Palaearctic Coleoptera* (Vol. 2). Apollo Books, Stenstrup, 579–624.
- Yale P, Ham A, Greenway P (2001) *Iran*. Melbourne, Oakland, London, Paris, 432 pp.
- Zehzad B, Kiabi BH, Majnoonian H (2002) The natural areas and landscape of Iran: an overview. *Zoology in the Middle East* 26: 7–10. doi: 10.1080/09397140.2002.10637915
- Zohary M (1973) *Geobotanical Foundations of the Middle East*. Vol. I and II. Gustav Fischer, Stuttgart; Swets & Zeitlinger, Amsterdam, 739 pp.

Supplementary material 1

Distribution data of Steninae species from Iran.

Authors: Sayeh Serri, Johannes Frisch

Data type: Excel

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Review of the genus *Aphanostola* Meyrick, 1931 (Lepidoptera, Gelechiidae, Anomologinae) with description of 19 new species from the Afrotropical Region

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Afrotropical region

Oriental region

New diagnosis of the genus *Aphanostola* is provided, and its position within Gelechiidae is briefly discussed. 19 species are described from South Africa, Namibia, Botswana, Zimbabwe, Tanzania, Kenya and Ethiopia: *A. acaciae* Bidzilya & Mey, **sp. n.**, *A. morogorensis* Bidzilya, **sp. n.**, *A. calderae* Bidzilya & Mey, **sp. n.**, *A. kenyella* Bidzilya & Agassiz, **sp. n.**, *A. kruegeri* Bidzilya & Mey, **sp. n.**, *A. alternella* Bidzilya & Agassiz, **sp. n.**, *A. antennata* Bidzilya & Mey, **sp. n.**, *A. rooiklipella* Bidzilya & Mey, **sp. n.**, *A. griseella* Bidzilya & Mey, **sp. n.**, *A. centripunctella* Bidzilya & Mey, **sp. n.**, *A. joannoui* Bidzilya & Mey, **sp. n.**, *A. namibiensis* Bidzilya & Mey, **sp. n.**, *A. brandbergensis* Bidzilya & Mey, **sp. n.**, *A. aarviki* Bidzilya, **sp. n.**, *A. africanella* Bidzilya, Agassiz, & Mey, **sp. n.**, *A. emarginata* Bidzilya & Mey, **sp. n.**, *A. melliferae* Bidzilya, Agassiz & Mey, **sp. n.**, *A. maxima* Bidzilya & Mey, **sp. n.**, *A. longicornuta* Bidzilya, Agassiz & Mey, **sp. n.** A key to the species is given based on external characters and the genitalia of both sexes. Adults and genitalia of all species are illustrated.

Introduction

The genus *Aphanostola* was originally established for two species: *A. atripalpis* Meyrick, 1931 (type species) and *A. sparsipalpis* Meyrick, 1931. Later *A. intercepta* Meyrick, 1932 was added to this genus. The latter two species are only known from single males without abdomens, therefore their generic assignment with *Aphanostola* remains rather obscure.

As a result of our study of the Gelechiidae from the Brandberg Massif in Namibia, a number of small-sized specimens that represent a separate group consisting of four species have been discovered. Their genitalia matched in most details to the genitalia of *Lanceopen-*

na pentastigma Janse, 1960. It was realized however that *L. pentastigma* is not congeneric with *L. pseudogaleotis* Janse, 1950 – the type species of *Lanceopenna* Janse, 1950, but better fits in genitalia characters to *A. atripalpis* from India (Bidzilya 2007). In spite of similarity of the male genitalia of *A. atripalpis* and specimens from the Brandberg the species have not been transferred to *Aphanostola* because the type specimens of *A. atripalpis* remained unexamined. They were mentioned in the list of the Gelechiidae from the Brandberg as “Genus 1, spec. 1” – “Genus 1, spec. 4” (Bidzilya 2007).

The recent examination of the holotype and male paratype of *A. atripalpis* confirmed the assumption that specimens from the Brandberg are indeed congeneric with

Aphanostola. Moreover, a number of additional species from this genus have been found in collections of material from southern Africa and other countries of the Afro-tropical region since 2007. Some of these species were mentioned as new but not formally described in recent papers (Mey and Kühne 2014; Agassiz and Bidzilya 2016 in press). However, we already transferred *Lanceopenna pentastigma* to the genus *Aphanostola* (Agassiz and Bidzilya 2016 in press).

The aim of the present paper is to describe new species, which were found belonging to *Aphanostola*. A total of 19 new species are described and an improved and expanded diagnosis of the genus *Aphanostola* within the subfamily Anomologinae is provided.

Material and methods

The present paper is based mainly on material from Museum für Naturkunde, Berlin, Germany (MfN). Additional material has been received from Ditsong National Museum of Natural History (formerly Transvaal Museum), Pretoria, South Africa (TMSA), Natural History Museum, London, United Kingdom (BMNH), Natural History Museum, University of Oslo, Norway (NHMO), Landesmuseum für Kärnten, Klagenfurt (LMK) and from the collection of David Agassiz, London, UK (Agassiz coll.) (now deposited in BMNH).

The genitalia slides were prepared according to the “unrolling technique” (Pitkin 1986; Huemer 1988). The descriptive terminology of genitalia structures generally follows Huemer and Karsholt (1999) and Kristensen (2003).

In the paragraph “Material” of the descriptions the localities were arranged geographically from south-west to north-east and countries are referred to using their current names.

Results

Check-list of the genus *Aphanostola*

A. acaciae Bidzilya & Mey, sp. n.
A. pentastigma (Janse, 1960)
A. morogorensis Bidzilya, sp. n.
A. calderae Bidzilya & Mey, sp. n.
A. kenyella Bidzilya & Agassiz, sp. n.
A. kruegeri Bidzilya & Mey, sp. n.
A. alternella Bidzilya & Agassiz, sp. n.
A. antennata Bidzilya & Mey, sp. n.
A. rooiklipella Bidzilya & Mey, sp. n.
A. griseella Bidzilya & Mey, sp. n.
A. centripunctella Bidzilya & Mey, sp. n.
A. joannoui Bidzilya & Mey, sp. n.
A. namibiensis Bidzilya & Mey, sp. n.
A. brandbergensis Bidzilya & Mey, sp. n.
A. aarviki Bidzilya, sp. n.
A. africanella Bidzilya, Agassiz & Mey, sp. n.
A. emarginata Bidzilya & Mey, sp. n.
A. melliferae Bidzilya, Agassiz & Mey, sp. n.

A. maxima Bidzilya & Mey, sp. n.

A. longicornuta Bidzilya Agassiz & Mey, sp. n.

A. atripalpis Meyrick, 1931

A. sparsipalpis Meyrick, 1931

A. intercepta Meyrick, 1932

Aphanostola Meyrick, 1931

Exotic Microlepidoptera 4: 56

Type-species. *Aphanostola atripalpis* Meyrick, 1931 (by original designation).

Diagnosis. The genus *Aphanostola* is defined by the combination of the following characters in the male genitalia (Fig. 40a): phallus usually with basal projection, uncus covered with setae, gnathos long sickle-shaped, valva divided into strongly sclerotized basal part and weakly sclerotized distal part, sacculus strongly curved inwardly, the posterior margin of the vinculum with medial incision and more or less developed projections. The female genitalia (Fig. 40b) are rather variable, but a weakly sclerotized unmodified sternite VIII, moderately thick apophyses anteriores and a usually well defined antrum are the characteristic features of the genus. The presence of the basal projection of the phallus can be considered as a presumed autapomorphy of *Aphanostola*. The lack of this character in some species seems to be a secondary reduction.

Remarks. The male genitalia of *Aphanostola* display similarity to the genitalia of *Leuronoma* Meyrick, 1918 and *Platyphala* Janse, 1951. These genera share such characters as a weakly sclerotized distal portion of the valva, the sacculus strongly curved inwardly and the inner margin of the valva with tendency to form a thorn. The adults of all three genera are characterized by sexual dimorphism in the width of the antenna. The monotypic genus *Platyphala* seems to be more closely related to *Aphanostola* in having the phallus with short basal projection, but differs in the prolonged uncus without long setae and the shorter gnathos. The diagnosis of *Leuronoma* is unclear as the type species (*L. chlorotoma* Meyrick, 1918) lacks the abdomen and its affiliation with of the other species is rather provisional. Most of the species currently associated with *Leuronoma* differ from *Aphanostola* species in the uncus which is deeply divided into two lobes, the reduced saccus and a differently shaped phallus. *Aphanostola*, *Platyphala* and *Leuronoma* along with several unrevised groups of species form a separate branch within the tribe Anomologini (subfamily Anomologinae) remotely related to *Aristotelia* Hübner, [1825].

Based on the above diagnosis 23 species are considered here to be members of *Aphanostola*. However, there is a group of still undescribed species which takes an intermediate position among *Aphanostola*, *Leuronoma* and *Platyphala*. It is possible that the current diagnosis of *Aphanostola* must be expanded and additional species have to be included resulting from future revisions of related genera.

Description. Head smoothly scaled, ocelli absent, grey or brown sometimes white (*A. brandbergensis* sp. n.). Labial palpus straight or weakly up-curved, segment 2 slightly broader than segment 3, segment 3 acute, about as wide as segment 2; antenna of male slightly thicker and more distinctly ciliated than antenna of female in most of species (*A. calderae* sp. n., *A. longicornuta* sp. n., *A. rooiklipella* sp. n., *A. griseella* sp. n.), scape without pecten, antennal segments grey to brown with black rings at base.

Thorax grey to brown; wingspan 5.8–10.5 mm; forewing usually pale, grey, or light brown, sometimes whitish or yellowish with brown base of costal margin (*A. calderae* sp. n., *A. morogorensis* sp. n., *A. brandbergensis* sp. n., *A. aarviki* sp. n.), three diffuse dark spots in cell, margins often mottled with black appearing darker than medial part of wing, some species with additional black spots at base and on $\frac{3}{4}$ of dorsum (*A. morogorensis* sp. n.). Hindwing grey, with well developed tornal excavation and pointed tip.

Abdomen. Male tergum VIII sub-rectangular, usually broader than long, strongly edged and weakly emarginated anteriorly; sternum VIII broader than long, posterior margin broadly rounded, anteriolateral corners projected, sometimes strongly. Female segment VII trapezoidal, tergum VIII about twice length of other abdominal segments, sternum VIII three times longer than broad; sternum II of both sexes with pair of venulae, apodemes well developed.

Male genitalia (Fig. 40a). Uncus usually short, broader than long, rounded in *A. atripalpis* and *A. brandbergensis* sp. n., posterior margin weakly or distinctly emarginated, covered with strong setae. Gnathos usually long, slender, hook-shaped, curved in middle or at base, distal portion straight, apex pointed. Tegumen sub-rectangular or trapezoidal, about twice as long as broad, anterior margin with deep medial emargination, lateral folds well developed, turned inwardly and connected medially. Valva (cucullus) digitate, distinctly exceeding the apex of uncus, basal portion usually more strongly sclerotized than distal portion, inner margin distinctly edged in basal half, often bears a short thorn or serrated lobe (*A. aarviki* sp. n.), distal portion densely covered with short hairs, apex more or less inflated, rounded. Saccus merged on $\frac{1}{4}$ – $\frac{1}{2}$ length with cucullus, turned inwards, differing in shape, usually long, narrow, thorn-shaped (*A. calderae* sp. n., *A. acaciae* sp. n., *A. griseella* sp. n.) or short triangular (*A. centripunctella* sp. n., *A. brandbergensis* sp. n.), sometimes broad, beak-shaped (*A. joannoui* sp. n., *A. melliferae* sp. n.); saccus sometimes merged at base with medial thorn on inner margin of valva (*A. kenyella* sp. n., *A. centripunctella* sp. n., *A. africanella* sp. n., *A. brandbergensis* sp. n., *A. namibiensis* sp. n.). Vinculum usually broad, posterior margin with short, triangular or broadly rounded medial projections separated by a narrow incision, two additional medial humps or short projections on the posterior margin of the vinculum present in some species (*A. morogorensis* sp. n., *A. calderae* sp. n.); sometimes (*A. longicornuta* sp. n.) additional lateral

projections of the posterior margin of the vinculum well developed. Saccus broad, triangular, rounded or narrowly digitate (*A. centripunctella* sp. n., *A. longicornuta* sp. n.), exceeding beyond the apex of pedunculus, but sometimes short (*A. namibiensis* sp. n.) or nearly reduced (*A. brandbergensis* sp. n.). Phallus a flattened tube, usually slightly but in some cases considerably (*A. antennata* sp. n.) shorter than tegumen, very long in *A. longicornuta* sp. n., sub-apical area with small lateral teeth by *A. calderae* sp. n. and *A. acaciae* sp. n. or with big apical thorn (*A. kenyella* sp. n., *A. brandbergensis* sp. n.); vesica may bear very small (*A. acaciae* sp. n.) or moderately large (*A. africanella* sp. n.) cornuti, *A. longicornuta* sp. n. with one very big and numerous small spikes in vesica; a narrow and usually long projection of phallus is developed in most of species; ductus ejaculatorius elongate.

Female genitalia (Fig. 40b). Papilla analis ovate, covered with short hairs; segment VIII sub-rectangular, longer than broad, weakly sclerotized, without modifications except for *A. centripunctella* sp. n. and *A. namibiensis* sp. n. with sclerotized patches from the base of apophyses anteriores extending posteriorly to half length of segment VIII. Apophyses anteriores slightly (*A. rooiklipella* sp. n., *A. griseella* sp. n.) or more than twice as long as segment VIII, sometimes moderately thick (*A. pentastigma*, *A. brandbergensis* sp. n., *A. joannoui* sp. n.), apophyses posteriores narrow, twice as long as apophyses anteriores. Antrum elongated (*A. rooiklipella* sp. n., *A. griseella* sp. n., *A. africanella* sp. n.), short and funnel-shaped (*A. pentastigma*, *A. centripunctella* sp. n., *A. joannoui* sp. n., *A. antennata* sp. n.) or as wrinkled tube (*A. longicornuta* sp. n.), not developed by the remaining species. Ostium bursae surrounded with sub-ovate (*A. longicornuta* sp. n.), v-shaped (*A. antennata* sp. n.), rounded (*A. morogorensis* sp. n.), sub-rectangular (*A. rooiklipella* sp. n., *A. griseella* sp. n.) sclerite or with sclerite of another shape (*A. acaciae* sp. n., *A. centripunctella* sp. n.), sometimes sub-ostial area without modification (*A. brandbergensis* sp. n., *A. joannoui* sp. n.). Ductus bursae usually slender, moderately short, in exceptional cases very broad with indistinct transition to corpus bursae and with short lateral appendix at $\frac{1}{3}$ length (*A. acaciae* sp. n.), finely papillated in some species (*A. rooiklipella* sp. n., *A. centripunctella* sp. n., *A. joannoui* sp. n.). Corpus bursae globular, pear-shaped or distinctly prolonged (*A. brandbergensis* sp. n.); signa varying in shape: brush-shaped (*A. centripunctella* sp. n.), a prolonged sclerite laterally covered with small spikes (*A. morogorensis* sp. n., *A. rooiklipella* sp. n., *A. griseella* sp. n., *A. africanella* sp. n., *A. longicornuta* sp. n.), a spinose plate (*A. antennata* sp. n.), reduced by *A. acaciae* sp. n., *A. brandbergensis* sp. n., *A. joannoui* sp. n.; corpus bursae in *A. pentastigma* covered with numerous teeth and spikes, in *A. namibiensis* sp. n. with narrow sub-ovate belt consisting of very small spikes.

Distribution. Afrotropical (South Africa, Zimbabwe, Namibia, Botswana, Kenya, Tanzania, Ethiopia) and Oriental (India) regions.

Biology. *A. pentastigma*, *A. acaciae* sp. n., *A. africanella* sp. n. and *A. melliferae* sp. n. were reared from

various *Acacia*-species in Kenya (Agassiz and Bidzilya 2016 in press). *A. atripalpis* were bred from *Acacia* [*Senegalia*] *katechu* (L.f) P.J.H. Hurter & Mabb. in India. It is most likely that *Acacia* s. l. (Fabaceae) is a host plant for most of the *Aphanostola*-species.

In the southern Africa the adults were observed from late August to early May, up to 2000 m elevation in Auas Mts and Brandberg, easily attracted to light. In East Africa adults fly from August to January up to 1850 m elevation.

Key to adults based on external characters

(Note: *A. joannoui* sp. n., *A. antennata* sp. n., *A. longicornuta* sp. n., *A. alternella* sp. n. and *A. rooiklipella* sp. n., *A. melliferae* sp. n., *A. africanella* sp. n. can hardly be distinguished from each other without examination of the genitalia)

- 1 Wingspan 9.5–10.5 mm, forewing light brown with brown dots..... *A. maxima* sp. n.
- Wingspan less than 9.5 mm 2
- 2 Forewing white with distinct black markings..... *A. acaciae* sp. n.
- Forewing otherwise coloured..... 3
- 3 Forewing yellow, black markings large..... 4
- Forewing grey, light brown, cream or light yellow, black markings usually small 5
- 4 Black spot on $\frac{3}{4}$ of dorsum large, forewing comparatively narrow, 7.1 mm..... *A. morogorensis* sp. n.
- Black spot on $\frac{3}{4}$ small, forewing comparatively broad, 6.2 mm..... *A. aarviki* sp. n.
- 5 Forewing light yellow or cream-white 6
- Forewing grey..... 7
- 6 Forewing light yellow, costal margin without black irroration, 7.1–7.5 mm *A. calderae* sp. n.
- Forewing cream-white, costal margin with black irroration, 5.8–6.1 mm..... *A. brandbergensis* sp. n.
- 7 Forewing with large brown, transverse spot in middle *A. centripunctella* sp. n.
- Forewing without large brown, transverse spot in middle 8
- 8 Wingspan 8.0–9.1 mm 9
- Wingspan less than 8.0 mm 10
- 9 Forewing black-brown without markings, head brown, 8.0–8.2 mm..... *A. kenyella* sp. n.
- Forewing grey with rounded black spot in middle, head white, 9.0–9.1 mm *A. namibiensis* sp. n.
- 10 Forewing long and narrow, with four black spots in cell and three black spots on costal margin *A. pentastigma*
- Forewing shorter and broader..... 11
- 11 Forewing light brown 12
- Forewing grey..... 13
- 12 Forewing densely mottled with black irroration..... *A. kruegeri* sp. n.
- Forewing without black irroration..... *A. emarginata* sp. n.
- 13 Forewing uniformly grey *A. atripalpis*
- Forewing with black markings..... 14
- 14 Forewing comparatively dark, grey *A. joannoui* sp. n., *A. antennata* sp. n., *A. longicornuta* sp. n., *A. alternella* sp. n.
- Forewing comparatively light grey, with white pattern 15
- 15 Forewing uniformly grey except of margins mottled with black *A. griseella* sp. n.
- Forewing with black markings in cell *A. rooiklipella* sp. n., *A. melliferae* sp. n., *A. africanella* sp. n.

Key to male based on genitalia

(Note: The male of *A. griseella* sp. n. is unknown)

- 1 Projection of phallus present..... 2
- Projection of phallus absent..... 13
- 2 Vesica with one long cornutus, lateral vincular projections very long..... *A. longicornuta* sp. n.
- Vesica with several small cornuti or without cornutus, lateral vincular projections short or absent 3
- 3 Phallus as long as or slightly longer than saccus..... *A. antennata* sp. n.
- Phallus twice as long as saccus 4
- 4 Projection of phallus very short, reaching $\frac{1}{5}$ of its length..... *A. kruegeri* sp. n.
- Projection of phallus long, reaching at least $\frac{3}{4}$ of its length..... 5
- 5 Tooth on inner margin of valva situated close to sacculus and joined on base 6
- Tooth on inner margin of valva situated more distally from sacculus 8
- 6 Phallus with apical tooth *A. kenyella* sp. n.
- Phallus without apical tooth 7

7	Tooth on inner margin of valva about as long as sacculus	<i>A. centripunctella</i> sp. n.
–	Tooth on inner margin of valva much shorter than valva.....	<i>A. alternella</i> sp. n.
8	Sacculus twice as broad as valva in middle.....	<i>A. joannoui</i> sp. n.
–	Sacculus as broad or narrower than valva in middle.....	9
9	Lateral vincular projections large, rounded, phallus strongly pointed apically	<i>A. rooiklipella</i> sp. n.
–	Lateral vincular projections small or absent, phallus not pointed apically or gradually tapered	
10	Phallus serrated laterally in distal portion.....	11
–	Phallus not serrated in distal portion.....	12
11	Saccus rounded apically, process of phallus broadened at apex, vesica with small cornuti	<i>A. acaciae</i> sp. n.
–	Saccus pointed apically, process of phallus not broadened at apex, vesica without cornuti.....	<i>A. calderae</i> sp. n.
12	Saccus long, subrectangular, process of phallus arising from 1/3 of its length	<i>A. morogorensis</i> sp. n.
–	Saccus triangular, process of phallus arising from about middle of phallus.....	<i>A. pentastigma</i>
13	Uncus covered with short setae	<i>A. atripalpis</i>
–	Uncus covered with long setae.....	14
14	Vesica with 7–9 cornuti	<i>A. africanella</i> sp. n.
–	Vesica without cornuti	15
15	Saccus stout, broadly rounded	<i>A. melliferae</i> sp. n.
–	Saccus smaller.....	16
16	Tegumen broad, trapezoid, sacculus sub-rectangular.....	<i>A. maxima</i> sp. n.
–	Tegumen narrow, elongate sub-rectangular	17
17	Saccus comparatively long, pointed apically, sacculus very short, hump-shaped.....	<i>A. emarginata</i> sp. n.
–	Saccus comparatively short, rounded, sacculus longer.....	18
18	Sacculus narrow, long, uncus longer than broad	<i>A. namibiensis</i> sp. n.
–	Sacculus broader and shorter, uncus broader than long or rounded	19
19	Uncus rounded, sacculus strongly pointed, phallus without apical thorn	<i>A. aarviki</i> sp. n.
–	Uncus heart-shaped, sacculus weakly pointed, phallus with single apical thorn	<i>A. brandbergensis</i> sp. n.

Key to female based on genitalia

(Note: The females of *A. calderae* sp. n., *A. kenyella* sp. n., *A. emarginata* sp. n., *A. aarviki* sp. n., *A. maxima* sp. n., *A. alternella* sp. n. are unknown; the female of *A. atripalpis* has not been examined.)

1	Signum present.....	2
–	Signum absent.....	8
2	Antrum longer than half length of apophyses anteriores.....	3
–	Antrum shorter than half length of apophyses anteriores	5
3	Signum a prolonged plate with small teeth	<i>A. africanella</i> sp. n.
–	Signum a prolonged plate covered with spikes and with cord inside	4
4	Antrum distinctly longer than apophyses anteriores, subostial sclerite with posterior projection	<i>A. rooiklipella</i> sp. n.
–	Antrum sub-equal in length to apophyses anteriores, subostial sclerite without posterior projection	<i>A. griseella</i> sp. n.
5	Signum a large, rounded plate with numerous spikes.....	<i>A. morogorensis</i> sp. n.
–	Signum of another shape	6
6	Signum brush-shaped, corpus bursae large, rounded; subostial sclerite big, of irregular shape	<i>A. centripunctella</i> sp. n.
–	Signum a weakly curved, narrow plate, corpus elongated; subostial sclerite narrow.....	<i>A. kruegeri</i> sp. n.
7	Ductus bursae coiled, posterior portion weakly wrinkled, signum a prolonged plate with serrated margins	
–	Ductus bursae not coiled and without wrinkles, signum a spinose plate.....	<i>A. longicornuta</i> sp. n.
8	Ductus bursae with short appendix.....	<i>A. acaciae</i> sp. n.
–	Ductus bursae without appendix.....	9
9	Corpus bursae covered with numerous spikes	<i>A. pentastigma</i>
–	Corpus bursae without spikes	10
10	Ductus bursae with sclerotized band	<i>A. melliferae</i> sp. n.
–	Ductus bursae without sclerotized band	11
11	Subostial sclerite absent	<i>A. brandbergensis</i> sp. n.
–	Subostial sclerite present	12
12	Sternum VIII with sclerotized patches arising from base of apophyses anteriores, subostial sclerite digitate	
–	Sternum VIII without sclerotized patches, subostial sclerite a transverse prolonged plate	<i>A. namibiensis</i> sp. n.
–	Sternum VIII without sclerotized patches, subostial sclerite a transverse prolonged plate	<i>A. joannoui</i> sp. n.

Review of species

Aphanostola acaciae Bidzilya & Mey, sp. n.

<http://zoobank.org/CF042B14-D95D-4369-BAE0-0713B53BC496>

Figs 1–3, 41, 42, 65

Genus 1, sp. 1. – Bidzilya 2007: 94, figs 2, 5; pl. 5, figs 2, 3. *Aphanostola* sp. 1 – Agassiz and Bidzilya 2016 (in press).

Type material. Holotype ♂, [Namibia] 20 km NW Uis, LF, 27.ii.2002 (Turm) (Mey) (gen. slide 101/05, O. Bidzilya) (MfN). Paratypes: 1 ♂, 2 ♀, Namibia, Brandberg, Ugab, LF (MEY), 30.xi.2000, LF (gen. slide 78/05♀; 224/12♂; 575/14♂, O. Bidzilya) 1 ♀, Namibia, 10 km W Brandberg, 28.ii.2002 (Turm) (Mey) (gen. slide 73/05, O. Bidzilya); 2 ♂, 1 ♀, Namibia, Omatako Ranch, LF, 22–23.iii.2003 (Mey) (gen. slide 501/14♂, O. Bidzilya); 1 ♂, Namibia, Mile 46, 18 18 S, 19 15 E, 24–26.iii.2003 (Mey); 2 ♂, Namibia, Erichsfelde, 21 35 S, 16 56 E, 19–21.iii.2003 (Mey) (gen. slide 164/15, O. Bidzilya); 2 ♀, Namibia, Waterberg NP, 21–22.xi.2000, LF (Mey); 2 ♂, 2 ♀, Namibia, Namutoni, Etosha Nat. Park, 14–16.xii.1993 (Mey & Ebert); 1 ♀, Namibia, Etosha, Namutoni, 7.xi.1999 (Mey); 2 ♀, Namibia, Namutoni, Etosha NP, 23–25.xi.2000, LF (Mey) (gen. slide 152/15, O. Bidzilya); 1 ♂, Namibia, Okatjikona, Waterberg Nat. Park, 14–16.ii.2008, LF (Mey); 1 ♂, NAMIBIA-Exp., ZMB 1992, E. Caprivi, Katima Mulilo, 17 29 S/ 24 17 E, lux, 3–8.iii.92 (Mey); 1 ♂, 2 ♀, Namibia, Naukluft, Tsams-Ost, 3.xii.08 (Ebert, Mey & Kune); 4 ♀, Namibia, Mirabib, Central Namib, 27.i.2009, LF (Mey) (gen. slide 548/14, O. Bidzilya); 1 ♂, 1 ♀, Namibia, Auas Mts., Windhoek, 1917 m, 25.i.2009 LF (Mey); 1 ♀, RSA, Transvaal, Nylsvley Nat. Res., 29.xi.2004, LF, Turm (Mey); 1 ♂, Namibia, Gamsberg, Rooiklip Farm, 10–11.ix.2012 (Mey) (gen. slide 496/14, O. Bidzilya); 4 ♀, Namibia, Rooisand, Gamsberg Pass, 20.i.2007, aut. Falle (Mey & Ebert) (gen. slide 200/12; 201/12; 42/15, O. Bidzilya) (all MfN); 2 ♂, [Namibia] Gobabeb, Game Reserve No. 3, 12–17.iv.1967 (Potgieter) (gen. slide 57/15, O. Bidzilya); 3 ♂, S.W.Afr., Namib, Gobabeb, 23.24 S – 15.03 E, 3.x.1974: E-Y447, light trap (Endrödy-Younga) (gen. slide 35/15, O. Bidzilya); 1 ♂, Abachaus, SWA, xii.1946 (Hobohm) (gen. slide 16/15, O. Bidzilya) (all TMSA); 1 ♂, **South Africa**, Kgalagadi, Transfrontier Park, Mata Mata, 950 m, 18.xii.2009, 25 15 403 S; 021 38 427 E (Wieser) (gen. slide 513/14, O. Bidzilya) (LMK); 1 ♀, **Zimbabwe**, 6–10.iv.1954 (Janse) (gen. slide 19/15, O. Bidzilya) (all TMSA); 1 ♂, **Kenya**: Rift Valley, Logumgum 1000 m, 0°27'N, 36°05'E, e.l. *Acacia tortilis*, em. 1.ix.2007 (Agassiz) (gen. slide 1362, O. Bidzilya) (coll. Agassiz).

Diagnosis. The species is recognizable externally by the white or light grey forewing with a black dash at base of costa, two black dashes at base of fold and three distinct black spots in cell. The male genitalia differ from the rest of *Aphanostola* species in the very short uncus in combination with apically narrowed saccus, the long, strongly curved gnathos, the basal projection of the phallus broadened at apex and the presence of small cornuti

in the vesica. The female genitalia can be recognized unmistakably by the shape of the antrum and by the broad ductus bursae bearing a lateral appendix.

Description. Adult (Figs 1–3). Wingspan 7.2–8.4 mm. Head, thorax and tegulae light grey to white; labial palpus up-curved, segment two black with white apex, segment three white with broad black ring in middle; antenna in male thicker than in female, scape brown with some white scales beneath, other segments brown with white rings. Forewing white to light grey, costal margin black from base to 1/3 length, single black scales sparsely scattered along costal and dorsal margins; two black dashes in fold, sometimes merging; two black spots at base of cell and one black spot in corner of cell; cilia white, black-tipped. Hindwing white to greyish white.

Variation. Ground colour of forewing varies from white to light grey.

Male genitalia (Figs 41, 42). Uncus very short, posterior margin weakly emarginated, covered with strong setae; gnathos long, curved by nearly right angle in middle; tegumen broad, with deep and broad anterior emargination; valva weakly narrowed in middle, apical half distinctly inflated, teeth on inner margin indistinct; sacculus narrow, thorn-shaped; vinculum moderately broad with short projections on posterior margin, medial postero-medial incision narrow; saccus broad at base, narrow distally, apex abruptly cut or rounded, exceeding far beyond apex of pedunculus; phallus wide, apex with group of 3–8 very small cornuti and three lateral teeth, basal projection slightly shorter than length of phallus, its apex weakly widened.

Variation. Uncus sometimes reduced to short, paired hump.

Female genitalia (Fig. 65). Segment VIII weakly sclerotized, distinctly shorter than apophyses anteriores; antrum broad, rounded; left side with a few teeth; sub-ostial sclerite narrow, prolonged with outwardly curved apex; ductus bursae of moderate width in basal 1/3, then very wide with indistinct transition to prolonged corpus bursae, short lateral appendix at 1/3 length; signum absent.

Etymology. The specific epithet refers to the host-plant, *Acacia tortilis*, of the new species.

Distribution. South Africa, Namibia, Zimbabwe, Kenya.

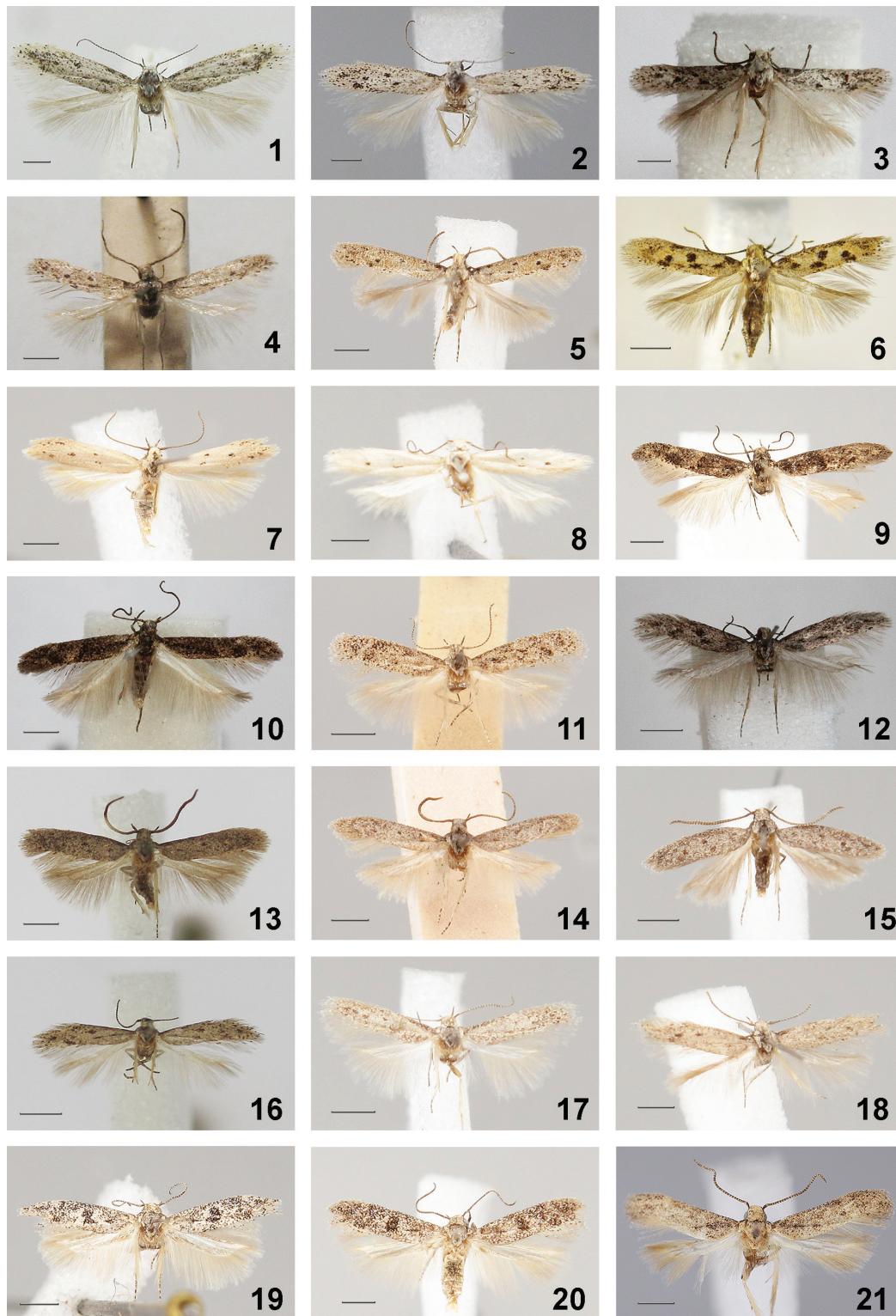
Biology. The larva feeds on *Acacia tortilis* (Forssk.) Hayne (Fabaceae) in Kenya (Agassiz and Bidzilya 2016 in press). Adults were collected from late August to early June.

Aphanostola pentastigma (Janse, 1960)

Figs 4, 5, 43, 66, 67

Lanceopenna pentastigma Janse, 1960 – Moths of South Africa, 6 (2): 216, pl. 105, pl. 109f, pl. 121e, pl. 118 h, i. *Aphanostola pentastigma* (Janse, 1960) – Agassiz and Bidzilya 2016 (in press).

Material examined. Holotype of *L. pentastigma*, ♀, [South Africa], Pretoria, 28.viii.1937 (Vári) (gen. slide.



Figures 1–21. Adults of *Aphanostola* spp. (scale bar 1.0 mm) **1.** *A. acaciae* sp. n., Namibia, Brandberg (gen. slide 73/05); **2.** *A. acaciae* sp. n., Namibia, Mirabib (gen. slide 548/14); **3.** *A. acaciae* sp. n., Kenya, Logumgum (gen. slide 1362); **4.** *A. pentastigma*, HT, RSA, Pretoria; **5.** *A. pentastigma*, Kenya, L. Naivasha; **6.** *A. morogorensis* sp. n., HT, Tanzania, Morogoro Town; **7.** *A. calderae* sp. n., RSA, Asante-Sana; **8.** *A. calderae* sp. n., HT, RSA, Asante-Sana; **9.** *A. kenyella* sp. n., Kenya, between Limuru and Mai Mahiu (gen. slide 1497); **10.** *A. kenyella* sp. n., HT, Kenya, between Limuru and Mai Mahiu; **11.** *A. kruegeri* sp. n., RSA, Pretoria (gen. slide 8/15); **12.** *A. alternella* sp. n., HT, Kenya, Turi; **13.** *A. antennata* sp. n., HT, Namibia, Popa Falls; **14.** *A. antennata* sp. n., RSA, Nwanedzi (gen. slide 36/15); **15.** *A. antennata* sp. n., Namibia, Kavango; **16.** *A. rooiklipella* sp. n., HT, Namibia, Rooiklip Farm; **17.** *A. griseella* sp. n., HT, Namibia, Grootfontein; **18.** *A. griseella* sp. n., Kenya, Nakuru NP (gen. slide 596/14); **19.** *A. centripunctella* sp. n., Namibia, E. Caprivi (gen. slide 76/05); **20.** *A. centripunctella* sp. n., Namibia, E. Caprivi; **21.** *A. centripunctella* sp. n., Namibia, E. Caprivi (gen. slide 155/15).

8394), *L. pentastigma* Janse, ♀, Holotype No: 3684. Paratypes: ♂, Pretoria, 30.x.1948 (Vári) (gen. slide 8781), 2 ♂, Gladde Klipkop, 1–9.iii.1954 (Janse) (gen. slide 254/12, O. Bidzilya); 1 ♀, Pretoria, 20.x.1952 (Vári) (gen. slide 260/12, O. Bidzilya); 1 ♀, Pretoria, 10.i.1951 (Vári); 1 ♂, Pretoria, 21.viii.1949 (Vári); 1 ♂, Pretoria, 15.viii.1953, e.l. *Acacia* sp. (Vári); 1 ♂, Pretoria, 8.i.1975 (Vári) (gen. slide 32/15, O. Bidzilya); 1 S, Pafuri, K.N.P. Survey, 8.v.1975 (Potgieter & Scoble) (gen. slide 44/15, O. Bidzilya) (all TMSA); 1 ♀, Zimbabwe, 6–10. iv.1954 (Janse); 1 ♀, Kei River Bridge, 5–6.ii.1955 (Janse) (slide venation 2913) (TMSA); 9 ♂, 9 ♀, Kenya: Rift Valley, L. Naivasha 1900 m, 0°47'S, 36°24'E, l. on *Acacia xanthophloea*, em. 18–23.xi, 4–10.xii.2003 (Agassiz) (gen. slide 1357♂; 1358♀, O. Bidzilya); 1 ♂, 1 ♀, KENYA: Rift Valley, L. Naivasha 2000 m, 0°45'S, 36°24'E, ex l. on *Acacia xanthophloea*, em. 27.iv.2003 (Agassiz) (gen. slide 1357♂; 614/14♀, O. Bidzilya) (coll. Agassiz); 2 ♂, 1 ♀, Kenya, Nakuru National Park, Makalia Falls Camp Site, 00°25'S 036°04'E, 1830 m, 11.x.2001 (J. De Prins) (BMNH).

Diagnosis. *L. pentastigma* is recognizable externally by the narrow, prolonged forewing with four black spots in cell and two black spots on costal margin. The male genitalia resemble those of *A. acaciae* sp. n., but the uncus is longer, the saccus is narrower, the phallus lacks cornuti and teeth, and the basal projection is shifted nearly to the middle. The female genitalia differ from the other *Aphanostola* species in the presence of numerous spikes on the wall of the corpus bursae.

Redescription. Adult (Figs 4, 5). Wingspan 7.2–8.0 mm. Head, thorax and tegulae covered with grey black-tipped scales, frons light grey; labial palpus weakly up-curved, pale with broad black medial belts, segment two whitish on inner surface; antenna in male finely ciliated and thicker than antenna in female, scape black, other antennal segments grey with narrow black rings at base. Forewing grey densely suffused with brown, black spot just at base, at 1/4 and 1/3 of costal margin; four black spots in cell: two in fold, one in middle under costal margin and last one in corner of cell; diffuse black spot at 2/3 of dorsal margin, apex mottled with black, termen black spotted; cilia grey. Hindwing grey.

Male genitalia (Fig. 43). Uncus more than two times broader than long, posterior margin with broad and shallow emargination, densely covered with strong setae; gnathos long, curved before middle, weakly broadened in distal portion, with pointed tip; tegumen broad, with deep and broad anterior emargination; distal half of valva gradually widened towards rounded apex, inner margin with very small tooth; saccus narrow, beak-shaped; vinculum moderately broad with short projections on posterior margin, postero-medial incision narrow; saccus broad at base, triangular, apex weakly pointed, slightly exceeding beyond the apex of pedunculus; phallus gradually tapered, basal projection narrow, shifted nearly to middle of phallus.

Female genitalia (Figs 66, 67). Segment VIII without modification, weakly sclerotized, distinctly shorter

than apophyses anteriores; antrum short, funnel-shaped; sub-ostial sclerite cup-shaped; ductus bursae long, narrow, weakly widened before entrance to globular corpus bursae; signum absent, but corpus bursae covered with a number of teeth and spikes.

Variation. The specimens from Kenya have no teeth on the wall of the corpus bursae, only spikes are present, and their number is much smaller than in females from South Africa; the corpus bursae is distinctly smaller too, the ductus bursae is broader, the transition to the corpus bursae is more gradual.

Distribution. South Africa, Zimbabwe, Kenya.

Biology. Larva feeds on *Acacia xanthophloea* Benth. (Fabaceae) in Kenya (Agassiz and Bidzilya 2016 in press) and in *Acacia* sp. in South Africa. Adults were observed from late August to early April, up to 1830 m elevation in Kenya.

Notes. *Lanceopenna pentastigma* was described from nine specimens of both sexes collected in South Africa and Zimbabwe. We were able to examine the type series. The genitalia of both sexes match well with those of *Aphanostola*, therefore the species was transferred to this genus (Bidzilya and Agassiz 2016 in press).

The specimens from Kenya agree well externally with specimens from the type series and also in the male genitalia, but differ in some details in the female genitalia (see above). However, we do not consider these to be separate species.

Aphanostola morogorensis Bidzilya, sp. n.

<http://zoobank.org/B92045EC-677F-4E58-94BC-4C359DA5F285>

Figs 6, 44, 68

Type material. Holotype ♂, Tanzania, Morogoro, Morogoro Town, 20.ix.1992 (Aarvik) (gen. slide 2378, O. Bidzilya) (MNHO). Paratype: 1 ♀, same data as holotype but 13.ix.1992 (gen. slide 2375, O. Bidzilya) (MNHO).

Diagnosis. The new species is very similar externally to *A. aarviki* sp. n., but larger, the forewing is narrower and black spot on ¾ of dorsum is larger. The male genitalia are most close to those of *A. acaciella* sp. n. but differ in the longer saccus, the bigger vincular projections, a slenderer phallus and in other details. The female genitalia remotely resemble those of *A. africanella* sp. n., but the antrum is not developed and the signum is larger, rounded rather than elongated.

Description. Adult (Fig. 6). Wingspan 7.1 mm. Head, thorax and tegulae light brown, frons lighter, dark yellow, labial palpus yellow with broad black medial rings, scape brown, other segments brown with yellowish rings; forewing yellow, costal margin and subapical area mottled with black, two black spots just at base of costal margin and middle width near the base, black spot in middle of cell and another prolonged spot below near dorsum, two black spots in 2/3 near dorsal margin; cilia grey. Hindwing grey.

Male genitalia (Fig. 44). Uncus very short, posterior margin weakly emarginated, with strong long setae;

gnathos long, evenly curved in basal half, distal portion straight, weakly widened before narrow tip; tegumen broad, with deep and broad anterior emargination; valva straight, apical half distinctly inflated, curved outwardly; sacculus narrow, digitate, straight, weakly constricted before apex; vinculum moderately broad, posterior margin with broad, comparatively big medial projections, lateral projection very small, tooth-shaped, postero-medial incision narrow; saccus parallel-sided, apex tapered, far exceeding beyond apex of pedunculus; phallus narrow, vesica with three small cornuti, basal projection extending from 1/3 length, slightly shorter than phallus.

Female genitalia (Fig. 68). Segment VIII weakly sclerotized, distinctly shorter than apophyses anteriores; apophyses posteriores very long, slender; antrum short, narrow; sub-ostial sclerite rounded, edged posteriorly; ductus bursae long, narrow, gradually broadened in distal half towards rounded corpus bursae; signum a big rounded plate densely covered with small spikes, with tapered posterior process.

Etymology. The name refers to the type locality.

Distribution. Tanzania.

Biology. The host plant is unknown. The adults have been collected in September.

Aphanostola calderae Bidzilya & Mey, sp. n.

<http://zoobank.org/71E004FA-DE31-4302-AC3F-931D4112062E>

Figs 7, 8, 45, 46

Type material. Holotype ♂, [South Africa], RSA, East. [ern] Cape, Sneeu Berg [area], Asante-Sana, 2.-6. iv.2011 (Mey) (gen. slide 184/12, O. Bidzilya) (MfN). Paratypes: 5 ♂, same locality, 22-26.i.2012 (Mey) (gen. slide 582/14; 609/14, O. Bidzilya) (all MfN).

Diagnosis. The new species is well recognizable externally by the yellow-white forewing with black markings. The male genitalia resemble those of *A. acaciae* sp. n. but differ in the longer uncus, the inner margin of the valva bearing a medial thorn, the sacculus not constricted before apex, the triangular saccus, and the shorter process of the phallus.

Description. Adult (Figs 7, 8). Wingspan 7.1-7.5 mm. Head, thorax and tegulae white, labial palpus weakly up-curved, brown with white apical rings, inner surface white; antenna dark brown, ciliated in male; forewing yellow-white, black dot in middle of cell, black dash in middle of fold, black spot on 2/3 near dorsal margin, a few black dots along termen, cilia white. Hindwing and cilia white.

Male genitalia (Figs 45, 46). Uncus short, twice as broad as long, covered with strong, long setae, posterior margin weakly emarginated in middle; gnathos narrow, weakly curved, sickle-shaped; tegumen as a right angle, anterior margin deeply emarginated; basal half of valva straight, basal half of inner margin strongly sclerotized, terminating in a short thorn in the middle of valva length, distal part inflated, hairy, far exceeding top of

uncus; sacculus narrow to moderately wide, prolonged, apex abruptly cut; vinculum moderately broad, posterior margin with very short medial and short triangular lateral humps, postero-medial incision relatively broad; saccus a right-angled triangle or slightly elongated; phallus comparatively wide, straight, edges finely serrated in apical 1/4, apex abruptly cut, about as long as length of valva, basal projection shorter than phallus, narrow, pointed.

Female. Unknown.

Etymology. The name refers to the location of the game farm Asante Sana in the escarpment, where the landscape is reminiscent of a caldera.

Distribution. South Africa.

Biology. Host plant unknown. Adults were collected late January and early April.

Aphanostola kenyella Bidzilya & Agassiz, sp. n.

<http://zoobank.org/470BB9F9-0E57-44A3-95E8-7929A3BD424F>

Figs 9, 10, 47

Type material. Holotype ♂, Kenya, Central, Escarpment, between Limuru and Mai Mahiu, 01°02'09"S, 36°35'58"E, 1850 m, M.V., light, 14.viii.1999 (Agassiz) (gen. slide 578/14, O. Bidzilya) (coll. Agassiz). Paratype: ♂, same data as holotype (gen. slide 1497, O. Bidzilya) (coll. Agassiz).

Diagnosis. *A. kenyella* sp. n. is recognizable externally by the dark, nearly entirely black forewing and comparatively large size. The male genitalia are characterized by the broad sacculus, the narrow saccus and the phallus with distinct lateral teeth on the tip.

Description. Adult (Figs 9, 10). Wingspan 8.0-8.2 mm. Head and thorax brown, frons light brown, labial palpus weakly up-curved, segment two black with white apex, segment three black with white ring at base, apex white, scape black, other segments black with narrow whitish rings at base, finely ciliated by male; tegulae black with rare brown tipped scales; ground colour of forewing black to light brown, diffuse light brown medial fascia from 1/2 to 2/3 length, greyish indistinct spots on 3/4 length on both margins, light brown sub-apical area separated with black pattern of irregular shape from light brown medial fascia, cilia brown, black-tipped. Hindwing grey.

Variation. Forewing, head and thorax varies from those of described above to dark, nearly uniformly black.

Male genitalia (Fig. 47). Uncus twice as broad as long, posterior margin with deep v-shaped medial incision; gnathos strongly curved, apical 1/4 weakly widened; tegumen twice as long as broad, anteromedial incision deep and broad; valva straight, inner margin strongly sclerotized, terminating in a short thorn merged with the posterior margin of the sacculus; sacculus stout, sub-triangular, broader than valva; vinculum slightly broader than long, posterior margin with short triangular medial projections, medial incision deep and narrow, lateral projections short, hump-shaped, placed very close to sacculus; saccus narrow, far exceeding beyond the tip of pedunculus; phallus

about as long as valva, gradually narrowed apically, with distinct lateral teeth on apex, basal projection narrow, not reaching the tip of phallus.

Female. Unknown.

Etymology. The species name refers to the country of occurrence of the new species.

Distribution. Kenya.

Biology. Host plant unknown. The specimens from the type-series were collected in mid-August at 1850 m elevation.

***Aphanostola kruegeri* Bidzilya & Mey, sp. n.**

<http://zoobank.org/510FAAFA-E485-4EBA-939E-EEF2F8E21C3E>

Figs 11, 48, 81

Type material. Holotype ♀, [South Africa] Pretoria, 1.ii.1951 (Vári) (gen. slide 8/15, O. Bidzilya) (TMSA). Paratypes: 1 ♂, same data as holotype but 19.x.1951 (gen. slide 6/15, O. Bidzilya); 1 ♂, same data but 18.i.1950 (gen. slide 8332); 1 ♂, Pretoria N, 26.i.1954 (Vári) (gen. slide 4/15, O. Bidzilya); 1 ♀, Pretoria N, 27.i.1951 (gen. slide 11/15, O. Bidzilya) (all TMSA).

Diagnosis. The new species is externally very similar to *A. emarginata* sp. n. in having brown forewing, but the forewing is densely black irrorated. The male genitalia are defined by the very short basal projection of the phallus. The elongated narrow subostial sclerite and the narrow signum are characteristic for the female genitalia.

Description. Adult (Fig. 11). Wingspan 7.3–8.1 mm. Head, thorax and tegulae covered with grey brown-tipped scales, labial palpus brown, segment two mixed with grey on inner side, segment three with white medial belt and white apex, antenna in male thicker than antenna in female, finely ciliated, scape brown, flagellum with alternated brown and whitish rings; forewing brown, costal margin mottled with black, diffuse black spot at 2/3 on both margins, black dot in fold, paired black spots in cell, apical ¼ scattered with black, cilia grey, black tipped. Hindwing light grey.

Variation. Some specimens with blackish dorsal margin of forewing.

Male genitalia (Fig. 48). Uncus broader than long, posterior margin distinctly emarginated; gnathos long, gradually curved in basal half, weakly broadened before pointed tip; tegumen sub-trapezoidal, anterior margin twice as long as posterior margin, anteromedial emargination broad, moderately deep; basal half of valva straight, inner margin with distinct thorn just after sacculus, distal half narrow, densely haired, apex rounded; sacculus stout, triangular, broader than valva; vinculum moderately broad, medial projections short, rounded, medial incision very narrow; saccus basally broad, then tapered, far exceeding beyond apex of pedunculus; phallus weakly narrowed apically, basal projection narrow, nearly reaching tip of phallus.

Female genitalia (Fig. 81). Segment VIII slightly longer than broad, evenly sclerotized, apophyses anteri-

ores about 2.5 times longer than segment VIII; antrum funnel-shaped; sub-ostial sclerite sub-ovate with lateral folds; ductus bursae narrow in posterior part, then broadened gradually to broad corpus bursae; signum narrow, elongate.

Etymology. The species is dedicated to Martin Krüger, Lepidoptera curator in the TMSA, for his continuous help during our work in the collections of the TMSA.

Distribution. South Africa.

Biology. The host plant is unknown. The adults were collected in October, January and February.

***Aphanostola alternella* Bidzilya & Agassiz, sp. n.**

<http://zoobank.org/31062F61-FBB3-4C64-95B7-A625DCD7A146>

Figs 12, 49

Type material. Holotype ♂, Kenya, Rift valley, Turi, 8000ft, 11.iii.2000 (Agassiz) (gen. slide 307/14 (=1538), O. Bidzilya) (coll. Agassiz).

Diagnosis. The new species can be reliably separated from *A. joannoui* sp. n., *A. antennata* sp. n. and *A. longicornuta* sp. n. by the study of the genitalia. The male genitalia are most similar to those of *A. kruegeri* sp. n. but the sacculus is longer, the gnathos is narrower and the basal projection of the phallus is longer than in the mentioned species.

Description. Adult (Fig. 12). Wingspan 7.0 mm. Head, thorax and tegulae greyish-brown, labial palpus brown mottled with black, segment two mixed with grey on inner side, segment three with white medial belt and white apex, antenna in male moderately thick, finely ciliated, scape brown, flagellum with alternating brown and whitish rings; forewing grey, costal margin and apical 1/4 mottled with black, two black spots in cell; cilia grey, black tipped; hindwing light grey.

Male genitalia (Fig. 49). Uncus heart-shaped, posterior margin with deep medial emargination; gnathos long, narrow, slightly broadened before apex, gradually curved in basal half; tegumen sub-trapezoidal, anterior margin twice as long as posterior margin, anteromedial emargination broad, moderately deep; basal part of valva straight inner margin with distinct narrow thorn just after the sacculus, distal part densely haired, apex rounded; sacculus stout, elongated, as broad as valva, narrowed towards pointed apex, outer margin strongly curved; vinculum moderately broad, medial projections deep and narrow, medial incision very narrow; saccus basally broad, then tapered, slightly exceeding beyond apex of pedunculus; phallus weakly narrowed apically, basal projection narrow, reaching to ¾ length of phallus.

Female. Unknown.

Etymology. The specific name is derived from “alternarius” (Latin), alternating, which refers to the alternating brown and white rings of the antenna.

Distribution. Kenya.

Biology. The host plant is unknown. The adult moth was collected in March at an altitude of 2400 m.

***Aphanostola antennata* Bidzilya & Mey, sp. n.**

<http://zoobank.org/F9855EB9-E425-4BB1-AB14-FA0ABA6CFBFB>
Figs 13–15, 50, 69

Aphanostola sp. – Mey and Kühne 2014: 241.

Type material. Holotype ♂, **NAMIBIA**-Exp., ZMB 1992, Kavango: Popa Falls, 18 07S/ 21 35 E, lux., 26.ii.–3.iii.92 (Mey) (MfN). Paratypes: 12 ♂, 12 ♀, **NAMIBIA**-Exp., ZMB 1992, Kavango: Popa Falls, 18 07S/ 21 35 E, lux., 26.ii.–3.iii.1992 (Mey) (gen. slide 206/12♀; 214/12♂; 433/07♂; 41/15♂, O. Bidzilya); 7 ♂, 2 ♀, **NAMIBIA**-Exp., ZMB 1992, East Caprivi: Mudumu NP: Nakatwa, 18 10 S/ 23 26 E, lux., 8–13.iii.92 (Mey); 1 ♂, 1 ♀, Popa-Falls, Okavango River, 23–24.ii.1993 (Mey & Ebert) (gen. slide 54/08♂, O. Bidzilya; ♀ in glycerol); 1 ♀, same data but 13.xii.1993 (gen. slide 167/15, O. Bidzilya); 1 ♂, Namibia, Mt. Etjo, 30 km E Kalkrand, 14.iii.2005, LF (Mey); 1 ♀, [**South Africa**], RSA, Mpumalanga, Hongonyi Lodge, S 24 27, 17 E 31 4, 56, 30. iv.–1.v.2010, LF (Mey & Kühne) (gen. slide 478/14, O. Bidzilya) (all MfN); 1 ♂, [**RSA**] Skukuza, 3.iv.1952 (Vári) (gen. slide 579/14, O. Bidzilya); 1 ♀, Satara, 27.iii.1952 (Janse & Vári) (gen. slide 27/15, O. Bidzilya); 1 ♂, Nwanedzi, K.N.P. Survey, 30.iv.–1.v.1968 (Potgieter & Goode) (gen. slide 36/15, O. Bidzilya) (all TMSA).

Diagnosis. The new species can be reliably separated from *A. joannoui* sp. n., *A. longicornuta* sp. n., and *A. alternella* sp. n. by comparing the genitalia. The males can be recognized further by the extremely thickened antennae. The male genitalia are similar to those of *A. calderae* sp. n., but can be easily recognized by the short phallus, the short postero-medial incision of the vinculum and the more prolonged tegumen. The female genitalia are characterized by the unique spinose signum and V-shaped antrum.

Description. Adult (Figs 13–15). Wingspan 6.5–8.0 mm. Head, thorax and tegulae covered with grey black-tipped scales, frons off-white, labial palpus weakly up-curved, segment two black with whitish scales at base, segment three black with white basal, medial and apical rings, inner surface lighter, greyish, antenna very thick in male, thin in female, scape black, other antennal segments black with narrow whitish rings at base, underside greyish, finely ciliated by male; forewing grey densely suffused with brown along margins and particularly on apex, four diffuse brown dots in cell, cilia grey, brown-tipped; hindwing grey.

Male genitalia (Fig. 50). Uncus twice as broad as long, posterior margin slightly emarginated; gnathos evenly curved, of even width except for pointed tip; tegumen comparatively long, weakly narrowed distally, antero-medial emargination large, triangular; valva straight in basal half, distal portion turned outwards, weakly widened, apex rounded; sacculus narrow to moderately wide, thorn- or finger-shaped; vinculum broad, posterior margin with very short medial humps, postero-medial inci-

sion relatively broad but short; saccus triangular, tapered, slightly exceeding beyond the top of pedunculus; phallus short, about 2.5 times longer than broad, apex abruptly cut, basal projection relatively broad, distinctly shorter than phallus with rounded apex.

Female genitalia (Fig. 69). Segment VIII twice as long as broad, evenly sclerotized; apophyses anteriores moderately thick, twice as long as segment VIII; antrum short, funnel-shaped; lateral sub-ostial sclerite narrow horn-shaped; ductus bursae gradually broadened towards large, globular corpus bursae; signum a spinose plate.

Etymology. The specific name refers to the thickened antenna of the male.

Distribution. South Africa, Namibia.

Biology. Host plant unknown. Adults occur from November to December and from February to early May.

***Aphanostola rooiklipella* Bidzilya & Mey, sp. n.**

<http://zoobank.org/6E6F7B55-91F7-4807-A91E-26DAC7A50B24>
Figs 16, 51, 70, 71, 71a

Type material. Holotype ♀, **Namibia**, Gamsb[er]g., Rooiklip Farm, 10–11.ix.20012, LF (Mey) (MfN). Paratypes: 8 ♀, same data as holotype (gen. slide 495/14; 547/14; 554/14, O. Bidzilya); 1 ♀, Namibia, Rooisand, Gamsberg Pass, 20.i.2007, aut[omatische] Falle (Mey & Ebert) (gen. slide 203/12, O. Bidzilya); 1 ♂, 1 ♀, Namibia, Omatako Ranch, LF, 22–23.iii.2003 (Mey) (gen. slide 213/12♂, 66/15♀, O. Bidzilya); 1 ♀, Namibia, Otjiwarongo, Hohenfels, 25–27.viii.2012, LF (Mey) (gen. slide 561/14, O. Bidzilya) (MfN); 1 ♀, **RSA**, Natal, Mkuzi, [15°sq NW cnr, 27 30'S, 32 05'E], 23–26.iv.1982 (Soble, Laurenson & Kroon) (gen. slide 45/15, O. Bidzilya) (TMSA).

Diagnosis. The new species can reliably be separated from *A. melliferae* sp. n. and *A. africanella* sp. n. by the genitalia. The male genitalia most resemble those of *A. acaciae* sp. n., but are well recognizable by the presence of the big rounded lateral, vincular projections in combination with sub-rectangular tegumen and apically tapered phallus. The female genitalia resemble those of *A. griseella* sp. n., but the antrum is distinctly longer than the apophyses anteriores in *A. rooiklipella* sp. n. whereas the antrum in *A. griseella* sp. n. is sub-equal in length to apophyses anteriores; moreover the sub-ostial sclerite in *A. griseella* sp. n. is shorter and having shorter posterior projections.

Description. Adult (Fig. 16). Wingspan 6.2–6.4 mm. Head, thorax and tegulae covered with grey black-tipped scales, frons off-white, labial palpus weakly up-curved, segment two black with whitish scales at base, segment three black with white basal, medial and apical rings, inner surface lighter, greyish, antenna thick in male, thin in female, finely ciliated in both sexes, scape black, other antennal segments black with narrow whitish rings at base, underside greyish; forewing light grey densely suffused with brown along margins and particularly on apex,

three prolonged brown spots in cell, diffuse brown dash in fold, cilia grey, brown-tipped; hindwing grey.

Male genitalia (Fig. 51). Uncus about as broader as long, weakly widened apically, posterior margin slightly emarginated; gnathos sickle-shaped; tegumen sub-rectangular, 1.5 times longer than broad, anterior margin with comparatively shallow, rounded emargination; valva straight, inner margin with distinct thorn at 2/3 length, distal 1/3 inflated, hairy; sacculus prolonged, narrow, curved inwardly; vinculum narrow, posterior margin with short medial and long lateral projections, anteromedial emargination shallow; saccus broad, triangular, slightly exceeding beyond apex of pedunculus; phallus with pointed apex, basal projection arises from 1/3 length of phallus and exceeding nearly to its tip.

Female genitalia (Figs 70, 71, 71a). Segment VIII nearly as long as broad, evenly sclerotized; apophyses anteriores moderately thick, twice as long as segment VIII; antrum long, tubular, exceeding the tips of apophyses anteriores; sub-ostial sclerite sub-rectangular with long posterior projection; ductus bursae narrow; corpus bursae sub-ovate; signum a long sub-triangular plate densely covered with spikes and with medial cord inside.

Etymology. Named after the farm Rooiklip in the escarpment of Namibia.

Distribution. Namibia.

Biology. The host plant unknown. The adults were observed from late August to mid-September, and again in January and in March, which is suggestive for the development of two generations per year.

Aphanostola griseella Bidzilya & Mey, sp. n.

<http://zoobank.org/34C85764-6BB7-4917-93F3-9FE564802152>

Figs 17, 18, 72, 73

Type material. Holotype ♀, **NAMIBIA**-Exp., ZMB 1992, Grootfontein: Otavi Lux, 19 38S/ 17 21E, lux., 16.-19.ii.92, leg. Mey (gen. slide 502/14, O. Bidzilya) (MfN). Paratypes: 1 ♀, same data as holotype; 1 ♀, **NAMIBIA**-Exp., ZMB 1992, Kavango: Katima Mulilo, 17 29S/ 24 17 E, lux., 3-8.iii.92 (Mey) (gen. slide 225/12, O. Bidzilya) (all MfN); 1 ♀, Abachaus, SWA, xii.1946 (Hobohm) (gen. slide 5/15, O. Bidzilya) (TMSA); 1 ♀, **South Africa**, RSA, Transvaal, Nyslvley, Sericea-Farm, 28-30.xi.2004, LF (Mey) (gen. slide 221/12, O. Bidzilya) (MfN); 1 ♀, **Kenya**, Nakuru National Park, Makalia Falls Camp Site, 00°27'S 036°04'E, 1855 m, 10.x.2001 (J. De Prins) (gen. slide 596/14, O. Bidzilya) (NHM).

Diagnosis. The species is very similar externally to *A. rooiklipella* sp. n., *A. africanella* sp. n. and *A. melliferae* sp. n., but can be defined by the nearly uniformly grey forewing with poorly expressed black markings in cell. The female genitalia most closely resemble those of *A. rooiklipella* sp. n. - for the differences see under that species.

Description. Adult (Figs 17, 18). Wingspan 6.7-7.1 mm. Head, thorax and tegulae light grey with a few brown scales, labial palpus brown with narrow white apical rings,

antenna in male thick, antenna in female thin, finely ciliated in both sexes, scape brown with a few white scales, other antennal segments brown, whitish-ringed; forewing grey mottled with brown-tipped scales along margins and in subapical area particularly, costal margin brown from base to 1/5 length, two very indistinct brown spots in cell, brown dot on 3/4 of dorsal margin, cilia light grey; hindwing grey.

Male. Unknown.

Female genitalia (Figs 72, 73). Segment VIII about as broad as long, evenly sclerotized; apophyses anteriores about 1.5 times longer than segment VIII; antrum tubular, weakly broadened before ductus bursae, sub-equal in length to apophyses anteriores; sub-ostial sclerite trapezoidal with short and narrow posterior projection; ductus bursae of moderate width; corpus bursae large, egg-shaped; signum a prolonged plate densely covered with spikes and with medial cord inside.

Etymology. Derived from "griseus" (Latin), grey, referring to the grey forewings.

Distribution. South Africa, Namibia, Kenya.

Biology. The host plant is unknown. The adults were observed in October-November and again in February-March.

Aphanostola centripunctella Bidzilya & Mey, sp. n.

<http://zoobank.org/0575170C-7F9B-4824-97F5-F10095AFCD4C>

Figs 19-21, 52, 74, 74a

Genus 1, sp. 2. - Bidzilya 2007: 94, figs 3, 6; pl. 5, fig. 4.

Type material. Holotype ♂, **NAMIBIA**-Exp., ZMB 1992, E. Caprivi, Katima Mulilo, 17 29 S/ 24 17 E, lux., 3-8.iii.1992 (Mey) (gen. slide 542/14, O. Bidzilya) (MfN). Paratypes: 6 ♂, 3 ♀, same data as holotype (gen. slide 508/14♀, 509/14♂; 155/15♂, O. Bidzilya); 1 ♀, Namibia, Brandberg, Tsisab, 1.iii.2002 (Turm) (gen. slide 76/05, O. Bidzilya); 2 ♀, Namibia, nr Uis, Ugab Campsite, 2.iii.2002, 160 W (gen. slide 106/05, O. Bidzilya) (all MfN); 1 ♀, [**South Africa**], Mpumalanga, Lower Sabi, 26.iii.1962 (Janse & Vári) (gen. slide 49/15, O. Bidzilya); 1 ♂, **Botswana**, Maun c. 20 km W, [c.19 59°S, 23 13'E]. 19.i.1978 (Scoble) (all TMSA).

Diagnosis. The new species is well recognizable externally by the comparatively large size and the forewing with a large brown spot in the middle. The external differences to *A. namibiensis* sp. n. are explained under that species. The male genitalia are characterized by the sacculus merged with the medial teeth on the inner margin of the valva in combination with the narrow saccus. The female genitalia differ from other *Aphanostola* species by the shape of the sub-ostial sclerite, the large globular corpus bursae and the brush-formed signum.

Description. Adult (Figs 19-21). Wingspan 7.8-9.0 mm. Head, thorax and tegulae covered with white black-tipped scales, labial palpus up-curved, black, evenly mottled with white scales on inner surface particularly, segment two with narrow white apical ring, antenna in male

thick, finely ciliated, antenna in female thin, scape black, other antennal segments black with white basal rings, comparatively thick; forewing white, densely suffused with brown along margins and on apex, large brown, transversally elongated spot in the middle, an indistinct brown dash in fold, a small brown spot in the corner of cell, cilia white, black-tipped; hindwing grey.

Variation. Ground colour of head, thorax and forewing varies from white to light grey, paired black spot on $\frac{3}{4}$ of dorsal margin expressed in some specimens, medially prolonged spot sometimes divided into two smaller dots. Hindwings in male with light brown scales along margins, particularly on base near dorsal margin.

Male genitalia (Fig. 52). Uncus twice as broad as long, weakly broadened apically, posterior margin nearly straight; gnathos curved abruptly before middle, distal portion slightly widened, tip pointed; tegumen sub-rectangular, length exceeds width two times, anteromedial incision broad, moderately shallow; basal portion of valva moderately wide, distal $\frac{2}{3}$ narrow, gradually broadened towards rounded apex; sacculus 1.5 times longer than broad, merged at base with medial thorn on inner margin of valva; vinculum moderately broad, posterior margin with short, triangular, medial projections, medial incision narrow; saccus narrow, apex rounded, clearly exceeding beyond apex of pedunculus; phallus prolonged, apex tapered, basal projection straight, narrow extending nearly to apex of phallus.

Female genitalia (Figs 74, 74a). Segment VIII nearly as long as broad, evenly sclerotized, except for sclerotized patches from the base of apophyses anteriores extending posteriorely to half length of segment VIII; antrum short, funnel-shaped; sub-ostial sclerite big, of irregular shape; apophyses anteriores about three times longer than segment VIII; ductus bursae long, slender papillated in proximal half, with abrupt transition to large, globular corpus bursae; signum prolonged, brush-like.

Etymology. Named after the brown spot in the middle of the forewing.

Distribution. Namibia, Botswana, South Africa.

Biology. The host plant is unknown. The adults were collected in January and March.

Aphanostola joannoui Bidzilya & Mey, sp. n.

<http://zoobank.org/92C64E11-29BB-4ADF-9D81-FACEFF9C9174>

Figs 22, 23, 53, 75, 75a

Type material. Holotype ♂, [South Africa] RSA, Mpumalanga, Hongonyi Lodge, S24°27,17', E31°4,56', 30.iv–1.v.2010, LF (Mey & Kühne) (MfN). Paratypes: 8 ♂, 2 ♀ same data as holotype (gen. slide 28/12♂, W. Mey, 81/12♀; 82/12♂; 208/12♂; 209/12♀; 482/14 ♂; 383/14♂, O. Bidzilya) (all MfN); 1 ♂, RSA, Natal, Mkuzi, [15°sq NW cnr, 27 30'S, 32 05'E], 23–26.iv.1982 (Scoble, Laurenson & Kroon) (gen. slide 54/15, O. Bidzilya); 1 ♂, Punda Milia, K.N.S. Survey, 6–15.v.1975 (Potgieter & Scoble) (gen. slide 21/15, O. Bidzilya); 1 ♂, Pretori-
uskop, 1.iv.1952 (Vári) (gen. slide 10/15, O. Bidzilya); 1

♂, Malelane, 24.iii.1952 (Janse & Vári) (gen. slide 40/15, O. Bidzilya) (all TMSA).

Diagnosis. The new species can reliably be separated from *A. antennata* sp. n., *A. longicornuta* sp. n., and *A. alternella* sp. n. by the genitalia. The male genitalia are well recognizable by the large and broad sacculus. The female genitalia are characterized by the unmodified sclerite VIII in combination with the funnel-shaped antrum and the small corpus bursae.

Description. Adult (Figs 22, 23). Wingspan 6.0–7.2 mm. Head, thorax and tegulae covered with grey black-tipped scales, frons off-white, labial palpus weakly up-curved, black with white apex, antenna in male thick, finely ciliated, antenna in female thin, scape black, other antennal segments black with narrow whitish rings at base, underside greyish; forewing grey densely suffused with brown along margins and particularly on apex, three very indistinct brown spots in cell area, cilia grey, brown-tipped; hindwing grey.

Male genitalia (Fig. 53). Uncus as broad as long, weakly widened distally, posterior margin straight or weakly emarginated; gnathos weakly curved at $\frac{1}{4}$, wide at base, tapered apically with pointed tip; distal portion of tegumen rectangular, basal part broad, anteromedial emargination broadly rounded; basal part of valva comparatively broad, distal portion distinctly inflated, apex rounded, shortly ciliated; sacculus large, broader than distal portion of valva, with curved posterior margin; vinculum moderately broad, posterior margin without medial projections, postero-medial incision deep and narrow; saccus basally broad, then strongly narrowed, apex rounded; phallus gradually tapered, basal projection distinctly shorter than phallus, narrow, apically weakly inflated.

Female genitalia (Figs 75, 75a). Segment VIII weakly sclerotized, rectangular, twice as long as broad, without modifications; antrum funnel-shaped, strongly edged; sub-ostial sclerite a transversely prolonged plate; apophyses anteriores moderately thick, distinctly longer than segment VIII; ductus bursae long, slender, papillated in middle portion; corpus bursae small, rounded; signum absent.

Variation. The antrum is variable in width.

Etymology. Named in memory of the lepidopterist John Joannou (1949–2013), who participated in the collecting campaign around Hongonyi Lodge with the second author in 2010.

Distribution. South Africa.

Biology. The host plant is unknown. The adults were collected from late March to mid-May.

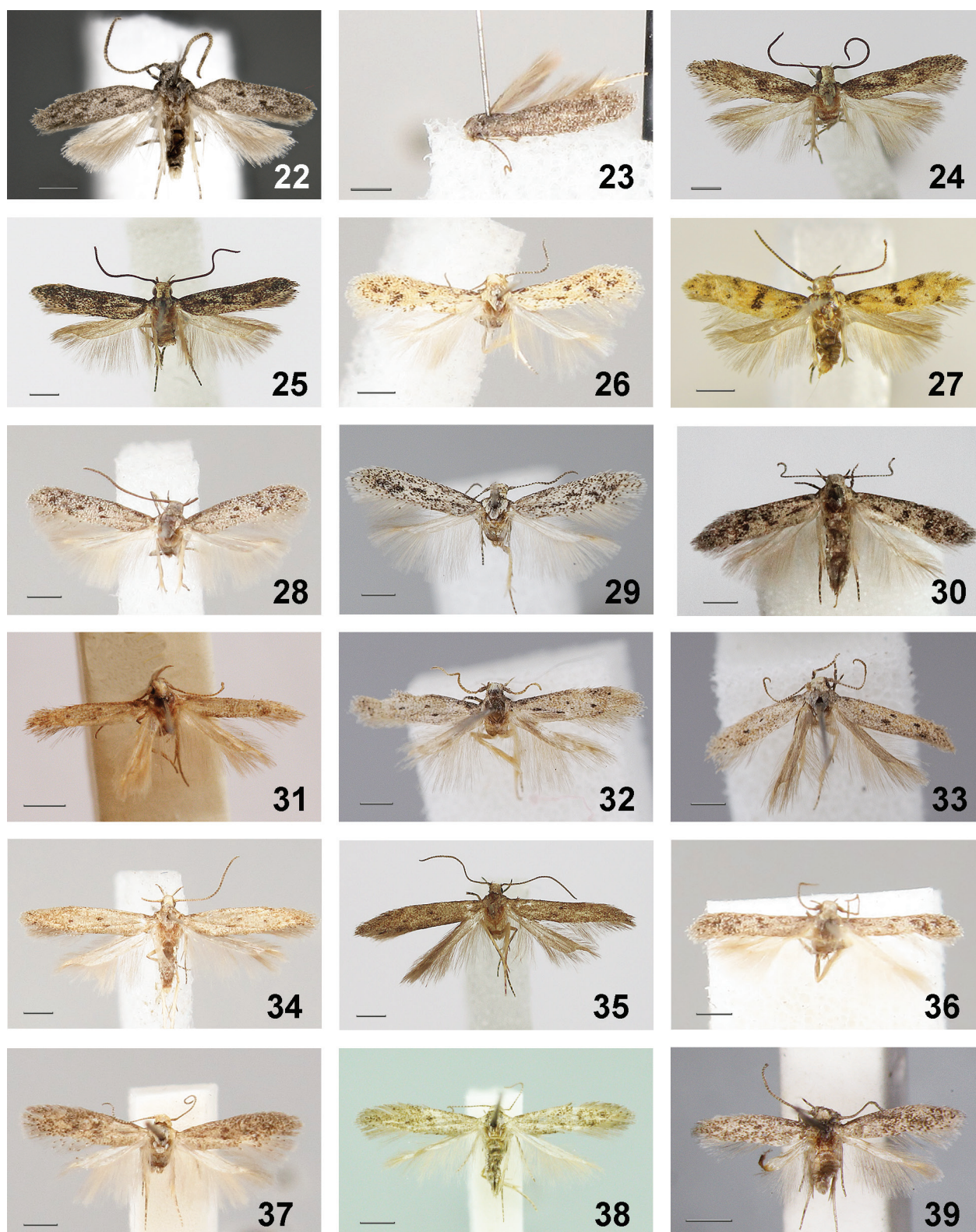
Aphanostola namibiensis Bidzilya & Mey, sp. n.

<http://zoobank.org/96418C55-813E-424A-896D-DE3E8E9DCD01>

Figs 24, 25, 54, 76

Genus 1, sp. 3. – Bidzilya 2007: 95, fig. 4; pl. 5, fig. 5.

Type material. Holotype ♂, Namibia, Brandberg, Wasserfallfläche, 18.iii.2002, LF, 1940 m (gen. slide 107/05,



Figures 22–39. Adults of *Aphanostola* spp. (scale bar 1.0 mm) **22.** *A. joannoui* sp. n., HT, RSA, Hongonyi Lodge; **23.** *A. joannoui* sp. n., RSA, Hongonyi Lodge (209/12); **24.** *A. namibiensis* sp. n., HT, Namibia, Brandberg; **25.** *A. namibiensis* sp. n., Namibia, Auas Mts.; **26.** *A. brandbergensis* sp. n., Namibia, Brandberg (gen. slide 74/05); **27.** *A. aarviki* sp. n., HT, Tanzania, Morogoro Town; **28.** *A. africanella* sp. n., Namibia, Mt. Etjo (gen. slide 597/14); **29.** *A. africanella* sp. n., Namibia, E. Etosha (gen. slide 151/15); **30.** *A. africanella* sp. n., Kenya, Baringo; **31.** *A. emarginata* sp. n., HT, RSA, Mkuzi; **32.** *A. melliferae* sp. n., Kenya, L. Bogoria (gen. slide 143/15); **33.** *A. melliferae* sp. n., HT, Kenya, L. Bogoria; **34.** *A. maxima* sp. n., Ethiopia, Tana-See; **35.** *A. maxima* sp. n., HT, Ethiopia, Tana-See; **36.** *A. longicornuta* sp. n., Kenya, L. Bogoria (gen. slide 577/14); **37.** *A. longicornuta* sp. n., Kenya, Kakamega Forest (gen. slide 590/14); **38.** *A. longicornuta* sp. n., Kenya, Kakamega Forest; **39.** *A. atripalpis*, PT, India, Pusa (gen. slide 411/14).

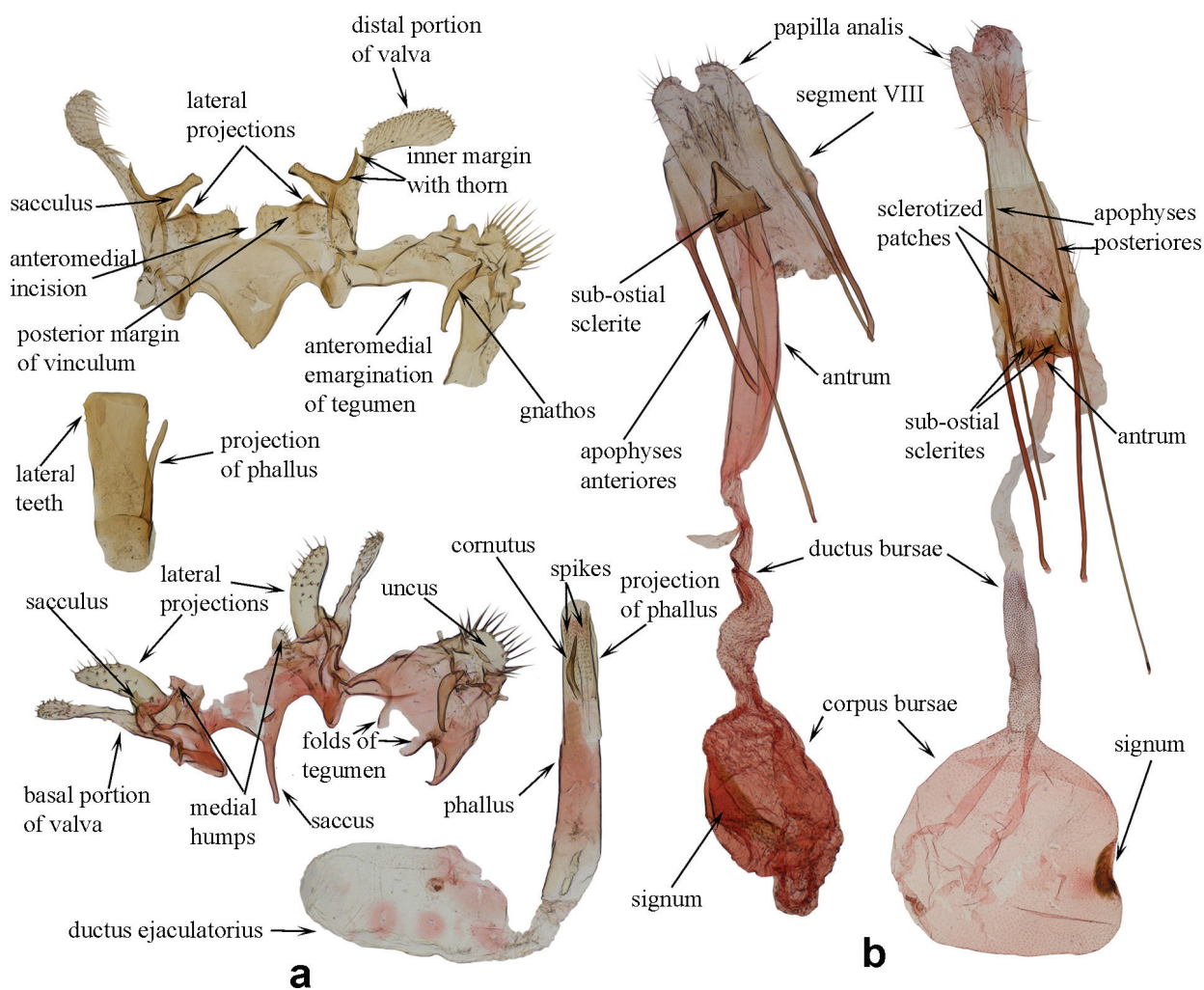


Figure 40. *Aphanostola* spp. Male (a) and female (b) genitalia.

O. Bidzilya) (MfN). Paratypes: 2 ♂ (1 ex abd. miss.), Namibia, Auas Mt., Kromhuk, 1850 m, 24.i.2009, LF (Mey); 1 ♀, Namibia, Auas Mt., Windhoek, 1917 m, 25.i.2009, LF (Mey) (gen. slide 465/14♀, O. Bidzilya); 1 ♀, Namibia, E Etosha, Farm Sachsenheim, 29-30.viii.2012 (Mey) (gen. slide 534/14, O. Bidzilya) (all MfN).

Diagnosis. The new species resembles externally *A. centripunctella* sp. n., but differs by the narrower forewing and the smaller, rounded black spot in the middle. The male genitalia are well recognizable by the shape of the saccus, deep and comparatively broad medial emargination of the posterior margin of the vinculum, the short saccus and the comparatively long uncus. The female genitalia are characterized by distinctly sclerotized patches on segment VIII, short, digitate sub-ostial sclerites, long ductus bursae and the presence of a belt of spikes on the wall of the corpus bursae.

Description. Adult (Figs 24, 25). Wingspan 9.0–9.1 mm. Head white, neck with some brown-tipped scales, segment two of labial palpus black rarely mottled with white, inner and outer surface white, three white with some black scales, antenna in male thick, finely ciliated,

antenna in female thin, scape and other antennal segments black; thorax and tegulae black, white-tipped; hindwing light grey to whitish, black pattern to ¼ of costal margin, in its distal half and in sub-apical area, black dash in fold to mid-length, rounded black spot in middle, diffuse black spot on ¾ near dorsal margin, cilia grey black-tipped; hindwing grey.

Male genitalia (Fig. 54). Uncus longer than broad, slightly widened apically, posterior margin shortly ciliated, with distinct triangular, medial incision; gnathos moderately thick, of even width, gradually curved; tegumen twice as long as broad, anterior margin with moderately deep triangular emargination; valva straight, strongly inflated in distal 1/3, apex rounded; saccus long, narrower than valva, apex distinctly pointed; vinculum broad, posterior margin with deep and wide medial emargination, medial projections short, triangular; saccus short, sub-rectangular, extending to apex of pedunculus; phallus comparatively long, weakly narrowed distally, apex distinctly tapered, basal projection absent.

Female genitalia (Fig. 76). Segment VIII nearly as long as broad, evenly sclerotized, except for distinct, sclero-

tized patches from the base of apophyses anteriores extending to the posterior margin of segment VIII; antrum weakly broadened, membranous; sub-ostial sclerite short, digitate; apophyses anteriores about 2.5 times longer than segment VIII; ductus bursae long, gradually broadening proximally to sub-ovate corpus bursae; the wall of corpus bursae with ovate belt of spikes; signum absent.

Etymology. The species is named after the country of its occurrence.

Distribution. Namibia.

Biology. The host plant is unknown. The adults were observed in late August, January and March up to 1900 m elevation.

***Aphanostola brandbergensis* Bidzilya & Mey, sp. n.**

<http://zoobank.org/25C76335-6C9E-498E-959D-183F69D38190>

Figs 26, 55, 77

Genus 1, sp. 4. – Bidzilya 2007: 94, figs 7, 8; pl. 5, fig. 6.

Type material. Holotype ♀, **Namibia**, Brandberg, Mason Shelter, 6.iii.2002, 1740 m (Mey) (gen. slide 74/05, O. Bidzilya) (MfN). Paratypes: 1 ♂, same data as holotype (gen. slide 103/05, O. Bidzilya); 2 ♂, 1 ♀, same data but 5.6.9.iii.2002; 2 ♂, Namibia, Brandberg, 1100 m, 1.xii.2000, LF (Mey) (gen. slide 82/05, O. Bidzilya); 1 ♂, Namibia, Brandberg, Ugab, 4.xii.2000 (Mey) (gen. slide 80/05, O. Bidzilya) (all MfN).

Diagnosis. The new species can easily be recognized by the cream forewing with black dots and black irroration along costal margin and by its comparatively small size. The male genitalia are well defined by the broad valva, the very short saccus, the shape of valva and other details. The female genitalia are characterized by long apophyses anteriores, prolonged corpus bursae and unmodified sternite VIII.

Description. Adult (Fig. 26). Wingspan 5.8–6.1 mm. Head yellowish-white, labial palpus nearly straight, segment two yellow basally, brown in distal portion, inner surface yellowish-white, segment three brown with yellow apex, antenna in male slightly thicker than in female, scape brown with some white scales, other segments brown with narrow, whitish basal rings; thorax and tegulae yellowish-white, sometimes with a few black scales; forewing cream, mottled with brown mostly along margins and near apex, costal margin brown from base to 1/5 length, three brown spots in cell, two brown spots on 3/4 of dorsal margin, diffuse brown spot and a few black dots in termen, cilia white, brown-tipped; hindwing light grey.

Male genitalia (Fig. 55). Uncus heart-shaped, short, twice as broad as long, posterior margin straight; gnathos strongly curved at base, distal portion straight, gradually narrowing towards pointed apex; tegumen sub-rectangular, twice as long as broad, anterior margin with deep emargination; valva wide and comparatively short, angled at 150° in the middle, distal half turned outwards,

apex rounded, inner margin with distinct, medial thorn placed close to sacculus; sacculus short, triangular and narrow; vinculum narrow, medial projections short, rounded, medial incision short, narrow; saccus weakly developed, very short, extending to apex of pedunculus; phallus as long as tegumen, gradually narrowed distally, apex with short tooth, basal projection absent.

Female genitalia (Fig. 77). Segment VIII twice as long as broad, weakly sclerotized, without modification; apophyses anteriores twice the length of segment VIII and less than half length of apophyses posteriores; ductus bursae narrow, gradually merging into the long corpus bursae; signum absent.

Etymology. The specific name is derived from the Brandberg, the type locality of the new species.

Distribution. Namibia.

Biology. The host plant is unknown. Adults were collected in December and in February up to 1740 m elevation.

***Aphanostola aarviki* Bidzilya, sp. n.**

<http://zoobank.org/8D052652-F4D3-47C3-830D-2CEC6B54CD6F>

Figs 27, 56

Type material. Holotype ♂, **Tanzania**, Morogoro, Morogoro Town, 11.iv.1992 (Aarvik) (gen. slide 2380, O. Bidzilya) (MNHO).

Diagnosis. The new species remotely resembles externally *A. morogorensis* sp. n., but is smaller, the forewings are broader and the black spot on 3/4 of dorsum is indistinct. The male genitalia somewhat resemble those of *A. brandbergensis* sp. n., but differ in the short, rounded uncus, longer saccus, slenderer gnathos and the phallus without apical tooth.

Description. Adult (Fig. 27). Wingspan 6.2 mm. Head yellow, labial palpus yellow with brown subapical rings, scape brown with few yellowish scales; other antennal segments brown with broad yellow belts at base; thorax and tegulae yellow, densely mottled with black; forewing yellow, diffuse black spot at base, in middle and on 2/3 of costal margin, black spot in middle of cell that is connected or nearly connected with medial sub-costal spot, indistinct black dot on 3/4 of dorsal margin, apex slightly mottled with black; cilia light brown; hindwing light grey.

Male genitalia (Fig. 56). Uncus short, broadly rounded; gnathos strongly curved at base, distal portion straight, gradually narrowing towards pointed apex; tegumen broader than long, anterior margin with deep emargination; basal portion of valva wide, inner margin with serrated lobe in basal half and with distinct thorn in the middle, distal portion narrow, digitate, outwardly curved; sacculus short, triangular; vinculum narrow, medial projections very short, hump-shaped, medial incision moderately broad; saccus broad, tapered, apex rounded, exceeding beyond apex of pedunculus; phallus prolonged, weakly narrowed apically, basal projection absent.

Female. Unknown.

Etymology. The species name is dedicated to Leif Aarvik (Natural History Museum, Oslo), the collector of the species.

Distribution. Tanzania.

Biology. The host plant is unknown. The holotype was collected in mid-April.

***Aphanostola africanella* Bidzilya, Agassiz & Mey, sp. n.**

<http://zoobank.org/8A708EFE-D286-45E8-BFE0-B01D4D00F843>

Figs 28–30, 57, 58, 78, 79, 79a

Aphanostola sp. 2 – Agassiz and Bidzilya 2016 (in press).

Type material. Holotype ♂, **Namibia**, Kombat, Omatjete Farm, 27.viii.2012, Turm (Mey) (gen. slide 553/14, O. Bidzilya) (MfN). Paratypes: 2 ♂, 1 ♀, Namibia, Kunene, Fort Sesfontein, 5.ix.2009, Turm (Mey) (gen. slide 488/14♂; 489/14♀, O. Bidzilya); 1 ♀, Namibia, E Etosha, Farm Sachsenheim, 29-30.viii.2012 (Mey) (gen. slide 151/15, O. Bidzilya); 1 ♂, Namibia, 50 km N Okahandja, 10.-11.i.2007, LF (Mey & Ebert) (gen. slide 198/12, O. Bidzilya); 1 ♀, Popa-Falls, Okavango River, 13.xii.1993 (Mey & Ebert) (gen. slide 162/15♀, O. Bidzilya); 1 ♂, Namibia, Waterberg, Touristencamp, 18.xii.1993 (Mey & Ebert) (gen. slide 584/14, O. Bidzilya); 1 ♂, Namibia, Mt. Etjo, 30 km E Kalkrand, 14.iii.2005, LF (Mey) (gen. slide 597/14, O. Bidzilya); 1 ♂, Namibia, Erongo, Kuduberg Farm, 12.-14.i.2007, LF (Mey, Ebert) (all MfN); 1 ♀, **South Africa**, Pretoria N., ix.1946 (van Son) (gen. slide 31/15, O. Bidzilya); 1 ♂, Zoutpan, Zp bg., 15–30.xi.1932 (van Son) (gen. slide 30/15, O. Bidzilya) (TMSA); 1 ♀, **Kenya**: Rift Valley, Lake Bogoria E, 1000 m, 0°15'N, 36°7'E, l. *Acacia mellifera*, em. 22.xi.2005 (Agassiz) (gen. slide 1370, O. Bidzilya); 2 ♀, Kenya: Rift Valley, L. Baringo 1000 m, 0°36'N, 36°00'E, l. *Acacia tortilis*, em. 25.viii.2007 (Agassiz) (gen. slide 1363, O. Bidzilya); 2 ♀, KENYA: Rift Valley, L. Baringo 1000 m, 0°36'N, 36°05'E, l. *Acacia seyal* galls, em. 30.viii.2007 (Agassiz) (gen. slide 1504, O. Bidzilya) (all coll. Agassiz).

Diagnosis. The new species is externally similar to *A. rooiklipella* sp. n. and *A. melliferae* sp. n. but differs in genitalia. The male genitalia are well defined by the phallus bearing seven to eight large cornuti in combination with a long saccus and other details. The female genitalia remotely resemble those of *A. morogorensis* sp. n., but differ in having a distinctly longer antrum and a narrow, rounded signum.

Description. Adult (Figs 28–30). Wingspan 7.1–7.3 mm. Head, thorax and tegulae grey, labial palpus weakly up-curved, light brown with narrow white ring before apex, scape light brown, other segments light brown with narrow whitish basal ring, antenna finely ciliated and very thick in male, moderately thick in female; forewing light grey, rarely covered with brown-tipped scales mainly along margins, costal margin brown from base to ¼, two brown spots in middle, diffuse brown dash in fold, cilia grey, brown-tipped; hindwing grey.

Variation. Black pattern along margins of forewing varies from grey to nearly black.

Male genitalia (Figs 57, 58). Uncus twice as broad as long, posterior margin with short medial emargination; gnathos curved at base, then straight, gradually narrowing towards pointed apex; tegumen gradually narrowing distally, anterior margin with deep rounded emargination; basal half of valva moderately broad, distal half strongly constricted at base, then weakly inflated, apex rounded; sacculus short triangular, merged with the thorn on the inner margin of valva; vinculum moderately broad, posterior margin with short, broad, triangular medial projections, medial emargination deep and narrow; saccus broad at base, distal portion narrow, tapered apically, far exceeding beyond apex of pedunculus; phallus prolonged, tapered apically, with seven to eight big cornuti, which differ in length, basal projection absent.

Female genitalia (Figs 78, 79, 79a). Segment VIII distinctly longer than broad, evenly sclerotized; apophyses anteriores twice as long as segment VIII and half of apophyses posteriors; antrum long, tubular, strongly edged; sub-ostial sclerite rounded; ductus bursae long, narrow, papillated before antrum; ductus bursae sub-ovate; signum a prolonged sclerite densely covered with teeth.

Etymology. The name refers to the obviously wide distribution of the species in Africa.

Distribution. Namibia, Kenya.

Biology. The larva feeds on *Acacia mellifera* (M. Vahl) Benth. (Fabaceae) in Kenya (Agassiz and Bidzilya 2016). The adults were observed in late August-early September, then in November-January and in March.

***Aphanostola emarginata* Bidzilya & Mey, sp. n.**

<http://zoobank.org/3146B6FB-DBC9-43C3-91D9-AEE0BC3BAC8E>

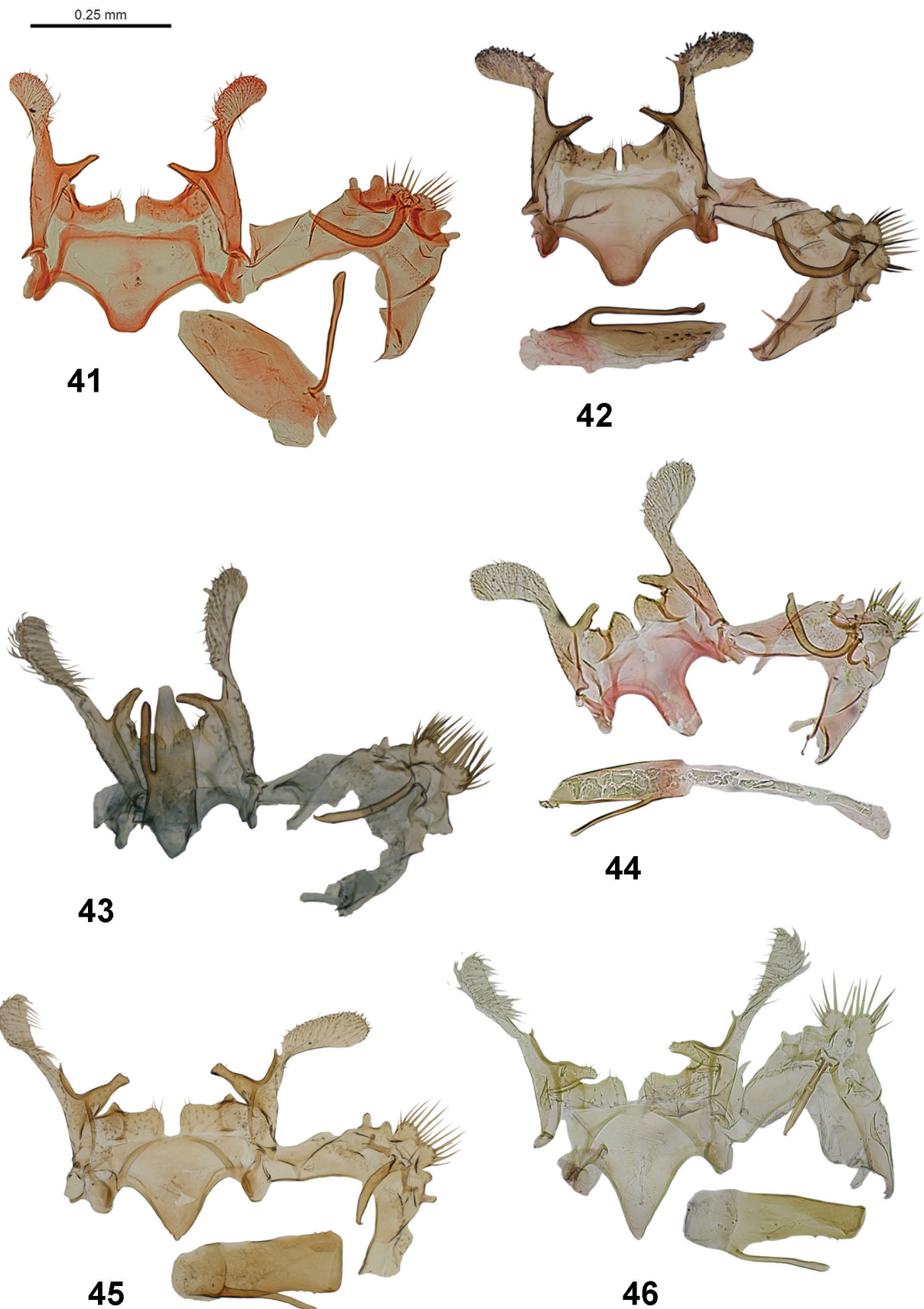
Figs 31, 59

Type material. Holotype ♂, [**South Africa**] RSA, Natal, Mkuzi, [15°sq NW cnr, 27 30'S, 32 05'E], 23–26. Apr. 1982 (Scoble, Laurenson & Kroon) (gen. slide 48/15, O. Bidzilya) (TMSA).

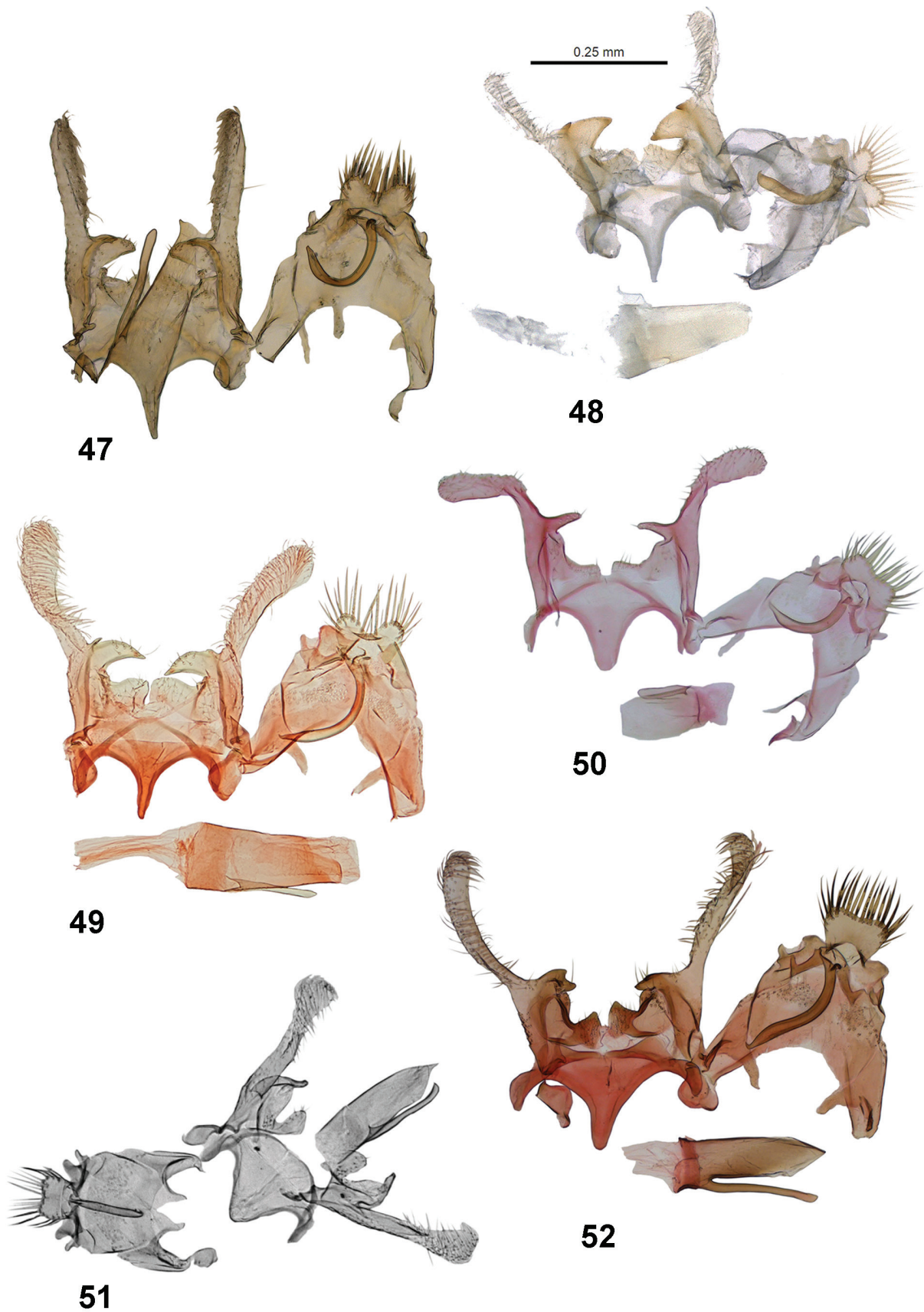
Diagnosis. As far as we can judge from the single male, the new species is most similar to *A. kruegeri* sp. n. in having brown forewings, but differs in exhibiting a poorly expressed irroration. The male genitalia are well defined by the very deep medial emargination of the posterior margin of the vinculum, a short hump-shaped sacculus and by the absence of the vincular projections.

Description. Adult (Fig. 31). Wingspan 6.0 mm. Head light grey, labial palpus brown, segment two with white upper and inner side, segment three with white medial ring and white apex, antenna in male moderately thick, scape brown, other antennal segments brown, whitish-ringed; thorax and tegulae brown; forewing light brown with dark brown scales particularly along margins and in sub-apical area, cilia grey, brown tipped; hindwing grey.

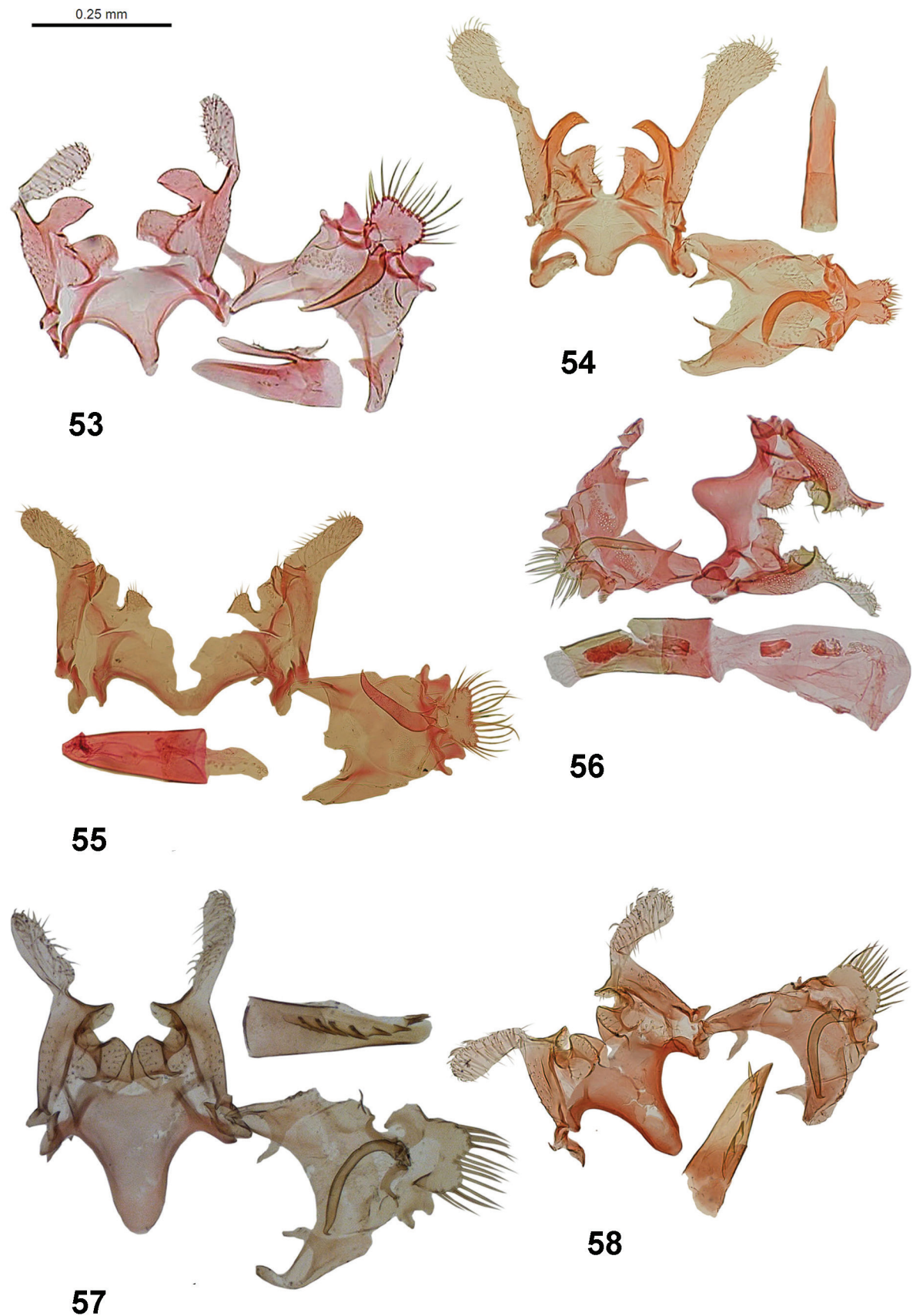
Male genitalia (Fig. 59). Uncus about as broad as long, weakly broadened apically, posterior margin slightly



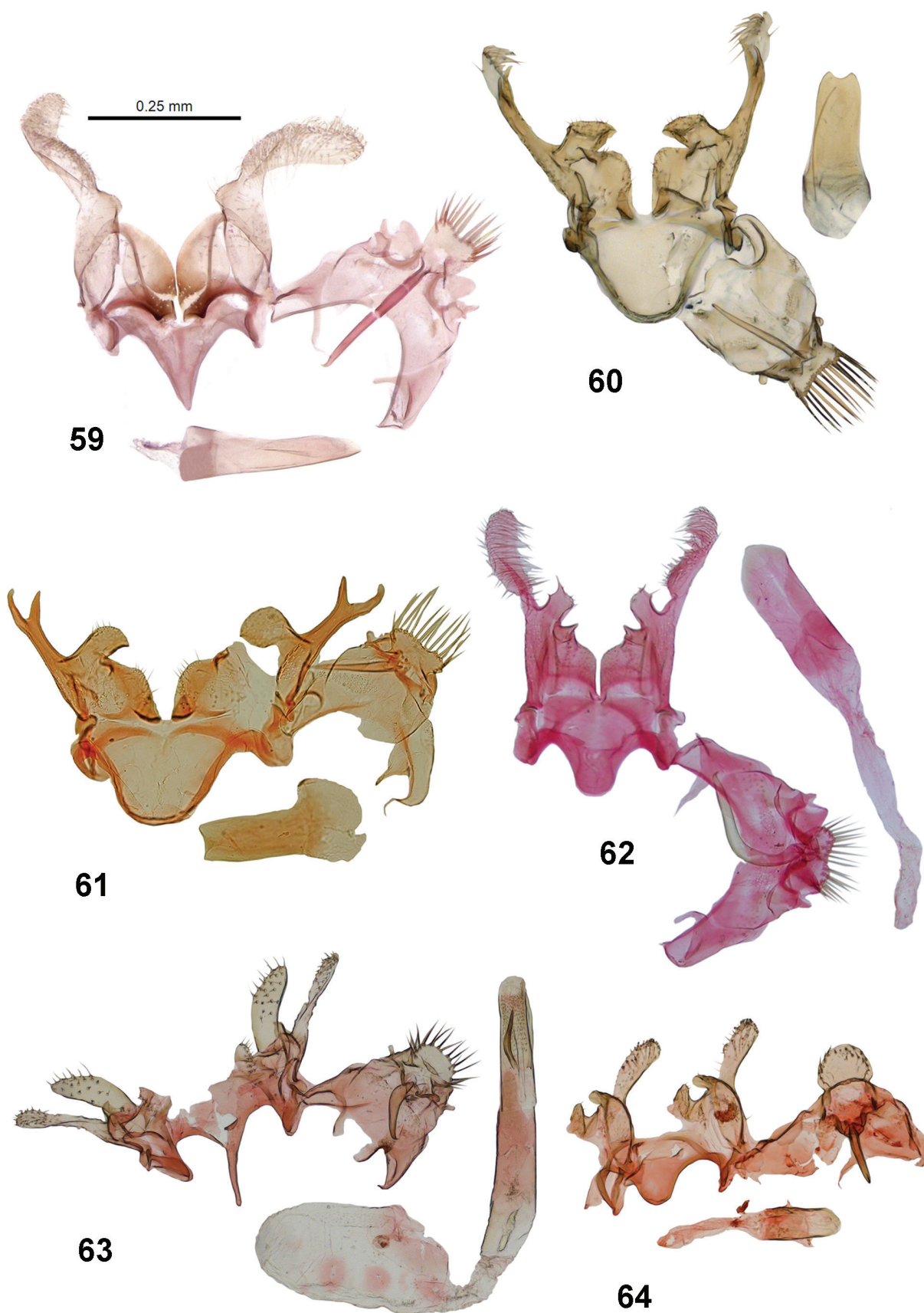
Figures 41–46. Male genitalia of *Aphanostola* spp. **41.** *A. acaciae* sp. n., HT, Namibia, 20 km NW Uis (gen. slide 101/05); **42.** *A. acaciae* sp. n., Namibia, Rooiklip Farm (gen. slide 496/14); **43.** *A. pentastigma*, Kenya, L. Naivasha (gen. slide 1357); **44.** *A. morogorensis* sp. n., HT Tanzania, Morogoro Town (gen. slide 2378); **45.** *A. calderae* sp. n., HT, Namibia, Asante-Sana (gen. slide 184/12); **46.** *A. calderae* sp. n., Namibia, Asante-Sana (582/14).



Figures 47–52. Male genitalia of *Aphanostola* spp. 47. *A. kenyella* sp. n., Kenya, between Limuru and Mai Mahiu (gen. slide 1497); 48. *A. kruegeri* sp. n., RSA, Pretoria (gen. slide 4/15); 49. *A. alternella* sp. n., HT, Kenya, Turi (gen. slide 307/14); 50. *A. antennata* sp. n., Namibia, Popa Falls (gen. slide 54/08); 51. *A. rooiklipella* sp. n., Namibia, Omatako (gen. slide 213/12); 52. *A. centripunctella* sp. n., Namibia, Brandberg (gen. slide 106/05).



Figures 53–58. Male genitalia of *Aphanostola* spp. **53.** *A. joannoui* sp. n., HT, RSA, Hongonyi Lodge (gen. slide 208/12); **54.** *A. namibiensis* sp. n., Namibia, Brandberg (gen. slide 107/05); **55.** *A. brandbergensis* sp. n., Namibia, Brandberg (gen. slide 103/05); **56.** *A. aarviki* sp. n., HT, Tanzania, Morogoro Town (gen. slide 2380); **57.** *A. africanella* sp. n., HT, Namibia, Omatjete Farm (gen. slide 553/14); **58.** *A. africanella* sp. n., Namibia, Okahanja (gen. slide 198/12).



Figures 59–64. Male genitalia of *Aphanostola* spp. **59.** *A. emarginata* sp. n., HT, RSA, Mkuzi (gen. slide 48/15); **60.** *A. melliferae* sp. n., Kenya, L. Bogoria (gen. slide 1549); **61.** *A. melliferae* sp. n., Namibia, Sandveld (gen. slide 457/07); **62.** *A. maxima* sp. n., HT, Ethiopia, Tana-See (gen. slide 427/07); **63.** *A. longicornuta* sp. n., Namibia, Etosha (gen. slide 503/14); **64.** *A. atripalpis*, India, Pusa, PT (gen. slide 411/14).

emarginated; gnathos narrow, weakly curved, tapered; tegumen sub-rectangular, anterior margin deeply emarginated; valva broad in basal half, weakly constricted in middle, distal portion outwardly curved and hairy, apex rounded; sacculus short, rounded, hump-shaped; vinculum broad, posterior margin without projections, divided by deep and narrow medial incision into strongly sclerotized rounded lobes, saccus triangular, broad on base, tapered; phallus long and narrow, weakly narrowed apically, without basal projection.

Female. Unknown.

Etymology. Derived from “emarginatus” (Latin), excised, referring to the excised vinculum in the male genitalia.

Distribution. South Africa.

Biology. The host plant is unknown. The holotype was collected in late April.

***Aphanostola melliferae* Bidzilya, Agassiz & Mey, sp. n.**

<http://zoobank.org/6C5CD8FD-4D8B-4C2D-8CF4-3F2ED9621B4D>
Figs 32, 33, 60, 61, 80

Aphanostola sp. 4 – Agassiz and Bidzilya 2016 (in press).

Type material. Holotype ♀, **Kenya:** Rift Valley, Lake Bogoria, 1000 m, 0°15'N, 36°05'E, l. *Acacia mellifera*, em. 30.viii.2007 (Agassiz) (gen. slide 142/15, O. Bidzilya) (coll. Agassiz). Paratypes: 1♂, 2♀, same data as holotype (gen. slide 1549♂, 1550♀, O. Bidzilya); 1♂, **KENYA:** Rift Valley, Lake Bogoria, 1000 m, 0°21'N, 36°04'E, l. *Acacia mellifera*, em. 6.xi.2007 (Agassiz); 1♀, **KENYA:** Rift Valley, Lake Bogoria, 1000 m, 0°21'N, 36°04'E, l. *Acacia mellifera*, em. 26.viii.2007 (Agassiz); 1♂, 1♀, **KENYA:** Rift Valley, Lake Bogoria, 1000 m, 0°15'N, 36°7'E, l. on *Acacia mellifera*, em. 23.xi, 2.xii.2005 (Agassiz) (gen. slide 143/15♂, O. Bidzilya); 1♂, **KENYA:** Rift Valley, Lake Bogoria, 1000 m, 0°21'N, 36°4'E, l. *Acacia mellifera*, em. 23.xi.2005 (Agassiz) (all coll. Agassiz); 2♂, 1♀, **Namibia**, Sandveld, 60 km N Gobabis, 22.–26.i.2007, LF (Mey & Ebert) (gen. slide 457/07♂, O. Bidzilya); 1♂, **Namibia**, Omatako Ranch, LF, 22–23.iii.2003 (Mey) (gen. slide 67/15, O. Bidzilya) (all MfN).

Diagnosis. The new species can reliably be separated from *A. rooiklipella* sp. n., and *A. africanella* sp. n. by the genitalia. *A. antennata* sp. n. is very similar to above mentioned species, but differs in broader forewing. *A. pentastigma* is usually larger than *A. melliferae* sp. n. the forewing are narrower with black spot at base of costal margin. The male genitalia are well recognizable by very short, weakly sclerotized distal portion of valva, stout broadly rounded sacculus and the shape of the phallus. The female genitalia are defined by a characteristically shaped antrum and sub-ostial sclerites as well as by a strongly sclerotized entrance to the corpus bursae which is unique for *Aphanostola*.

Description. Adult (Figs 32, 33). Wingspan 7.2–8.1 mm. Head white, labial palpus weakly curved, dark grey

with white apex, inner surface white, antenna thick and finely ciliated in male, thinner in female, scape brown, antennal segments light brown with whitish basal rings; head and thorax white to light grey; forewing covered with white brown-tipped scales, costal margin mottled with brown, apex black spotted, narrow black dash in folds, three black spots in cell, cilia grey, brown tipped; hindwing light grey.

Male genitalia (Figs 60, 61). Uncus very short, about 1.5 times broader than long, posterior margin straight; gnathos curved at base, then straight, narrow, strongly pointed apically; tegumen trapezoid anterior margin twice the length of posterior margin, anteromedial emargination deep; valva straight, narrow, basal portion strongly sclerotized, inner margin with long thorn on ¾ length, distal ¼ weakly sclerotized, hairy; sacculus, broader than valva, beak-shaped; vinculum broad, without projections, medial incision deep, narrow; saccus stout, wide, broadly rounded, far exceeding beyond the apex of pedunculus; phallus straight, broad, posterior margin weakly emarginated, base weakly inflated, basal projection absent.

Female genitalia (Fig. 80). Papilla analis sub-ovate; apophyses posteriores long, narrow; apophyses anteriores thick, twice as long as segment VIII; segment VIII sub-rectangular, weakly sclerotized; antrum tubular, strongly edged, broadened in distal half; lateral sub-ostial sclerite prolonged, leaf-shaped, posterior sub-ostial sclerite rounded; ductus bursae narrow, gradually merging into very long and narrow corpus bursae with strongly sclerotized entrance; signum absent.

Etymology. The species is named after the name of its host plant, *Acacia mellifera*.

Distribution. Kenya, Namibia.

Biology. Larvae feed on *Acacia mellifera* in Kenya (Agassiz and Bidzilya 2016 in press) and probably also on this tree in Namibia. Adults were observed in late August and late November to early December in Kenya and in January and March in Namibia.

***Aphanostola maxima* Bidzilya & Mey, sp. n.**

<http://zoobank.org/6000099E-9332-499D-9F06-83F269FBC5A3>
Figs 34, 35, 62

Type material. Holotype ♂, [**Ethiopia**], Äthiopien, 11.–16.i.1996, Tana-See, Bahir-Dar, 1600 m (Mey & Ebert) (gen. slide 427/07, O. Bidzilya) (MfN). Paratypes: 3♂, same data as holotype (all MfN).

Diagnosis. *A. maxima* sp. n. is the largest species of the genus. Besides the big size it is recognizable by comparatively narrow, light brown, uniformly coloured forewing with distinct brown dots in the cell. The male genitalia can be distinguished by broad trapezoidal tegumen, sub-rectangular sacculus, and elongated vinculum.

Description. Adult (Figs 34, 35). Wingspan 9.5–10.5 mm. Head, cream-white, labial palpus up-curved, brown with diffuse grey belts, scape brown, other antennal segments brown with whitish basal rings, moderately thick;

thorax and tegulae light brown; forewing light brown, mottled with brown in sub-apical area, diffuse brown spot at base near costal margin, three brown dots in cell, cilia light brown; hindwing grey.

Male genitalia (Fig. 62). Uncus heart-shaped, twice as broad as long, posterior margin slightly emarginated medially; gnathos large, curved at right angle in the middle, distal portion straight, apex pointed; tegumen broad, trapezoid, anterior margin twice as long as posterior margin, anteromedial emargination deep, rounded; basal half of valva straight inner margin with distinct thorn just near the sacculus, distal half constricted at base, weakly inflated, densely haired, apex rounded; sacculus sub-rectangular, about as wide as distal part of valva; vinculum long, medial projections absent, medial incision deep and narrow; saccus moderately broad, apex rounded, exceeding beyond apex of pedunculus; phallus parallel-sided, apex tapered, lamina very long, basal projection absent.

Female. Unknown.

Etymology. Derived from “maximus” (Latin), the largest, referring to the large size of the species.

Distribution. Ethiopia.

Biology. The type series was collected in mid-January at 1600 m elevation.

***Aphanostola longicornutata* Bidzilya, Agassiz & Mey, sp. n.**

<http://zoobank.org/7E679154-CDB7-4CA9-9D73-1361222864CF>

Figs 36–38, 63, 82

Type material. Holotype ♀, **Namibia**, E. Etosha, Farm Sachsenheim, 29.-30.viii.2012, LF (Mey) (MfN). Paratypes: 3 ♂, 12 ♀, same data as holotype (486/14♂; 503/14♂; 484/14♀; 485/14♀; 487/14♀, O. Bidzilya); 3 ♀, **Namibia**, Kunene, Fort Sesfontein, 5.ix.2009, Turm (Mey) (gen. slide 500/14, O. Bidzilya) (all MfN); 1 ♂, **Kenya**: Rift Valley, L. Bogoria, 3000 ft, 3.vii.1999 (Agassiz) (gen. slide 577/14) (coll. Agassiz); 2 ♂, 1 ♀, **Kenya**, Kakamega Forest, UDO Camp, 1600 m, 00 21N, 34 52 E (08), 17.iv.2001 (J. De Prins) (gen. slide 589/14♂; 590/14♀, O. Bidzilya) (all BMNH).

Diagnosis. The new species can be separated from the similar *A. joannoui* sp. n., *A. antennata* sp. n., and *A. alternella* sp. n. only by examining the genitalia. The male genitalia can easily be recognized by the presence of a very large, lateral, vincular projection, a long and narrow saccus as well as an extremely long phallus with one large cornutus. The female genitalia are defined by a wrinkled antrum, a narrow, serrated signum, the coiled corpus bursae and by the other details.

Description. Adult (Figs 36–38). Wingspan 5.8–7.0 mm. Head, thorax and tegulae light grey with a few brown-tipped scales, frons slightly lighter, labial palpus nearly straight, black with white apex, inner surface grey, antenna thick in both sexes, finely ciliated by male, scape brown, flagellum with alternate brown and whitish rings; forewing dark grey, margins and apical area suffused with

black, two black spots in middle of cell, indistinct black dash in fold, black spot in the corner of cell hidden by black scales, cilia grey, black-tipped; hindwing and cilia light grey.

Variation. The black markings can be reduced so that the forewing looks uniformly grey in some specimens.

Male genitalia (Fig. 63). Uncus very short, posterior margin broadly rounded; gnathos short, strongly curved at base, distal portion straight, gradually narrowed apically; tegumen short, sub-rectangular, anteromedial emargination broad, shallow; valva straight, narrow; sacculus short, beak-shaped; vinculum moderately broad, medial projections short, lateral projections very large, broader than valva, extending to $\frac{3}{4}$ of its length; medial incision triangular, v-shaped; saccus very long, far exceeding beyond the apex of pedunculus, distal portion very narrow; phallus very long, straight apex broadly rounded, distal portion with big weakly curved cornutus, basal projection narrow, arising from $\frac{2}{3}$ length of phallus, vesica with numerous small spikes.

Female genitalia (Fig. 82). Segment VIII about as long as broad, weakly narrowed posteriorly, evenly sclerotized, apophyses anteriores moderately thick, longer than segment VIII; antrum tubular, wrinkled; sub-ostial sclerite sub-ovate; ductus bursae long, coiled before corpus bursae, with sclerotized filament inside of coil; corpus bursae large, pear-shaped; signum a narrow, prolonged plate with serrated margins.

Etymology. Derived from “longus” and “cornutus” (Latin), long resp. cornutus, referring to the unusual long cornutus of the phallus

Distribution. Namibia, Kenya.

Biology. The host plant is unknown. The adults have been collected in late August-early September in Namibia and in mid-April, early July in Kenya.

***Aphanostola atripalpis* Meyrick, 1931**

Figs 39, 64

Aphanostola atripalpis Meyrick, 1931 – Exotic Microlepidoptera 4: 57.

Clarke 1969: VI, pl. 134, figs 1–1c.

Material examined. Lectotype: ♂, **India**, Pusa, Bihar. R. bred. .6.29, reared from *Acacia catechu*, Rungi (slide No. 8328) (BMNH).

1 ♂, 6.vi.1929, Pupa on leaves of *Acacia cati*[sic!]chu, Pusa, Rangi Coll., 5699, Cotype, *Aphanostola atripalpis*, M., Meyrick det. 1980, Presented by R.L.E. Ford, B.M. 1949-487 (gen. slide 411/14, O. Bidzilya) (BMNH).

Diagnosis. As far as we can judge from rather limited material, *A. atripalpis* differs from the other species by the uniformly greyish-brown forewings and the whitish head. The male genitalia have a rounded uncus covered with very short setae.

Redescription. Adult (Fig. 39). Wingspan 5.9–6.1 mm. Head whitish, labial palpus weakly up-curved, grey



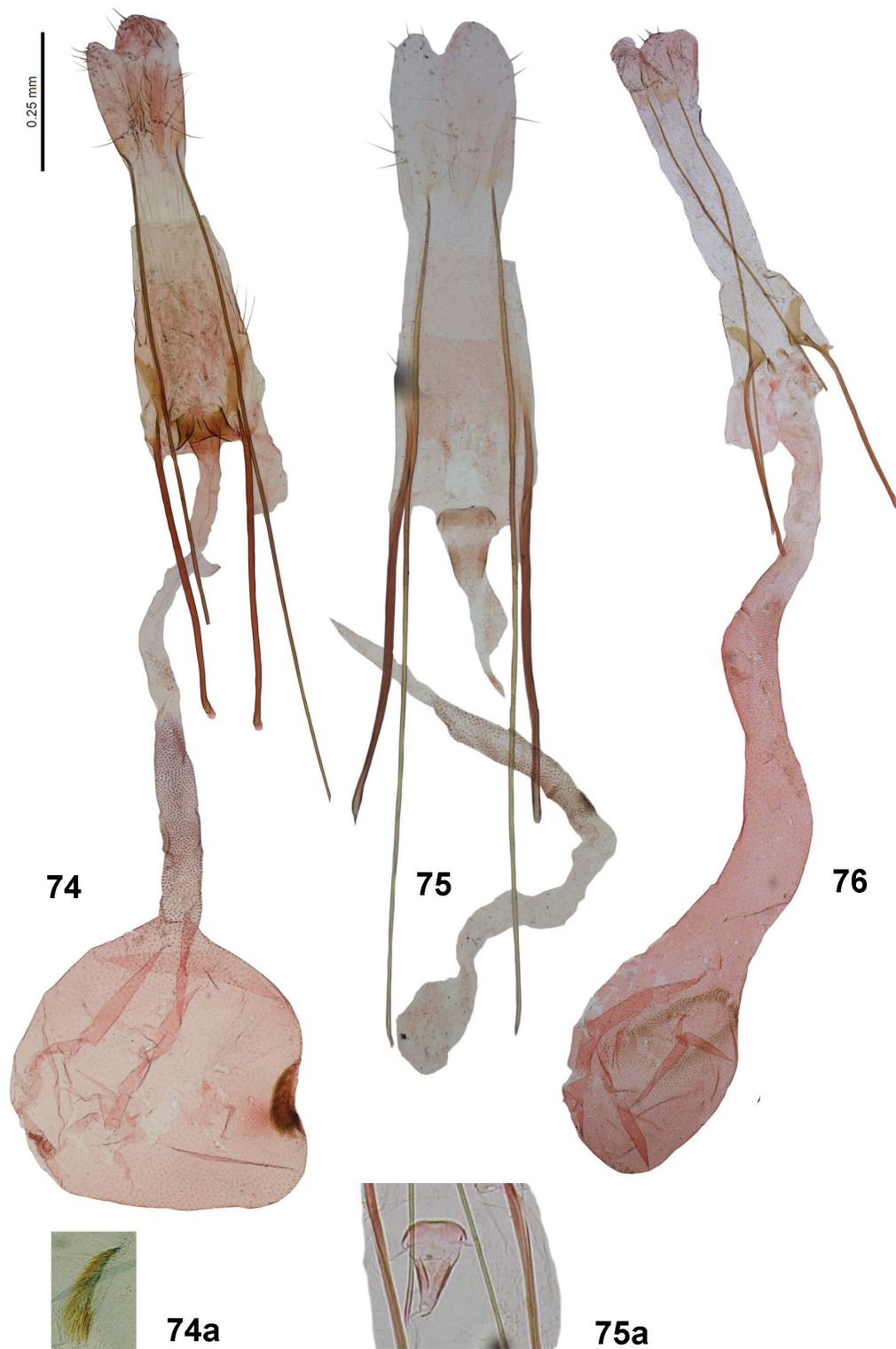
Figures 65–67. Female genitalia of *Aphanostola* spp. **65.** *A. acaciae* sp. n., Namibia, Mirabib (gen. slide 548/14); **66.** *A. pentastigma*, RSA, Pretoria (gen. slide 260/12); **67.** *A. pentastigma*, Kenya, L. Naivasha (gen. slide 614/14).



Figures 68–70. Female genitalia of *Aphanostola* spp. **68.** *A. morogorensis* sp. n., Tanzania, Morogoro Town (gen. slide 2375); **69.** *A. antennata* sp. n., Namibia, Popa Falls (gen. slide 206/12); **70.** *A. rooiklipella* sp. n., Namibia, Rooisand (gen. slide 203/12).



Figures 71–73. Female genitalia of *Aphanostola* spp. **71.** *A. rooiklipella* sp. n., Namibia, Rooiklip Farm (gen. slide 554/14); **71a.** Signum (gen. slide 547/14); **72.** *A. griseella* sp. n., HT, Namibia, Otavi (gen. slide 502/14); **73.** *A. griseella* sp. n., Namibia, Popa Falls (gen. slide 225/12).



Figures 74–76. Female genitalia of *Aphanostola* spp. **74.** *A. centripunctella* sp. n., Namibia, Katima Mulilo (gen. slide 508/14); **74a.** Signum (gen. slide 76/05); **75.** *A. joannoui* sp. n., RSA, Hongonyi Lodge (gen. slide 81/12); **75a.** Subostial sclerite (gen. slide 209/12); **76.** *A. namibiensis* sp. n., Namibia, Etosha (gen. slide 534/14).



Figures 77–79. Female genitalia of *Aphanostola* spp. **77.** *A. brandbergensis* sp. n., HT, Namibia, Brandberg (gen. slide 74/05); **78.** *A. africanella* sp. n., Namibia, Fort Sesfontein (gen. slide 489/14); **79.** *A. africanella* sp. n., Kenya, L. Baringo (gen. slide 1363); **79a.** Signum (enlarge) (gen. slide 1370).



Figures 80–82. Female genitalia of *Aphanostola* spp. **80.** *A. melliferae* sp. n., Kenya, L. Bogoria (gen. slide 1550); **81.** *A. kruegeri* sp. n., RSA, Pretoria (gen. slide 8/15); **82.** *A. longicornuta* sp. n., Namibia, E. Etosha (gen. slide 500/14).

with broad medial ring, antenna thick in male, scape brown, other antennal segments light brown with dark basal rings; forewing, thorax and tegulae covered with grey, brown-tipped scales, forewing uniformly coloured but costal margin and sub-apical area slightly darker, cilia grey; forewing light grey.

Male genitalia (Fig. 64). Uncus rounded, covered with short setae posteriorly; gnathos moderately long, thick, strongly curved at 1/4; tegumen broad, anterior emargination broad and shallow; valva gradually curved, basal portion distinctly edged; sacculus short, sub-rectangular, apex rounded; vinculum moderately broad with short sub-triangular projections on posterior margin, postero-medial incision moderately broad; saccus broad, weakly narrowed apically, apex rounded, extending to apex of pedunculus; phallus short, with triangular apex, basal projection absent, vesical with small cornuti.

Female. Not examined.

Distribution. India.

Biology. Larva feeds on *Acacia* [*Senegalia?*] *catechu* (L.f) P.J.H. Hurter & Mabb. (Fabaceae). Adults emerged in June.

Notes. *A. atripalpis* was described from two males collected in Bihar, Pusa (India). The adult moth and the venation, and the male genitalia in lateral position, were illustrated by Clarke (1969). We examined the second paratype and prepared the genitalia in unrolling position to compare them with other *Aphanostola* species.

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References

- Agassiz DJL, Bidzilya O (2016) Gelechiidae (Lepidoptera) bred from acacia in Kenya with description of eight new species. *Annals of the Ditsong National Museum of Natural History*. [in press]
- Bidzilya O (2007) The Lepidoptera of the Brandberg Massif in Namibia. Part 2. Gelechiidae (Lepidoptera: Gelechioidea) (Plates 5-8). *Espiana Memoir* 4: 91–118.
- Clarke JFG (1969) Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick. *Glyphipterigidae, Gelechiidae (A-C)* 6: 537 pp. [267 pls.]
- Huemer P (1988) A taxonomic revision of *Caryocolum* (Lepidoptera, Gelechiidae). *Bulletin of the British Museum (Natural History), Entomology* 57(3): 439–571.
- Huemer P, Karsholt O (1999) Gelechiidae I (Gelechiidae: Gelechiinae, Teleiodinae). In: Huemer P, Karsholt O, Lyneborg L (Eds) *Microlepidoptera of Europe*. Vol. 3. Apollo Books, Stenstrup, 356 pp.
- Janse AJT (1960) Gelechiidae. *The Moths of South Africa* 6(2): 145–240. [pl. 33–129]
- Kristensen NP (Ed.) (2003) *Lepidoptera: Moths and Butterflies 2. Morphology, Physiology and Development. Handbook of Zoology* 4(36). Berlin & New-York, 564 pp.
- Mey W, Kühne L (2014) Results of a short collecting trip to the Central Lowveld in the Limpopo Province, South Africa, with description of *Deltote johnjoannoui* sp. nov. (Lepidoptera: Noctuidae). *Entomologische Zeitschrift* 124(4): 239–246.
- Meyrick E (1931) *Exotic Microlepidoptera* 4: 33–64.
- Pitkin L (1986) A technique for the preparation of complex male genitalia in Microlepidoptera. *Entomologist's Gazette* 37: 173–179.

Enigmatic distribution: first record of a hitherto New World planthopper taxon from Japan (Hemiptera, Fulgoroidea, Delphacidae, Plesiodelphacinae)

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Abstract

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Burnilia japonica sp. n. of the delphacid subfamily Plesiodelphacinae from southern Japan (Kyushu, Yakushima, Okinawa) is described. The surprising discovery of a *Burnilia*-species in Japan is the first record of a member of this subfamily outside the New World. As the generic assignment is beyond any doubts, this finding reveals a puzzling geographic distribution of this group. A natural – indigenous – occurrence of *B. japonica* in Japan versus a recent introduction e.g., by human traffic, is discussed. A phylogenetic study of the whole Plesiodelphacinae including the Japanese species is desired.

Introduction

The genus *Burnilia* Muir & Giffard, 1924, was established monotypically with the type species *Delphax pictifrons* Stål, 1864 described from Mexico (Stål 1864). Five more *Burnilia*-species have been described since: *B. belemensis* Muir, 1926 and *B. williamsi* Muir, 1926 from Brazil, *B. heliconiae* Muir, 1926, *B. longicaput* Muir, 1926 from French Guiana (see Muir 1926), and *B. spinifera* Fennah 1945 from French Guiana (Fennah 1945) with the subspecies *B. spinifera antillana* Fennah, 1959 from the Caribbean: St. Vincent Island (Fennah 1959). The genus *Burnilia* was hitherto considered as entirely

Neotropical. Due to the display of a cross-sectional circular post-tibial spur with well separated conical teeth Muir and Giffard (1924) placed *Burnilia* into the tribe Alohini Muir, 1915, still listed here in Metcalf (1943). Asche (1985a) described a second genus close to *Burnilia*, viz., *Plesiodelphax* with the type species *Plesiodelphax guayanus* Asche, 1985 from Brazil (type locality: Porto 14 de Mayo) and French Guiana. Moreover, Asche (1985a) removed *Burnilia* from the Alohini (the latter being integrated as junior synonym into the Delphacini: Asche 1985b), and established the subfamily Plesiodelphacinae for *Burnilia* and *Plesiodelphax*, based on characters regarded as autapomorphies (concerning hind wing vena-

tion, the special carination of the vertex, the arrangements of distal spine at the first post-metatarsus, and in the special configuration of the male genitalia, as described and discussed in Asche 1985b). The display of the post-tibial spur was rather regarded as “*kelisoid*” than as “*alohinid*” (Asche 1985a). In his phylogeny of Delphacidae, Asche (1985b), placed the Plesiodelphacinae above the level of Stenocraninae as the sistergroup of Delphacinae (see also Asche 1990). Mainly based on larval morphology, Emeljanov (1995) distinguished only three subfamilies of Delphacidae: Asiracinae, Ugyopinae and Delphacinae. The latter comprises seven tribes including Plesiodelphacini which were placed in his cladogram above the level of Stenocranini and considered as the sistergroup of a clade Tropidocephalini – Saccharosydniini plus Delphacini, - congruent with the hypothesis of Asche (1985b). However, Emeljanov’s tribal classification is not fully adopted here, with consequence that plesiodelphacine taxa are still regarded as separate subfamily as suggested by Asche (1985b, 1990). The higher classification of Delphacidae has also been addressed by Hamilton (2006) who interpreted and supplemented mainly Emeljanov’s data (Emeljanov 1995). Hamilton (2006) moved most subfamilies and tribes with the exception of Plesiodelphacinae to a single subfamily “Delphacinae”. For Plesiodelphacinae he referred to Bartlett (2005) who reported about possible relationships of this group to Asiracinae. Urban et al. (2010) investigated the phylogeny of Delphacidae on the basis of molecular data and implications revealed from host plant associations, providing the first substantive molecular phylogeny of this family. According to their data, Plesiodelphacinae would possibly have derived from a level basally of Kelisiinae and Stenocraninae; however, as this hypothesis would have a substantial impact on the interpretation of morphological data as suggested earlier by Asche (1985b) and Emeljanov (1995), we here adopt the morphology-based phylogenetic hypothesis. A phylogenetic study for the whole group of Plesiodelphacinae is in preparation by the senior author.

Meanwhile several more plesiodelphacine species were discovered in the Neotropics, and are currently subject of a revision of the whole group (Asche, in preparation). The finding of persistent populations of a new *Burnilia* species in South Japan represents an enormous enlargement of the whole subfamily’s range of distribution. Here we describe this new *Burnilia* species and provide information on its host plants and ecology.

Material and methods

The specimens were collected by sweeping or by visual search directly from the host plant, and preserved dry. Measurements and line drawings were made by using a Leitz stereomicroscope with camera lucida attachment. Genital structures were examined after the whole abdominal were macerated for 24 hours at room temperature in KOH, subsequently transferred to glycerine (for

drawings to glycerine jelly). Photographs were taken by the digital camera Canon50D with a MP-E 65mm Macro Photo Lens and by some compact digital cameras in the field, arranged by Paintshop Pro X4. The terminology used for bodily parts including male genitalia largely follows Asche (1985a, b; 1990), Holzinger et al. (2003), Hoch (2013), for female genitalia Bourgoin (1993), for wing venation Bourgoin et al. (2015).

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Taxonomy

Burnilia Muir & Giffard, 1924

Proterosydne: Crawford 1914: 570, nec Kirkaldy 1907: 130.

Burnilia Muir & Giffard, 1924: 7. Type species: *Delphax pictifrons* Stål, 1864, [Mexico], by original designation.

Diagnosis (modified from Asche 1985a, b). As a plesiodelphacine genus, *Burnilia* is recognizable by the following combination of characters: head with vertex well projected in front of compound eyes, carination weakly developed or partly entirely missing; frons elongate and usually widest at frontoclypeal suture; antennal joints subcylindrical with elongate pedicel; head usually with boldly coloured contrasting blackish marks, either as transverse frontal stripe(s), or as longitudinal frontal stripe enclosing median carina; sides of head in front and/or above compound eyes partly with extended black patches; pronotum anterolaterally with a dark mark, in some species bearing waxy exudations; post-tibial spur “*alohine*”, i.e., elliptical in cross-section bearing well separated cone-shaped teeth at the posterior margin; hind wings with anastomosis of M and Cu; drumming organ sexually dimorphic, males with elongate and erect apodemes of the second abdominal sternite and development of a “central plate” in the second abdominal tergite; diaphragm of male genital segment dorsally with conspicuous transverse spatula-shaped or subtriangular projections directed cephalad (probably as ventrocaudal support of the aedeagus); aedeagal complex devoid of a free suspensorium, dorsal base of phallosome directly connected with ventral base of anal segment; aedeagus tubular, elongate, curved dorsally, central tube strongly sclerotized, phallosome membranous, in most species subapically a single spinose or flag-like process; females ditrysic, i.e., full separation of copulation and oviposition duct; entry to prevaginal chamber mostly sclerotized, often forming a funnel-shaped guiding aid for the aedeagus.

Asche (1985a, b) considered the shape and carination of the vertex as well as the unique configuration of the male genitalia associated with the ditrysic female genitalia (diaphragm of the genital segment with a spatula-like

transverse plate directed interiorly, supposedly for guiding the aedeagus into the female copulatory duct) as autapomorphic for *Burnilia*. The newly discovered species from Japan displays these autapomorphies, and can therefore be regarded as a congener.

We refrain from the establishment of a separate subgenus for the Japanese species based on certain morphological differences from Neotropical *Burnilia* (see below) before a phylogenetic analysis of this taxon is available.

Distribution. Neotropical Region (6 species, one of which two subspecies), South East Palearctic Region: Japan (one species described below, new record).

Burnilia japonica sp. n.

<http://zoobank.org/23CFB02E-DB32-474A-8D89-4894670B3692>

Colour plate 1, Figs 1–6

Description. Slender, medium-sized delphacid species of delicate appearance with strongly pale-dark contrasting colouration of the head.

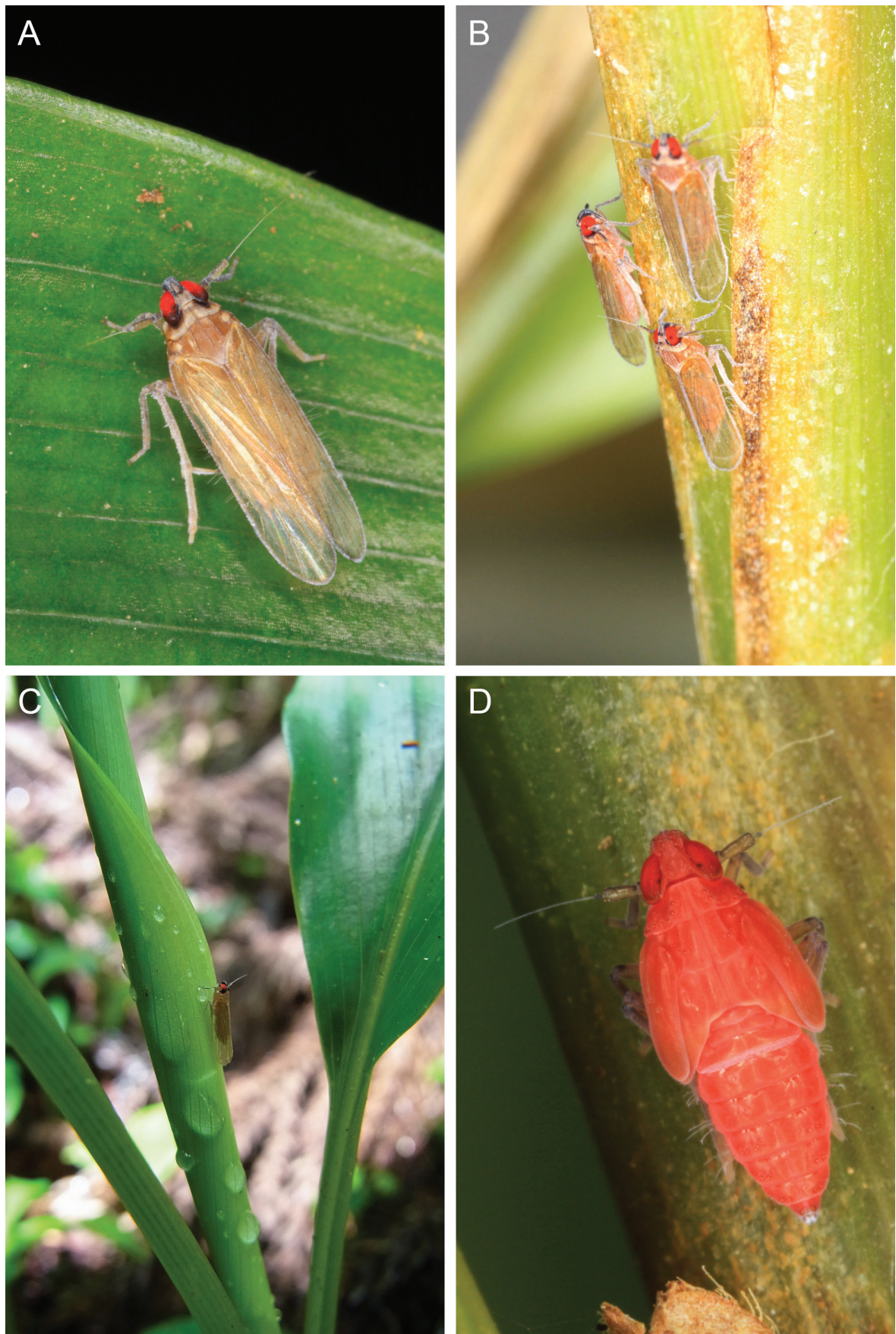
Length (from tip of head to apex of tegmina): Males (n=20): 4.0–4.4 mm (mean 4.2 mm); Females (n=20): 4.3–4.7 mm (mean 4.5 mm)

Colouration: Ground colour pale yellow to orange. Vertex pale yellow, with a narrow transverse dark brown to blackish stripe across the posterior margin of the anterior compartment; lateral margins, posterior corners and converging anterior carinae blackish brown; transition to frons as well as dorsal part of median frontal carina blackish. Frons pale yellow, lateral margins blackish, median carina centered in a narrow black-brown stripe. Post- and anteclypeus orange, median carina of postclypeus brownish. Rostrum orange with black tip. Antennae sordid orange-brown; scape distally fringed blackish-brown; pedicel anteriorly with a broad oblique brown stripe which is distally darker. Sides of head in front and dorsally of compound eyes broadly marked black, posterior corners above compound eyes blackish; compound eyes bright red; sides otherwise pale yellow to orange; ocelli centered in a brown spot; oblique genal carina anteriorly fringed brown; lower part of genae pale yellow; lamina mandibularis (lorae) orange. Pronotum sordid pale yellow, carinae of disk and posterior margin brownish, sides behind compound eyes anteriorly brown; laterodistal part of pronotum pale yellow, anteriorly with a blackish fringe. Mesonotum and tegulae sordid orange-brown. Tegmina translucent, smokey pale yellow or light sordid brown, veins light brown. Hind wings hyaline with brown veins. Legs orange to pale yellow, distal outer margin of tibiae brown. Abdominal tergites and sternites as well as male and female genitalia, mostly orange; ovipositor and posteromedian parts of tergite IX brown, anal style in males brownish, and females blackish.

Head and thorax: Head with large compound eyes, narrow vertex and frons; head including compound eyes about 3 times wider than vertex at base, about 0.8 times narrower than maximum width of pronotum. Vertex elongate, narrow, medially about 1.87 times longer than wide

at base, distinctly projected in front of compound eyes; lateral margins subparallel, slightly converging towards apex, apex in dorsal view truncate; compartments of vertex concave, limited by faint but well recognizable carinae; basal compartments elongate, anteriorly limited by anteriorly diverging carinae; anterior compartment rhomboid, lateral carinae converging towards apex and medially continuing as median frontal carina; transition of vertex to frons in lateral view in an almost right angle, apically slightly rounded. Frons elongate, apically rather narrow, continuously widening towards frontoclypeal suture, medially about 2.1 times longer than maximally wide, widest at frontoclypeal suture, basally about 3 times wider than apically, frons medially about 1.3 times longer than post- and anteclypeus together; lateral frontal carinae ridged, very slightly convex, in parts nearly straight, diverging from apex towards base; median frontal carina distinctly ridged, frontal surface in upper part shallowly concave, in lower part almost plain or slightly convex; frontoclypeal suture almost straight. Postclypeus vaulted, median carina ridged, lower part forming a nose-like projection (best seen in lateral view). Antennal joints subcylindrical, elongate, terete; pedicel about 2.8 times longer than scape, furnished with about 16 sensory plaques, arranged in 7 groups, partly in rows. Compound eyes large, in lateral view flat kidney-shaped, mediobasal incision above antennal base distinct, ocelli well developed; oblique genal carina sharply ridged. Pronotum about 3.6 times wider than medially long, carinae of disk sharply ridged, attaining posterior margin, lateral carinae slightly convex, diverging posteriorly; surface of disk shallowly concave. Mesonotum medially about 2.6 times longer than pronotum, carinae ridged, lateral carinae very slightly concave, diverging towards and attaining the posterior margin, median carina vanishing before reaching scutellum; surface of disk nearly plane. Tegulae well developed, in dorsal view about as long as wide. Tegmina elongate and narrow, about 4.5 times longer than maximally wide, widest shortly distad of nodal line, the latter in distal third; subapical cells small and narrow, inner cell (C5) slightly longer than outer one (C1), in membrane M branched into M1 and M2. Margin of hind wing with distinct notch at A1, M distally branched. Legs slender; hind leg with tibia about 1.25 times longer than tarsal joints together, laterally furnished with 2 spines, one close to base, the other shortly below midlength, distally with 5 spines: 2 rather small ones inside, 3 increasingly longer ones towards outside; post-basitarsus about twice as long as 2nd and 3rd post-tarsal joints together, distally with 5 spines: 4 in a row, one spine positioned anteriorly out of row; 2nd post-tarsal joint distally with 4 spines: the 3 inner ones forming an oblique row, the outer one distinctly longer.

Abdomen slightly depressed, hypopleurites subrectangular with straight outer margin. Male drumming organ with paired apodemes of the second abdominal sternite elongate, erect, slightly widening dorsally, nearly attaining tergites.



Colour plate 1. *Burnilia japonica* sp. n. **A.** Adult female (27. August 2013); **B.** Adults approaching each other (16. July 2014); **C.** Adult, on a rolled leaf of *Alpinia intermedia* (Yakushima; 20. August 2013); **D.** 5th instar nymph (body length ca. 2.7 mm) on potted host plant, *Alpinia intermedia* (13. July 2014).

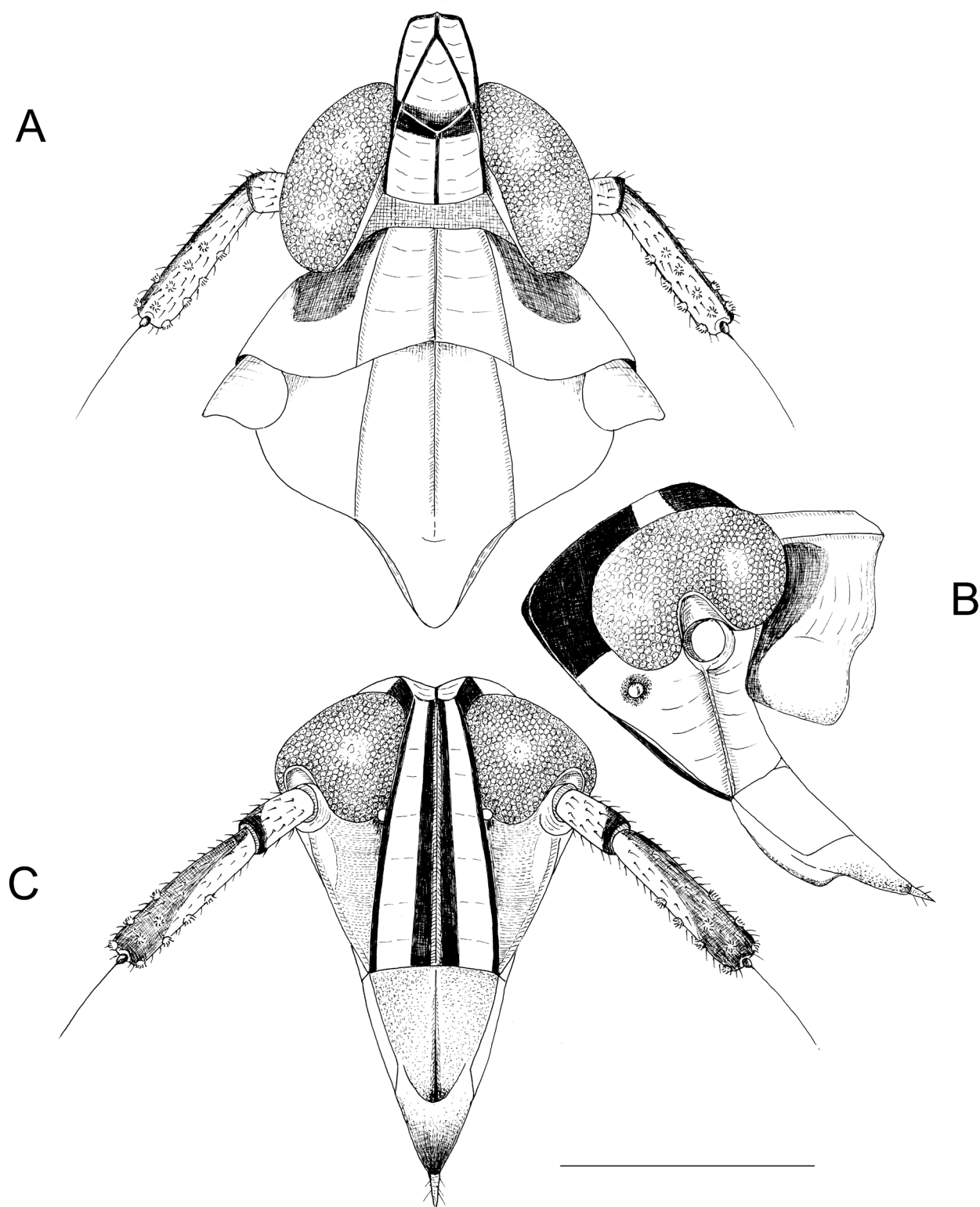


Figure 1. A. Head and thorax, dorsal view; B. Head, left lateral view; C. Head, frontal view; scale bar 0.5 mm.

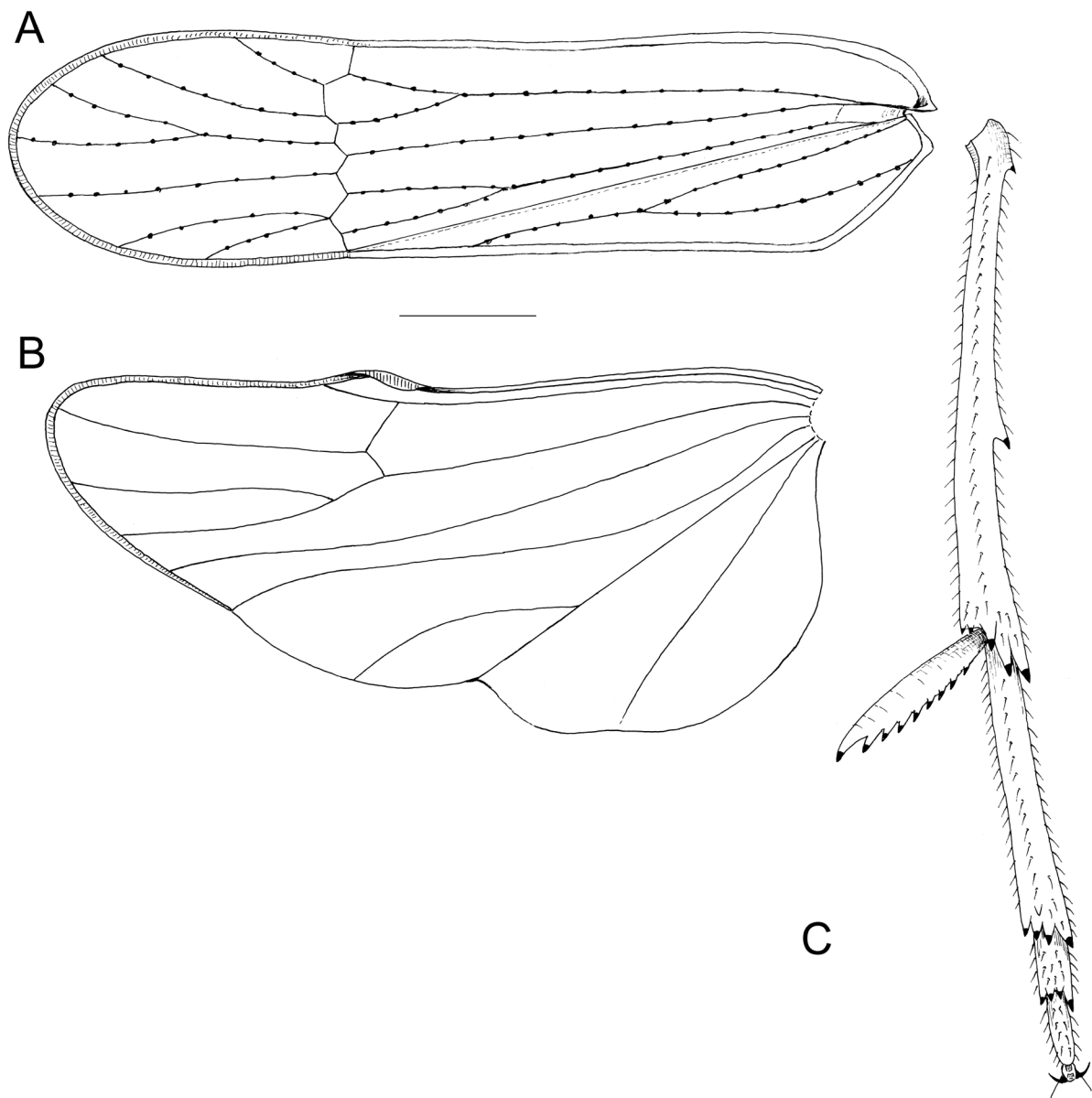


Figure 2. A. Left tegmen, venation; B. Left hind wing, venation; C. Left hind leg, ventral view; scale bars 0.5 mm.

Male genitalia: Genital segment in lateral view trapezoidal, ventrally about 1.3 times longer than dorsally, laterodorsal corners slightly produced, caudal margin nearly straight; in ventral view medially slightly longer than wide, mediocaudal margin straight with a small central knob; in caudal view ovoid, slightly higher than wide; diaphragm narrow, median sclerotized portions lobe-like with median membranous interruption. Aedeagus relatively short, when exposed hardly surpassing tip of anal segment, in lateral view curved dorsally; central sperm-conducting tube (sheath sensu Yang and Chang 2000) strongly sclerotized and ending in an apical phallotreme which is fringed by a crown of grooves and exposed to the left side; no free suspensorium: base of phallosome connecting to anal segment strongly sclero-

tized forming phallobase sensu Yang and Chang (2000), otherwise phallosome membranous, subapically on dorsal side slightly dilated and very finely serrate, on ventral side with a stronger sclerotized patch, in one of the examined individuals subapically on right dorsal side with a small sclerotized tooth directed dorsally; dorsally, immediately below the phallotreme on the left side, with a slender, apically pointed flag-like process which is almost semicircularly curved over the dorsal towards the right side, process subapically with small teeth. Anal segment, elongate, robust, shaft in ventral view about 1.7 times longer than maximally wide, widest caudally, ventrocaudal corners projected ventrally forming ear-like lobes, slightly asymmetrical; ventral surface membranous; anal style subconical, ventral side slightly concave,

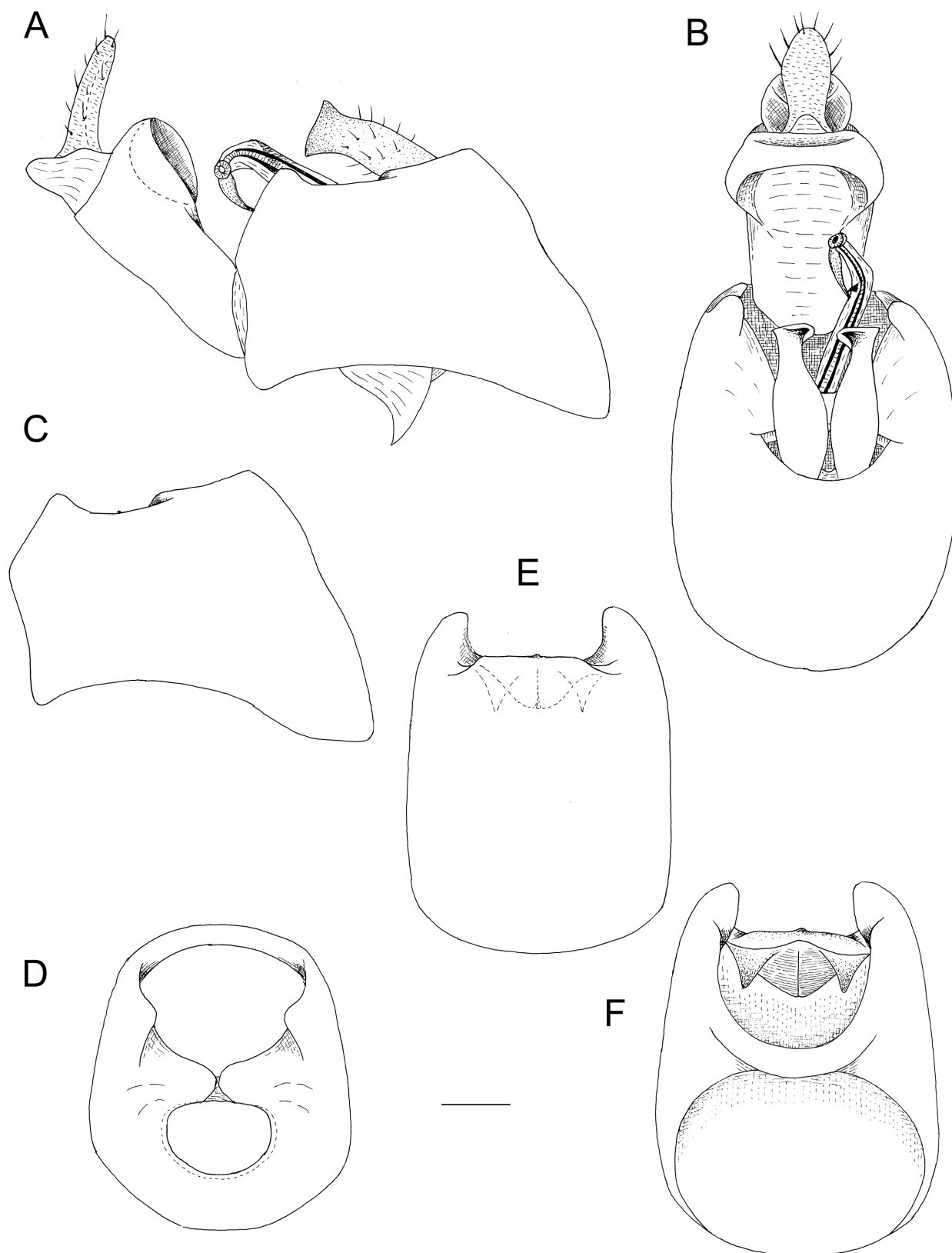


Figure 3. Male genitalia. **A.** Genital complex in left lateral view; **B.** Genital complex in ventral view; **C.** Genital segment in left lateral view; **D.** Genital segment in caudal view; **E.** Genital segment in ventral view; **F.** Genital segment in dorsal view; scale bar 0.1 mm.

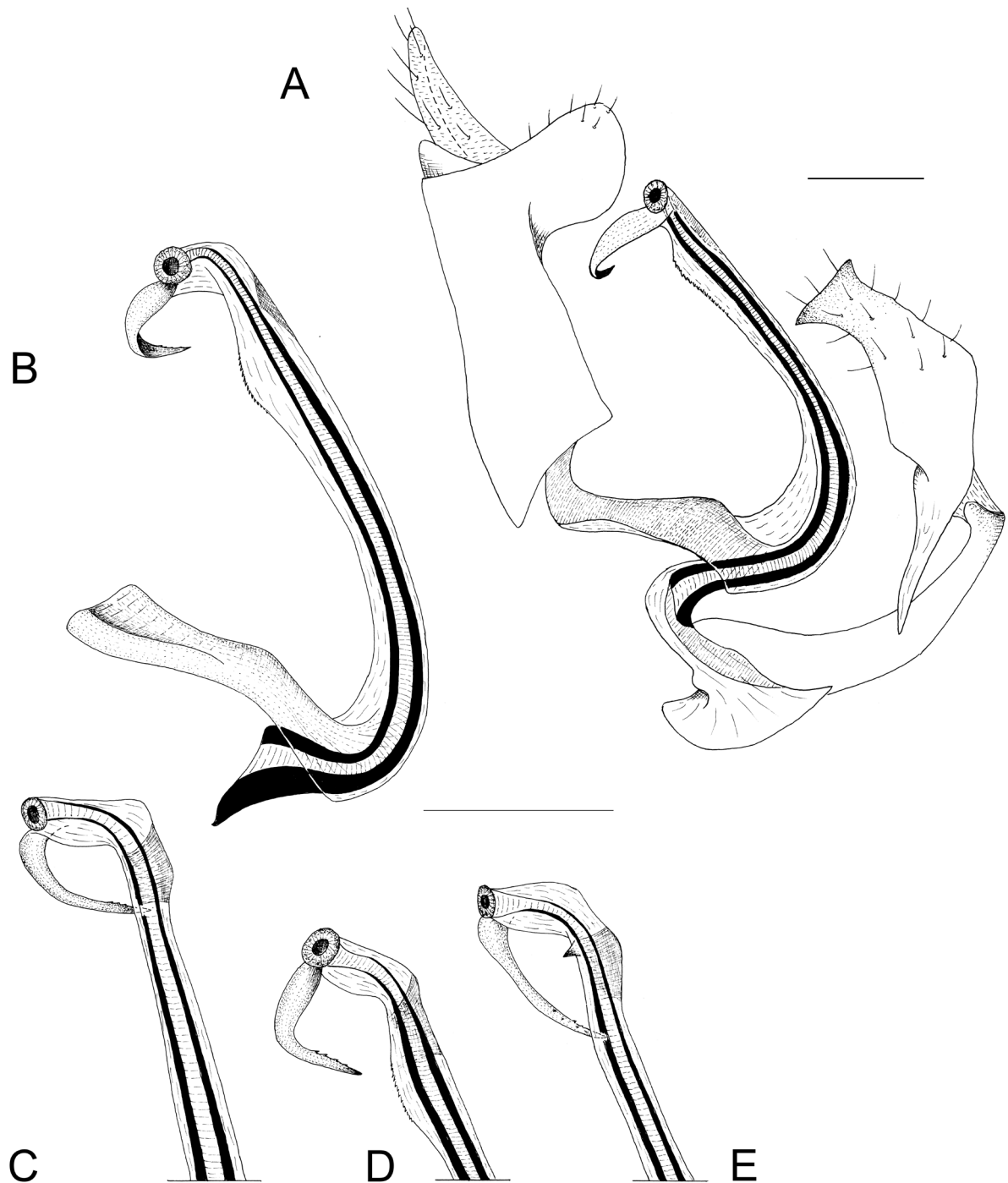


Figure 4. Male genitalia. **A.** Genital complex in left lateral view, genital segment removed; **B.** Aedeagus left lateral view; **C.** tip of aedeagus in ventral view; **D.** tip of aedeagus in ventral view, *versus* **C.** slightly twisted to left; **E.** tip of aedeagus in ventral view, another specimen, notice the short ridged spine; scale bars 0.1 mm.

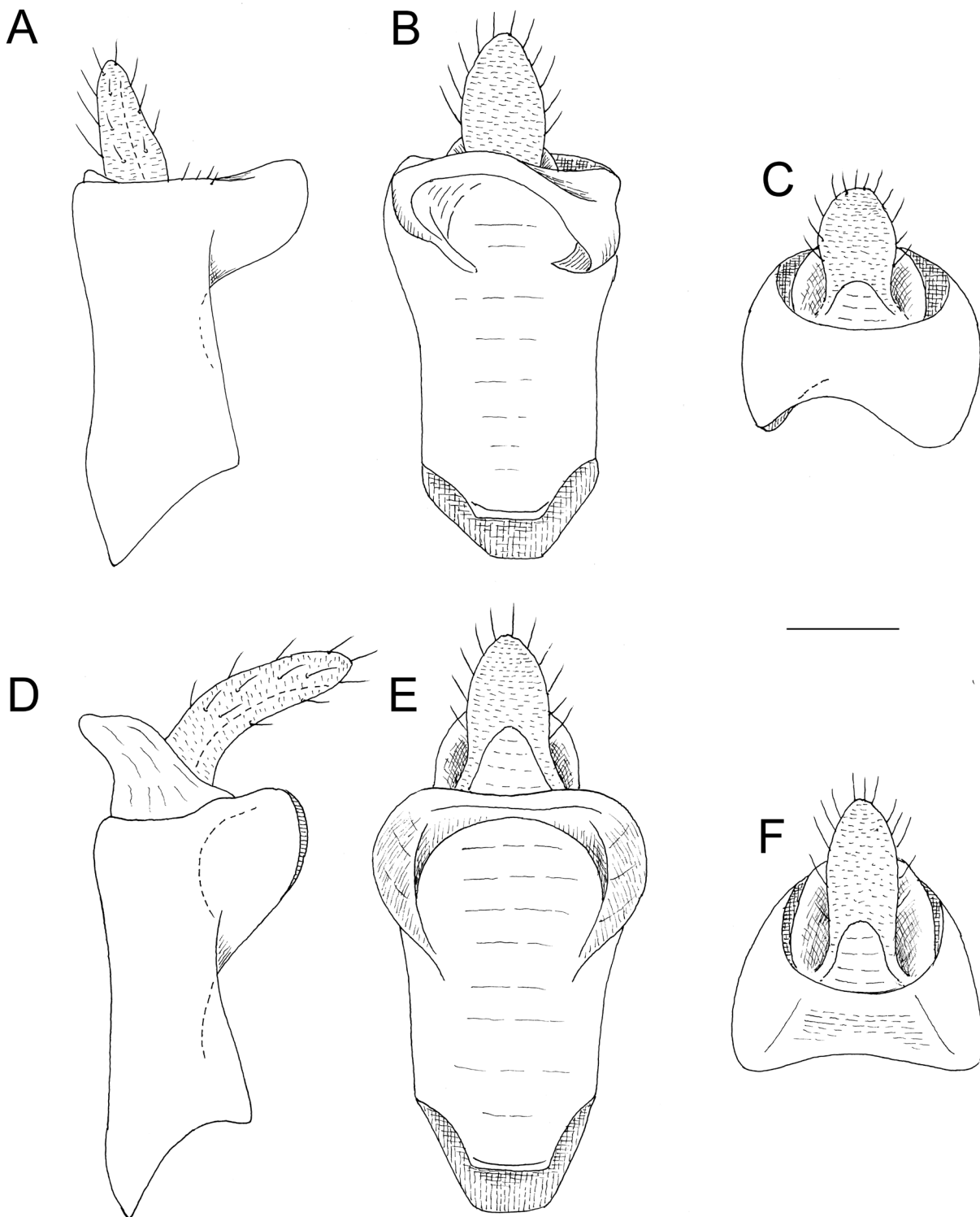


Figure 5. Male genitalia. **A–D:** ♂ 1, **D–F:** ♂ 2. **A, D.** Anal segment and anal style in left lateral view; **B, E.** Same in ventral view; **C, F.** Same in dorsal view; scale bar 0.1 mm.

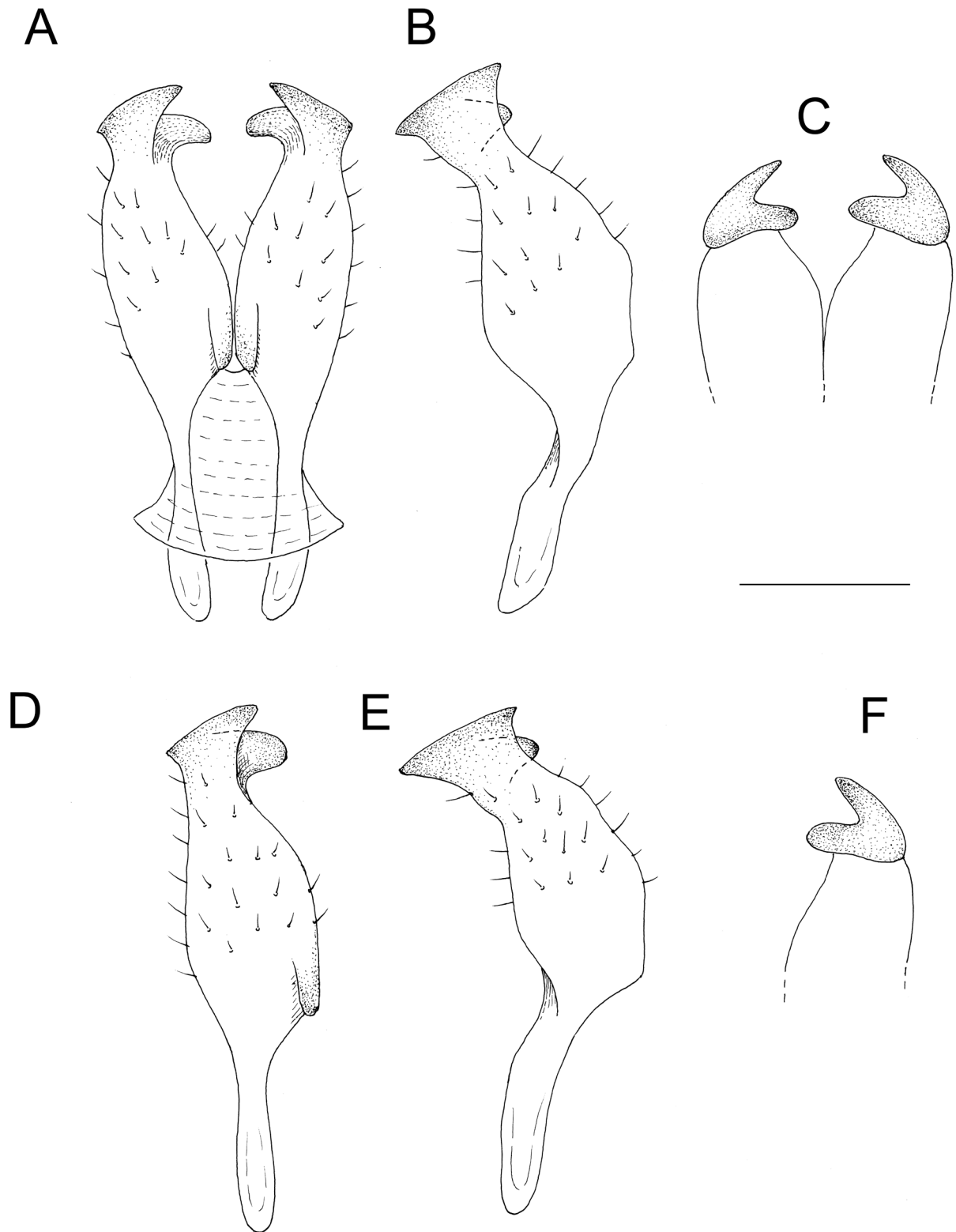


Figure 6. Male genitalia. A–C: ♂ 1, D–F: ♂ 2. A, D. Genital styles resp. left genital style in ventral lateral view; B, E. left genital style in left lateral view; C, F. left genital style, tip in caudal view; scale bar 0.1 mm.



Colour plate 2. Habitat of *Burnilia japonica* sp. n. **A.** Cedar forest floor, Yakushima Island, Japan; **B.** same locality, undergrowth of cedar forest, ferns interspersed with *Alpinia intermedia*.

about 4 times shorter than anal segment, mostly gently curved ventrally. Genital styles distinctly shorter than anal segment, in repose not attaining dorsolateral edges of genital segment, arising from a broad base and continuously narrowing towards apex, narrowest subapically, apically dilated into a bilobate tip; the inner apical lobe shorter than the outer one, apically rounded and pointing medially; the outer lobe ventrally and dorsally pointed, in lateral view forming a wide trapezoidal tip with nearly straight caudal margin.

Female genitalia: as in all Plesiodelphacinae ditrysic with clear separation of copulation and oviposition duct (Asche 1985a, b). Ovipositor slender, compressed, slightly curved dorsally, not surpassing the lateral edges of tergite IX; at base of ovipositor a sclerotized groove into the vagina guiding and supporting the aedeagus during copulation; gonopods large and relatively wide, fully enclosing gonapophyses VIII and IX, gonapophysis IX dorsally in distal third finely serrate; gonocoxae VIII elongate, slightly dilated and rounded at base; tergite IX laterocaudally slightly pointed; anal segment short and depressed, about as long as wide, anal style about as long as anal segment, ventrally concave and membranous.

Diagnosis. *Burnilia japonica* sp. n. can easily be distinguished from the New World species of the genus by the colouration of the frons: median carina broadly bordered by a blackish stripe *versus* frons entirely devoid of colour patterns, or frons furnished by one or two transverse blackish stripes in Neotropical species. In *B. japonica* sp. n. the vertex displays a faint but distinct carination separating the two posterior from the anterior compartment; in the Neotropical species at least the median carina separating the basal compartments is strongly reduced or absent, in some species also the basal carinae limiting the anterior compartment are absent. *B. japonica* sp. n. is also unique by the possession of a relatively short and sturdy aedeagus (usually distinctly more slender and elongate in Neotropical species), by a flag-like semicircular subapical aedeagal process (forming a straight, slender spine in Neotropical species, if present), and by an anal segment with large ear-shaped lateroventral lobes (no such lobes are observed in the Neotropical species).

Distribution. Japan: Kyushu (south-westernmost area), Yakushima Island of the Osumi Isles and Okinawa Island (northern part) of the Ryukyus, endemic.

Hostplant, ecology, and biology (see Colour plate 2). In the extent of our field investigations on Yakushima Is. south of Kyushu, the host plant is restricted to a wild perennial zingiberaceous plant, *Alpinia intermedia* Gagnep. (Zingiberaceae: *gingers*) distributed in Japan and the East Orientalis growing on shady and wet forest floors of cedar afforestation or sometimes laurophyll forests. The occurrence of this *Burnilia*-species is usually strongly confined to narrow spots even in a same forest. Although two other species of Zingiberaceae, *A. formosana* K.Schum. and *A. zerumbet* (Pers.) (apparently introduced) are also found in same area, and are rather

dominant at sunny forest edges or at roadsides, *Burnilia japonica* has never been found on these plants, but exclusively on *A. intermedia*.

In the field, both nymphs and adults are found near the ground, on stems of the host plant below the level of fallen cedar leaves. Adults may appear from late July with a probable peak at mid- and late August on Yakushima Is.

Since late summer of 2013, M. Hayashi had been rearing several adults collected by Fujinuma, on potted ginger-lilies (*A. intermedia*) at his home near Tokyo. Adults were never observed to hibernate; thus it is assumed that overwintering occurs as eggs. Some nymphs were recognized in the following June, and a first adult appeared on July 5, 2014. The nymphs in every instar are wholly red, becoming vivid in last (5th) instar. On stems of the host plant, both adults and nymphs stand still with their heads directing upward and antennae fully stretching right laterally. Adults just after emerging are carmine red, gradually changing their colouration to yellowish with grey tinge. The compound eyes, however, remain brightly red with a black pseudopupil.

Etymology. The specific name refers to the geographical occurrence in Japan.

Material examined. Holotype ♂ macropterous, Japan, Kagoshima Pref., Osumi Isles, Yakushima, Yudomari, 20.VIII.2013, S. Fujinuma (TUA). The holotype is deposited in the Laboratory of Entomology, Tokyo University of Agriculture, Japan.

Paratypes: 3 ♂♂, 4 ♀♀, Kyushu, Kagoshima Pref., Minami-Satsuma, Bonotsu, Akime, 17.VIII.2014, K. Ôhara (TUA). 1 ♀, Kagoshima Pref., Makurazaki, Nishikago, 17.VIII.2014, K. Ôhara (TUA). 2 ♂♂, 6 ♀♀, Kagoshima Pref., Makurazaki, Hinokami, 17.VIII.2014, K. Ôhara (TUA). 25 ♂♂, 36 ♀♀, same data as holotype (TUA, MFNB). 2 ♂♂, 1 ♀, same locality, 19.VIII.2013, S. Fujinuma (TUA). 6 ♂♂, same locality, 18.VII.2014, M. Hayashi (TUA). 2 ♂♂, Yakushima, Kurio, 19.VIII.1983, Sk. Yamane (TUA). 2 ♀♀, Ryukyus, Okinawa Is., Kunigami, Benoki, S. Azuma, no collecting date (RUMF). All specimens macropterous.

Discussion

For the first time a representative of the plesiodelphacine Delphacidae, hitherto assumed to be confined to the New World, is recorded from the Old World, i.e., from warm-temperate and subtropical Japanese islands. The species is new to science, and beyond any doubt belongs to the genus *Burnilia* Muir & Giffard which is considered a monophyletic group. However, it appears to be unique in characters of the male genitalia displaying a relatively short aedeagal shaft with flag-like terminal process, an anal segment with large laterocaudal ear-shaped projections, and apically bifurcate genital styles. While in most New World *Burnilia*-species the carination of the vertex is strongly reduced or even absent, it is faintly present in the Japanese *Burnilia*, - possibly a plesiomorphic trait.

It is noticeable that the Japanese *Burnilia* species does not match the colouration patterns and the morphological display of any of the six described American *Burnilia*-species. Therefore it appears conceivable, even likely, that this species is in fact indigenous to the South Japanese Islands, and was just overlooked in previous surveys, although Japan including its southern islands must be regarded as comparatively well studied concerning its fauna, including planthoppers.

The extension of the range of occurrence of *Burnilia*-species to the Old World is remarkable, and represents a prime example of trans-Pacific disjunction. The question arises whether this zoogeographic pattern is due to dispersal or vicariance events.

Examples of recent New World introductions to Europe across the Atlantic are known, e.g., the (presumed invasive) American delphacine *Prokelisia marginata* (Osborn) feeding on the Poaceae-species *Spartina maritima* (Curtis) Fernald into coastal saltmarshes of Portugal and Slovenia (Curtis) (Seljak 2004). *Viceversa* the European delphacine *Conomelus anceps* (Germar) feeding on Juncaceae recently appeared in North America (Wheeler and Hoebeke 2008). For more examples of transatlantic migration see Bartlett et al. (2014). Natural long distance trans-Pacific dispersal of small arthropods by e.g., wind, rafting, has been documented by Gressitt 1961). In planthoppers, natural trans-Pacific dispersal with successful colonizations is assumed for the ancestors of the – now – endemic faunas of Pacific island groups such as Hawai'i (Asche 1997). In Hawai'i, however, also recent immigrant planthopper species from Oriental-Australian sources towards the East, and *viceversa* from the New World towards the West have been recorded (e.g., Asche 2000). We, however, are not aware of any Oriental or New World delphacid species that successfully crossed (by whatever means) the entire Pacific in either direction and established viable populations.

Although we cannot fully exclude the possibility of a recent introduction of a *Burnilia* species into Japan from a Neotropical source, and although a species-level phylogeny of the Plesiodelphacinae is still missing, we lean towards vicariance as the underlying mechanism of the currently observed distribution pattern in *Burnilia*. This hypothesis is also supported by the fact that *Burnilia japonica* feeds only upon a wild zingiberaceous plant, *Alpinia intermedia* Gagnep., distributed from southwestern Japan to Taiwan, China and the Philippines. This host plant is most likely native in Japan; it probably has never been introduced, and also not been cultivated as ornamental or decorative plants. The localization and endemism of this *Burnilia*-species very likely reflects a natural distribution. Neotropical *Burnilia*-species (as far information is available) feed on, *Heliconia* spp. (Heliconiaceae, - in older literature listed in Musaceae). In the Neotropics *Burnilia*-species have been collected “within new, curled leaves (like those seen in figure 8c) before the leaves have uncurled” (Ch. Bartlett, personal communication). For the second plesiodelphacine genus *Plesiodel-*

phax and its type-species *P. guayanus* Asche a host plant is unknown.

A rather similar distribution pattern is observed in another group of Delphacidae, namely taxa of the tribe Saccharosydmini, with 3 entirely Neotropical genera, and one more genus, *Saccharosydne* Kirkaldy, 1907, with type-species *S. saccharivora* (Westwood, 1833) described from the West Indies which contains some more species from the New World, but also a single species from the Old World, namely *S. procerus* Matsumura, 1931, described from Japan and reported from China, S. Russia, Taiwan, Korea, and probably Vietnam (Ch. Bartlett, personal communication).

Similar biogeographic patterns have also been reported from other groups of organisms, (e.g., Diptera, Keroplatidae: Matile 1990; plants: Heads 1999). An interesting hypothesis to explain trans-Pacific, trans-tropical disjunct distributions has been suggested by McCarthy (2003), assuming a “closed Pacific in the Upper Triassic-Lower Jurassic” some 200 Million years ago. The opening and expansion of the Pacific may be the vicariant event which eventually led to the split between the Japanese and Neotropical *Burnilia* lineages; however, this assumption appears rather speculative due to the high geological age concerned.

Although a far more recent distributional pathway across the Beringian bridge in Cenozoic times is theoretically conceivable (V.M. Gnezdilov, personal communication), there is no evidence for a historic occurrence of this group in the Holarctic Region.

Fossil records for Delphacidae in general are sparse, and mainly concern geologically younger periods like the Eocene (e.g., Szwedo et. al. 2004). For Plesiodelphacinae fossils are unknown.

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References

- Asche M (1985a) A new subfamily, genus and species of Delphacidae from South America: Plesiodelphacinae subfam. nov., Plesiodel-

- phax guayanus gen. et spec. nov. (Homoptera Fulgoroidea). Marburger Entomologische Publikationen 1(10): 219–240.
- Asche M (1985b) Zur Phylogenie der Delphacidae Leach, 1815 (Homoptera, Cicadina, Fulgoromorpha). Marburger Entomologische Publikationen 2(1-2): 1–912.
- Asche M (1990) Vizcayinae, a new subfamily of Delphacidae with revision of *Vizcaya* Muir (Homoptera: Fulgoroidea) - a significant phylogenetic link. Bishop Museum Occasional Papers 30: 154–187.
- Asche M (1997) A review of the systematics of Hawaiian planthoppers (Hemiptera: Fulgoroidea). Pacific Science 51(4): 366–376.
- Asche M (2000) Scientific Note, New State Records of immigrant planthoppers in Hawaii (Homoptera: Fulgoroidea). Proceedings of the Hawaiian Entomological Society 34: 205–207.
- Bartlett CR (2005) Progress in the phylogeny of the Delphacidae using molecular and morphological tools. In: Abstracts of talks and posters, 12th International Auchenorrhyncha Congress, University of California, Berkeley, 7–12 August 2005, S[ymposia]: 29–30.
- Bartlett CR, O'Brien LB, Wilson SW (2014) A review of the planthoppers (Hemiptera: Fulgoroidea) of the United States. Memoirs of the American Entomological Society 50: 287 pp.
- Bourgoin T (1993) Female genitalia in Hemiptera Fulgoromorpha, morphological and phylogenetic data. Annales de la Société entomologique de France (N.S.) 29(3): 225–244.
- Bourgoin T, Wang RR, Asche M, Hoch H, Soulier-Perkins A, Stroiński A, Yap S, Szwedo J (2014) From micropterism to hyperpterism: recognition strategy and standardized homology-driven terminology of the forewing venation patterns in planthoppers (Hemiptera: Fulgoromorpha). Zoomorphology, 15 pp. doi: 10.1007/s00435-014-0243-6
- Crawford DL (1914) A contribution toward a monograph of the Homopterous insects of the family Delphacidae of North and South America. Proceedings of the United States National Museum, Washington, 46: 557–640, plates 44–49. doi: 10.5479/si.00963801.46-2041.557
- Emeljanov AF (1995) On the question of the classification and phylogeny of the Delphacidae (Homoptera, Cicadina). Entomologicheskoye Obozrenie 74(4): 780–794. [In Russian] [Translated into English in Entomological Review 1996 75(9): 134–150.]
- Fennah RG (1945) The Fulgoroidea, or lanternflies, of Trinidad and adjacent parts of South America. Proceedings of the United States National Museum, Washington, 95: 411–520, plates 7–17. doi: 10.5479/si.00963801.95-3184.411
- Fennah RG (1959) Delphacidae from the Lesser Antilles (Homoptera: Fulgoroidea). Bulletin of the British Museum (Natural History) Entomology 8(6): 245–265.
- Gressitt LJ (1961) Problems in the zoogeography of Pacific and Antarctic insects. Pacific Insects Monograph 2: 127 pp.
- Hamilton KGA (2006) The planthopper genus *Stenocranus* in Canada: implications for classification of Delphacidae (Hemiptera). Canadian Entomologist 138: 493–503. doi: 10.4039/n06-805
- Heads M (1999) Vicariance biogeography and terrane tectonics in the South Pacific; analysis of the genus *Abrotanella* (Compositae). Biological Journal of the Linnean Society 67: 391–432. doi: 10.1111/j.1095-8312.1999.tb01941.x
- Hoch H (2013) Diversity and Evolution of the Southeast-Asian plant-hopper taxon Bennini (Hemiptera, Cixiidae). Nova Supplementa Entomologica 23: 1–296.
- Holzinger WE, Kammerlander I, Nickel H (2003) Die Zikaden Mitteleuropas (The Auchenorrhyncha of Central Europe) Volume 1: Fulgoromorpha, Cicadomorpha excl. Cicadellidae. Brill Publishers, Leiden-Boston, 673 pp.
- Kirkaldy GW (1907) Leafhoppers. Supplement (Hemiptera). Bulletin of the Experiment Station of the Hawaiian Sugar Planter's Association (Entomological Series) 3: 186 pp.
- Matile L (1990) Recherches sur la systématique et l'évolution des Kero-platidae (Diptera, Mycetophiloidea). Mémoires Museum national d'Histoire naturelle, série A, 148. Publications Scientifiques du Museum national d'Histoire naturelle, Paris, 1–682.
- McCarthy D (2003) The trans-Pacific zipper effect: disjunct sister taxa and matching geological outlines that link the Pacific margins. Journal of Biogeography 30: 1545–1561. doi: 10.1046/j.1365-2699.2003.00929.x
- Metcalf ZP (1943) General Catalogue of the Hemiptera. Fascicle IV. Fulgoroidea, Part 3. Araeopidae (Delphacidae). Smith College, Northampton, Massachusetts, 549 pp.
- Muir F (1926) Contributions to our knowledge of South American Fulgoroidea (Homoptera) Part I. The family Delphacidae. Bulletin of the Experiment Station of the Hawaiian Sugar Planter's Association (Entomological Series) 18: 1–51.
- Muir F, Giffard MW (1924) Studies in North American Delphacidae (Homoptera). Bulletin of the Experiment Station of the Hawaiian Sugar Planter's Association (Entomological Series) 15: 1–53.
- Seljak G (2004) *Prokelisia marginata* (Van Duzee, 1897) – a Nearctic planthopper new to Slovenia and Europe (Auchenorrhyncha: Delphacidae). Acta Entomologica Slovenica 12: 260–263. [In Slovenian with English Abstract]
- Stål C (1864) Hemiptera mexicana enumeravit speciesque novas descripsit. (Continuatio). Stettiner Entomologische Zeitung 25: 49–86.
- Szwedo J, Bourgoin T, Lefebvre F (2004) Fossil Planthoppers (Hemiptera: Fulgoromorpha) of the World. An annotated catalogue with notes on Hemiptera classification. Studio 1, Warszawa, Poland, figs 1–29, 1 table, 199 pp.
- Urban J, Bartlett CR, Cryan JR (2010) Evolution of Delphacidae (Hemiptera: Fulgoroidea): combined-evidence phylogenetics reveals importance of grass host shifts. Systematic Entomology 35: 678–691. doi: 10.1111/j.1365-3113.2010.00539.x
- Wheeler AG Jr, Hoebeke ER (2008) *Conomelus anceps* (Germar) (Hemiptera: Fulgoromorpha: Delphacidae) new to North America, with records of four other delphacid planthoppers new to Newfoundland. Proceedings of the Entomological Society of Washington 110: 265–283. doi: 10.4289/07-035.1
- Yang C-T, Chang T-Y (2000) The external male genitalia of Hemiptera (Homoptera-Heteroptera). Shih Way Publishers, Taichung, Taiwan, 746 pp. (600–645).

Revision of the *Dicranotropis hamata* group (Auchenorrhyncha, Delphacidae) and remarks on the implication of chiral dimorphism in its history

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<http://zoobank.org/59C70D23-24BD-4D07-BD17-D7736A26A0EC>

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Abstract

A new species, *Dicranotropis remaniaca*, is described. Morphological differences between the new species and the closely related *D. hamata* (Boheman) and *D. zenata* Logvinenko are summarized. Chirality is discussed in view of hypothetical implications in the history of the *D. hamata* group and of the presence of the phenomenon in a supposed hybrid area between *D. hamata* and *D. remaniaca* in southwestern France. Zoogeographic and phylogenetic aspects are discussed using *D. sagata* Logvinenko as outgroup.

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Introduction

The genus *Dicranotropis* was established by Fieber (1866) for the type species *Delphax hamata* Boheman, 1847. It is widely distributed in the Palearctic region. Some species are recorded also from tropical Africa, Australia and the Neotropic region, but these records concern probably other genera with double or bifurcate carinae on the frons. No species of *Dicranotropis* is recorded from North America.

Kirkaldy (1907) established for *Dicranotropis beckeri* Fieber, 1866 the genus *Leimonodite* on the base of the morphology of the frontal carinae. Nowadays this taxon is considered a subgenus of *Dicranotropis*. In Europe are recorded: *Dicranotropis* (*Dicranotropis*) *hamata* (Boheman, 1847), *D.* (*Leimonodite*) *beckeri* Fieber, 1866, *D.* (*Leimonodite*) *divergens* Kirschbaum, 1868, *D.* (*Leimonodite*) *montana* (Horváth, 1897). *D. carpath-*

ica Horváth, 1884 is considered a synonym of *D. divergens* Kirschbaum (Wagner 1963).

D. hamata is recorded from vast parts of Europe, Turkey, Siberia and perhaps North Africa, *D. divergens* from most parts of Europe (except for Fennoscandia and the Iberian Peninsula) and some regions of Central Asia, *D. beckeri* primarily from the Balkan region and Eastern Europe with some relictary area in France and Spain, Turkey and Central Asia, and *D. montana* from some alpine regions (Germany, Austria, Italy) and Romania.

D. hamata is closely related to *D.* (s. str.) *zenata* Logvinenko, 1969, described from the Caucasus region (Georgia), and shares with it a similar genital morphology. *D.* (s. str.) *sagata* Logvinenko, 1976, a further species from the Caucasus region described from Georgia, displays a quite different morphology of pygofer and styles, but has some other characters in common with *D. hamata*

concerning for example the aedeagus shape in males and the shape of the genital scale in females.

The existence of a taxon slightly different from *D. hamata* and replacing it in Italy was discovered by Remane and independently by D'Urso already many years ago, but difficulties to obtain material also from the closely related species described by Logvinenko from the Caucasus delayed the publication of these data until today.

The aim of the present paper is to describe the new taxon, *D. remaniaca* sp. n., to outline the distribution of *D. hamata* and *D. remaniaca*, respectively, and to discuss the relationships between both taxa and *D. zenata*, and to debate the relevance of aedeagal chiral dimorphism in the history of this species group.

Material and methods

Measurements were made by using a Zeiss Stemi SV 11 Stereomicroscope with ocular micrometer. A camera lucida attachment was used for the drawings; pencil sketches were subsequently copied on cardboard by means of a light table and elaborated with drawing ink. Photographs were prepared with a digital camera Canon Eos70D supplied with lens 105 mm f/2,8 Macro Canon, extension tube 25 mm Canon, and ring flash Nikon SM-2.

We examined specimens of the following collections:

- Institute of Zoology, National Academy of Sciences of Ukraine (Kiev) (CIZ).
- Naturhistorisches Museum, Basel, Switzerland (NHMB)
- Museo Cantonale di Storia Naturale, Lugano, Switzerland (MCSN)
- Muséum d'Histoire Naturelle, Genève, Switzerland (MHNG)
- Muséum National d'Histoire Naturelle, Collection Ribaut, Paris, France (MNHN/CR)
- Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia (ZIN)
- Museum für Naturkunde, Berlin, Germany (MNKB)
- Moravian Museum, Brno, Czech Republic (MMB)
- Museo Civico di Storia Naturale, Trieste (MCSNT)
- Museo di Storia Naturale, Collection Servadei, Verona (MSNV)
- Department of Agricultural and Forestry Sciences, University of Tuscia, Viterbo, Italy (collection Adalgisa Guglielmino) (CG)
- Department of Biological, Geological and Environmental Sciences, sec. Animal Biology, University of Catania (Collection Vera D'Urso) (CD)
- Private collection Ilia Gjonov, Sofia, Bulgaria (CIG)
- Private collection Christoph Bückle, Tübingen, Germany (CB)
- Private collection Gabrijel Seljak, Nova Gorica, Slovenia (CGS)
- Private collection Kees den Bieman, Ulvenhout, Netherlands (CDB)
- Private collection Werner Holzinger, Graz, Austria (CH)

The material of the Servadei collection is presently not available, but was checked and listed by our colleague Manfred Asche (Berlin) some years ago.

The locality numbers in parentheses in the examined material of the collection Guglielmino (CG) coincide with the locality number system used in our faunistic and zoogeographical papers.

Material examined

***Dicranotropis hamata* (Boheman):** 255 specimens from Albania, Austria, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Macedonia, Montenegro, Poland, Russia, Serbia, Slovenia and Switzerland.

***Dicranotropis remaniaca* sp. n.** (see also the Type series below): 390 specimens from Germany, Italy, Slovenia, Spain and Switzerland.

***D. hamata/D. remaniaca* intermediate forms:** 86 specimens from France.

***Dicranotropis zenata* Logvinenko:** Eight specimens from Georgia.

***Dicranotropis sagata* Logvinenko:** Three specimens from Georgia.

For a detailed list of the material please see Suppl. material 1.

Results

Description of the new species

Dicranotropis remaniaca sp. n.

<http://zoobank.org/2BE944FE-2E1F-404B-9218-0315B30A7E75>

Figs 9–26, 44–46

Measurements. Body length: 2.45–2.90 mm (brachypterous males), 3.85–4.20 mm (macropterous males), 2.90–3.40 mm (brachypterous females), 4.30–4.50 mm (macropterous females). Head length: 0.20–0.28 mm (males), 0.26–0.30 mm (females). Head width including eyes: 0.78–0.92 mm (males), 0.88–0.96 mm (females). Pronotum length: 0.20–0.25 mm (males), 0.22–0.26 mm (females). Mesonotum length: 0.40–0.50 mm (brachypterous males), 0.58–0.64 mm (macropterous males), 0.44–0.52 mm (brachypterous females), 0.66–0.80 mm (macropterous females). Length of fore wings from shoulder to wing tip: 1.15–1.48 mm (brachypterous males), 3.15–3.50 mm (macropterous males), 1.24–1.48 mm (brachypterous females), 3.65–3.75 mm (macropterous females).

Description. In size, coloration and shape very similar to *D. hamata*: Median carina of frons forked below junction with vertex (Figs 15, 16); lateral carinae of pronotum not reaching hind margin; wings of brachypterous specimens between 1.5 and 2 × longer than wide, apically rounded (Figs 9, 14).

Coloration. Males (Figs 9–12, 15): Face with carinae white and areas between carinae black or light brown bordered with black; vertex light brown, pronotum light brown with carinae white; mesonotum light brown or more or less dark with white central longitudinal stripe extending onto scutellum; upper side of abdomen black, often with central part and some spots on lateral parts more or less light brown; pygofer black with more or less extended light brown areas; anal tube white; anal style black; forewings (brachypterous) hyaline brown, in brachypterous specimens apical half of suture black with adjacent area of wing dark, basal half of suture and hind margin with adjacent veins white; in macropterous specimens forewings hyaline with apical half of clavus and narrow adjacent area dark; underside mostly black; legs black with knees, tibiae and tarsi light or dark brown, third tarsomere generally dark. Females (Figs 13, 14, 16): similar to males but generally lighter: areas between frontal carinae light brown narrowly bordered with black; dark spot on wing suture small; upper side of abdomen in great part light brown; ovipositor sheath light; femura often in part light brown.

Genital morphology. Males (Figs 17–26): Pygofer with distinctly protruding dorsocaudal protuberance on each side; protuberances apically with small and short spine in medioventral position (Figs 22–24); anal tube on each side with small tooth of variable size near the base in subbasal position (Figs 25, 26); styles subbasally on the mediocaudal side with scabrous surface and acute spine shaped process, in the middle distinctly curved mediocaudad and provided with preapical tooth (Fig. 21); aedeagus laterally depressed, ventrally bent, with phallotreme on the right side, only in rare exceptions on the left side; on its dorsal margin in central position with carina comprised of varying number of fused teeth and in preapical position with large single tooth, both bent towards right side; on right side, close to ventral margin, with group of about three small teeth in preapical position and, basally of them, single large tooth curved somewhat dorsad; on left side very close to ventral margin with one or more series of small teeth, varying in size and number, and with group of about three teeth more apically and quite distant from each other and from ventral aedeagus margin (Figs 17–20). Females: Gonocoxae VIII wide, median margin equally convex (Fig. 46); genital scale distinct, \pm triangular, with narrow deep apical incision reaching about half length of genital scale (Figs 44, 45).

Remarks. The pygofer and aedeagus morphology (in males), e.g. width of the aedeagus, number of the aedeagal spines (Figs 159–188), and shape of pygofer protuberances (Figs 201–206, 219–224, 249–256), and the morphology of the genital scale (in females) is to some degree variable, and apparently there are also slight regional differences (e.g. aedeagi of specimens from northern Italy, southern Switzerland and Slovenia (Figs 167–180) are particularly slender). For the variability of the genital styles see Figs 84–97.

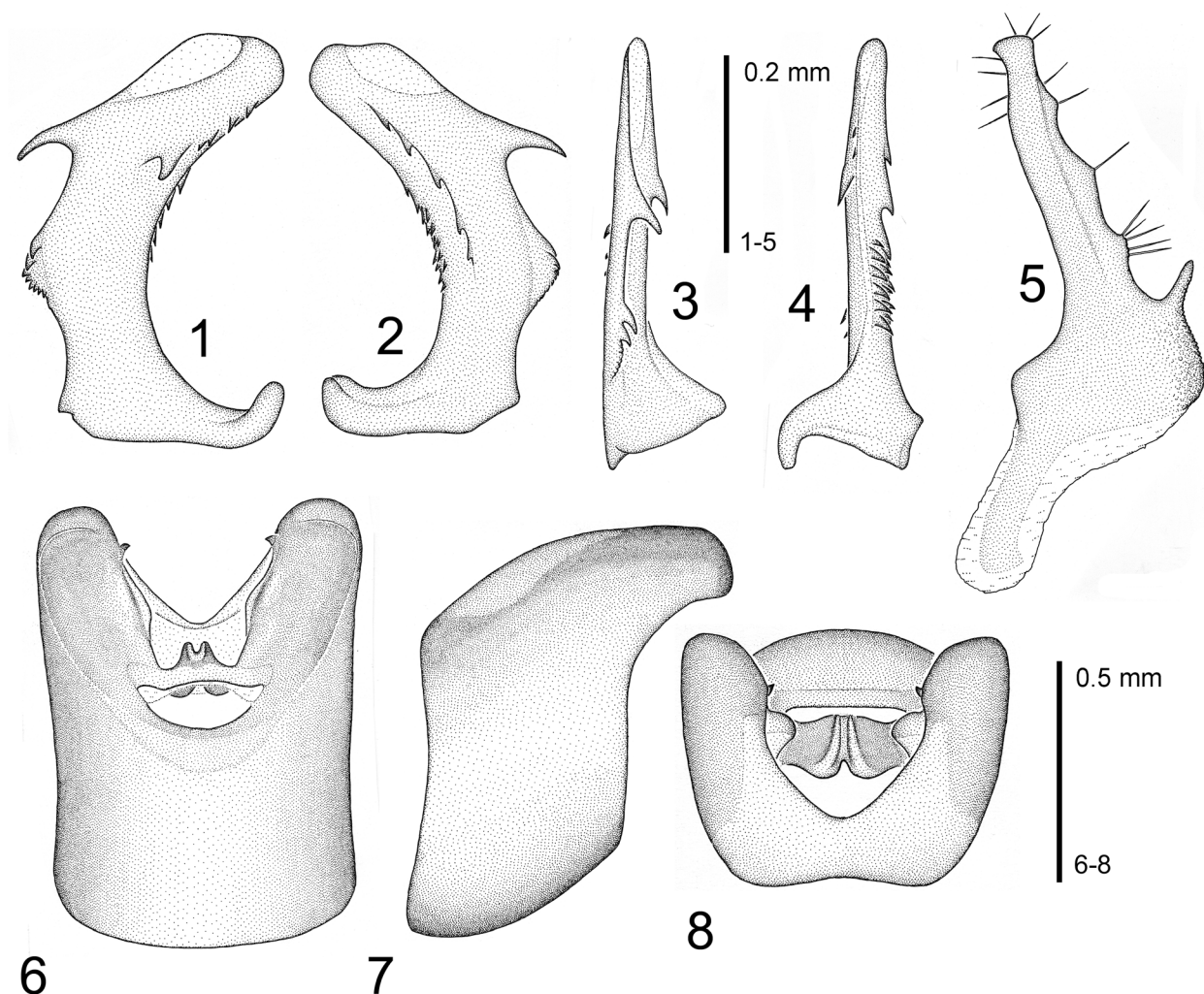
Diagnosis. Main differences to *D. hamata* consist in the shape of the genital styles and the aedeagus. The genital styles are stout, curved and provided with a preapical tooth in *D. remaniaca* while they are slender, straight, devoid of preapical tooth in *D. hamata* (Fig. 5). The aedeagus has its phallotreme on the right side, only in rare exceptions on the left side, while it is typically on the left side in *D. hamata*, and also in all other characters of the aedeagus *D. remaniaca* is the mirror image to *D. hamata* (Figs 1–4). Other differences lie in the shape of the pygofer which is in *D. remaniaca* generally with a less protruding dorsocaudal portion and further caudally and dorsally located preapical teeth, therefore these are often visible in lateral view (Figs 22–24), while *D. hamata* has a more protruding dorsal portion of the pygofer and the preapical teeth are not visible in lateral view (Figs 6–8). However, the pygofer characters are rather variable and can be misleading in some cases.

Distribution (Fig. 257). Spain (Figs 84–86, 159–164); Switzerland south of the main Alpine chain (Canton Ticino) (Figs 88–90, 167–172); Italy except for Sicily and Sardinia and a small part in the northeastern Alpine region (Figs 94–97, 179–188); western Slovenia (Figs 91–93, 173–178); and some regions in Germany (southeastern Baden-Württemberg, southwestern Bavaria) (Figs 87, 165, 166).

Ecology. *D. remaniaca* shares its ecological characteristics with *D. hamata* and is found generally on not too dry meadows, often near forest margins or groups of bushes, from low to medium high altitude until about 1600m. Host plants are different species of Poaceae.

Biology. The species was mostly found from beginning of June until end of August, but one record from April (340m) indicates that the taxon may be bivoltine in lowlands. In mountain regions it has apparently only one generation.

Type series. **Holotype**, male: Lazio (Frosinone), Monti Ernici, road Collepardo-Vérolì, east of Civita; N41°45.596', E13°24.384'; 735m; 09/08/2012; St. 679; dry open area with Poaceae, thistles, *Thymus*, *Satureja* and shadowy path near dry brook with *Acer*, *Corylus* etc.; Guglielmino & Bückle leg.. **Paratypes**: Same data as holotype, 6♂♂, 2♀♀. – Emilia-Romagna (Parma), SP 81 3,9km east (direction Bedonia) of Passo Tomarolo (km 11,4); ~ 1200m; 09/06/2007; St.385; dry meadow and moderately moist meadow near beech wood, *Salix myrsinifolia*, *Urtica*, Poaceae; Guglielmino & Bückle leg.; 4♂♂, 6♀♀. – Same locality; 22/08/2008; St.444; Guglielmino & Bückle leg.; 12♂♂, 10♀♀. – Emilia-Romagna (Parma), road from Ponteceno to Anzola, 2,4km east of Anzola; ~ 850m; 21/08/2008; St.443; meadow with *Dactylis* surrounded by *Quercus*, *Acer*, *Corylus*, *Clematis*; Guglielmino & Bückle leg.; 7♂♂, 6♀♀. – Toscana (Massa), Alpi Apuane, ca. 3km south of Vinca; ~ 1000m; 05/06/2008; St.420; mixed forest with *Alnus cordata* (?), and undergrowth with *Rubus*, ferns, Poaceae; Guglielmino & Bückle leg.; 4♂♂, 2♀♀. – Same locality; 17/08/2008;

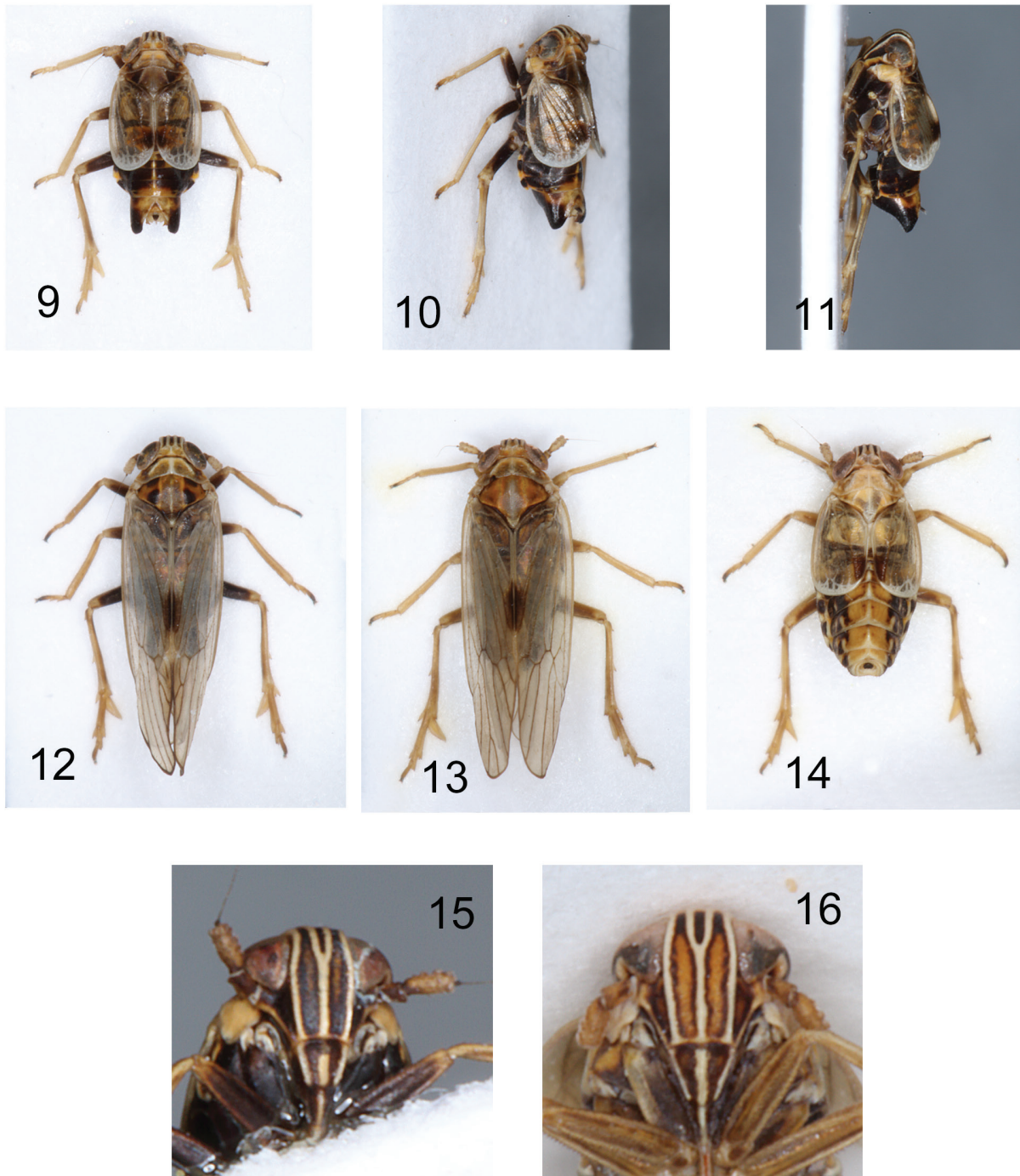


Figures 1–8. *Dicranotropis hamata* (Boheman), male. 1: Aedeagus, left lateral view. 2: Aedeagus, right lateral view. 3: Aedeagus, dorsal view. 4: Aedeagus, ventral view. 5: Right genital style from inside. 6: Pygofer, ventral view. 7: Pygofer, left lateral view. 8: Pygofer, caudal view. (1–5: Germany, Baden-Württemberg, Freudenstadt. 6–8: Germany, Bayern, Berchtesgaden).

St.435; Guglielmino & Bückle leg.; 5♂♂, 4♀♀. – Lazio (Rieti), Monti Reatini, M. Terminillo, S.P. 10, 4 Km from Leonessa; ~ 1200m; 22/8/1999; St. 36; vegetation along a brook; Guglielmino & Bückle leg.; 6♂♂, 15♀♀. – Lazio (Rieti), East of Lago di Piediluco, Madonna della Luce, SS 79 near fork Labro, Km 29,5; N42°31'15.0", E12°46'38.2"; 372m; 21/8/2000; St. 86; herbaceous vegetation with *Equisetum*, *Phragmites*, *Carex*, Cyperaceae, between *Ulmus*, *Salix*, *Quercus*; Guglielmino & Bückle leg.; 8♂♂, 5♀♀. – Lazio (Rieti), Amatrice, ca. 1km south of Preta, Tronto river; ~ 1150m; 18/6/2005; St.154; undergrowth of mixed forest with *Quercus cerris*, few *Ulmus*, *Salix*, *Populus tremula*; Guglielmino & Bückle leg.; 11♂♂, 12♀♀. – Lazio (Rieti), Rieti, Riserva Ripasottile-Lago Lungo, st. 3, 22/7/2009; St.454; Guglielmino & Bückle leg.; 8♂♂, 2♀♀. – Abruzzo (L'Aquila), slope south of Sella di Corno; ~ 1100m; 26/8/1999; St. 46; dry meadows with *Ostrya carpinifolia* Scop., *Quercus*,

Acer; Guglielmino & Bückle leg.; 7♂♂, 1♀. – Abruzzo (L'Aquila), slope south of Sella di Corno; ~ 1200m; 26/8/1999; St. 47; meadows on the borders of a mixed forest; Guglielmino & Bückle leg.; 8♂♂, 23♀♀. – Campania (Caserta), St.320: Strada da Gallo Matese a Fontegreca, prima del passo ~ 1,5 km a ovest di Gallo Matese, 850 m, 27/8/2006, prati fra siepi di *Acer monspessulanum*, *Rosa*, *Prunus spinosa*, *Crataegus* con Poaceae, Fabaceae ecc.; Guglielmino & Bückle leg.; 6♂♂, 8♀♀. – Basilicata (Potenza), Monte Sirino, road to Lauria, fountain 7,5km south of fork to Moliterno; ~ 1000m; 02/08/2009; St.470; forest with *Quercus*, *Crataegus*, *Alnus cordata*, *Spartium*, *Rubus* and small open pasture with Poaceae, Lamiaceae, *Holcus*; Guglielmino & Bückle leg.; 2♂♂, 3♀♀.

Type material deposited in Department of Agricultural and Forestry Sciences (DAFNE), University of Tuscia, Viterbo, Italy (Guglielmino's collection) (CG), two male and two female paratypes in Senckenberg Naturhistorische



Figures 9–16. *Dicranotropis remaniaca* sp. n. (Italy, Latium, Rieti). **9:** Brachypterous male, dorsal view. **10:** Brachypterous male, dorsolateral view. **11:** Brachypterous male, lateral view. **12:** Macropterous male, dorsal view. **13:** Macropterous female, dorsal view. **14:** Brachypterous female, dorsal view. **15:** Brachypterous male, frontal view. **16:** Brachypterous female, frontal view.

Sammlungen Dresden, Museum für Tierkunde, Dresden, Germany.

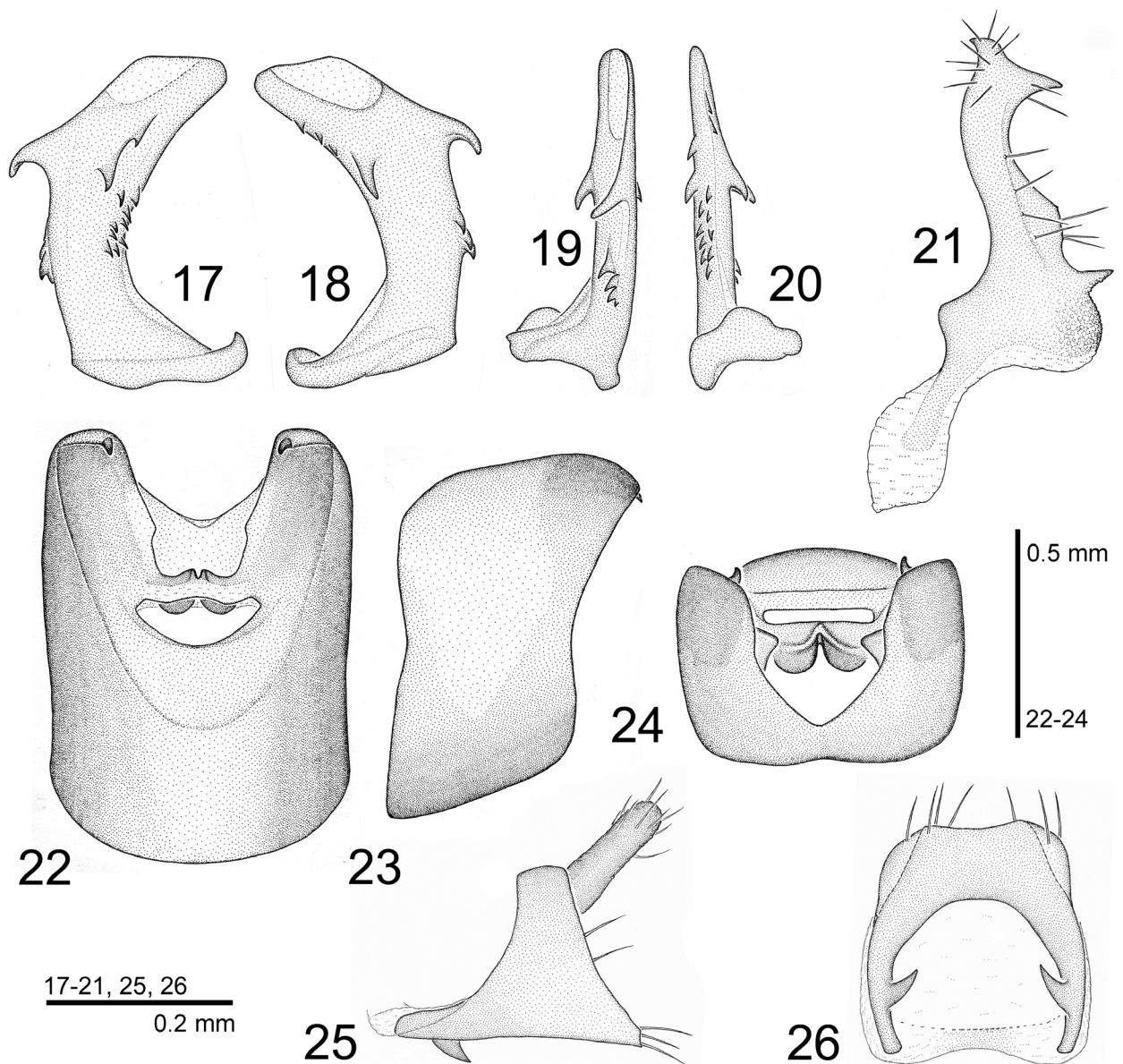
(For further material of this taxon see Suppl. material 1).

Redescription of genital morphology of related species

Dicranotropis hamata (Boheman): phallotreme on the left aedeagus side (Figs 1–4), only in some exceptions

on the right side, and slender, more or less straight styles without preapical tooth (Fig. 5), as figured e.g. in Ossianilsson (1978, Fig. 469). Females display the same type of triangular genital scale as *D. remaniaca* with narrow and deep caudal incision (Fig. 43), and have similar gonocoxae VIII without basal mediad protruding protuberance.

We examined specimens from Finland (Fig. 55), Denmark (Figs 56, 108, 109), most parts of France (Figs 50–54,



Figures 17–26. *Dicranotropis remaniaca* sp. n., male. **17:** Aedeagus, left lateral view. **18:** Aedeagus, right lateral view. **19:** Aedeagus, dorsal view. **20:** Aedeagus, ventral view. **21:** Right genital style from inside. **22:** Pygofer, ventral view. **23:** Pygofer, left lateral view. **24:** Pygofer, caudal view. **25:** Anal tube, lateral view. **26:** Anal tube, caudal view. (17–21: Italy, Emilia Romagna, Sologno. 22–24: Italy, Abruzzo, Campotosto. 25, 26: Italy, Abruzzo, Sella di Corno).

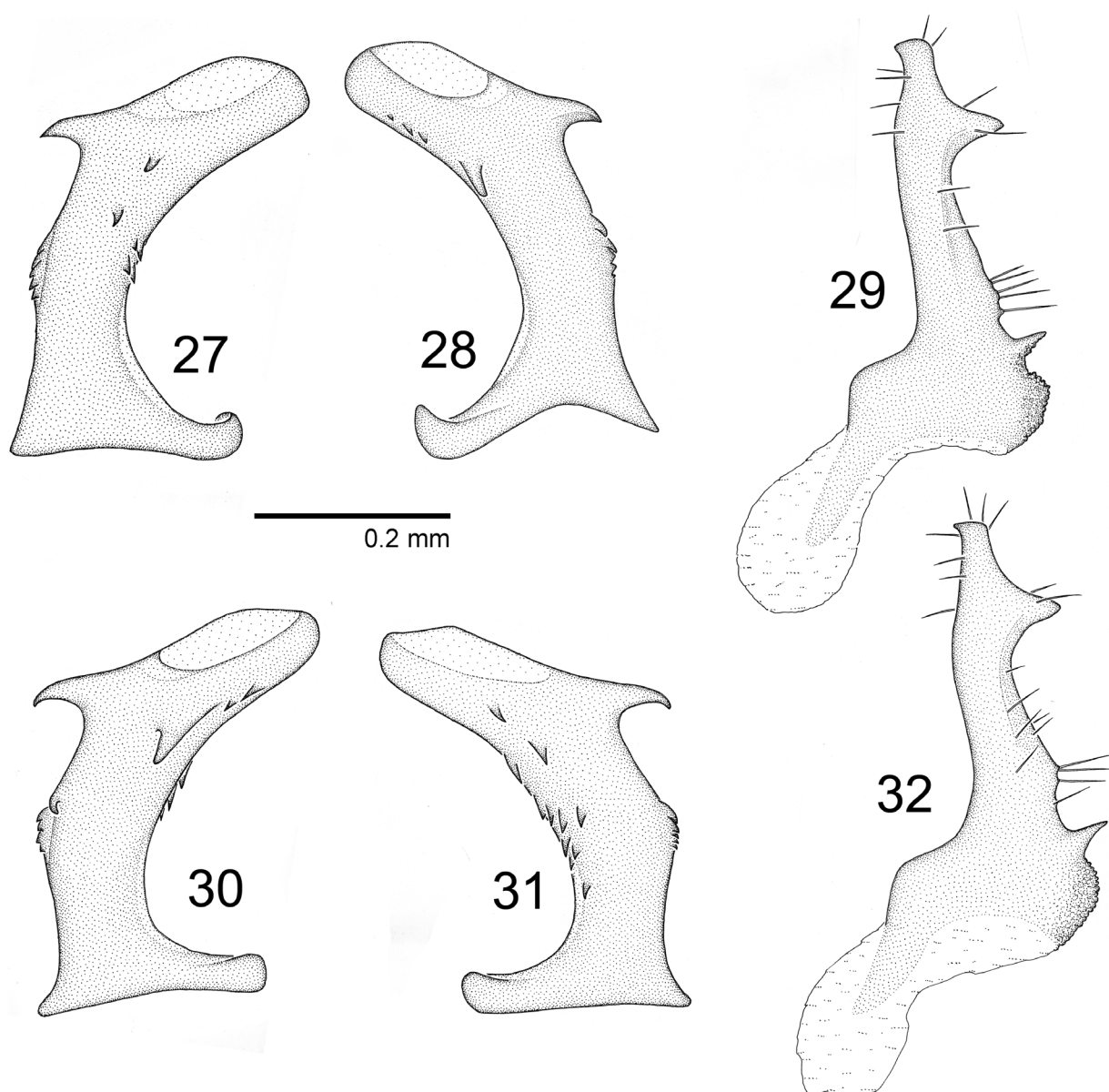
98–107) except for the southwestern regions, Germany (Figs 58, 59, 112–115) except for small areas in the southernmost parts, Czech Republic (Figs 63, 122, 123), Switzerland north of the main Alpine chain (Figs 57, 110, 111), Austria (Figs 60–62, 116–121), a small area in northeasternmost Italy, eastern Slovenia (Figs 65, 126, 127), Hungary (Figs 64, 124, 125), Ukraine (Crimea) (Figs 72, 140, 141), Russia (Krasnodar region) (Figs 73, 142, 143) and on the Balkan Peninsula: Serbia (Figs 66, 128, 129), Montenegro, Bulgaria (Figs 68, 69, 132–135), Macedonia (Figs 67, 130, 131), Albania, Greece (Figs 70, 71, 136–139).

Specimens from northern Poland display characters as those of other Central European regions, but have a small

preapical tooth on their styles (Fig. 74, see also fig. 470 in Ossiannilsson 1978).

The pygofer and aedeagus morphology (in males), e.g. width of the aedeagus, number of the aedeagal spines (Figs 98–143), and shape of pygofer protuberances (Figs 189–197, 207–215, 225–242), and the morphology of the genital scale (in females) is to some degree variable. For the variability of the genital styles see Figs 50–73.

D. hamata/*D. remaniaca* intermediate forms: intermediate style characters were found in specimens from southwestern France (Figs 29, 32, 75, 77–83). They display an aedeagus with phallotreme in some cases on



Figures 27–32. Transitional forms between *Dicranotropis hamata* (Boheman) and *D. remaniaca* sp. n. (hybrids?). 27: Aedeagus, left lateral view. 28: Aedeagus, right lateral view. 29: Right genital style from inside. 30: Aedeagus, left lateral view. 31: Aedeagus, right lateral view. 32: Right genital style from inside. (27–29: France, Haute-Garonne, Luchon. 30–32: France, Haute-Garonne, Luchon (other specimen)).

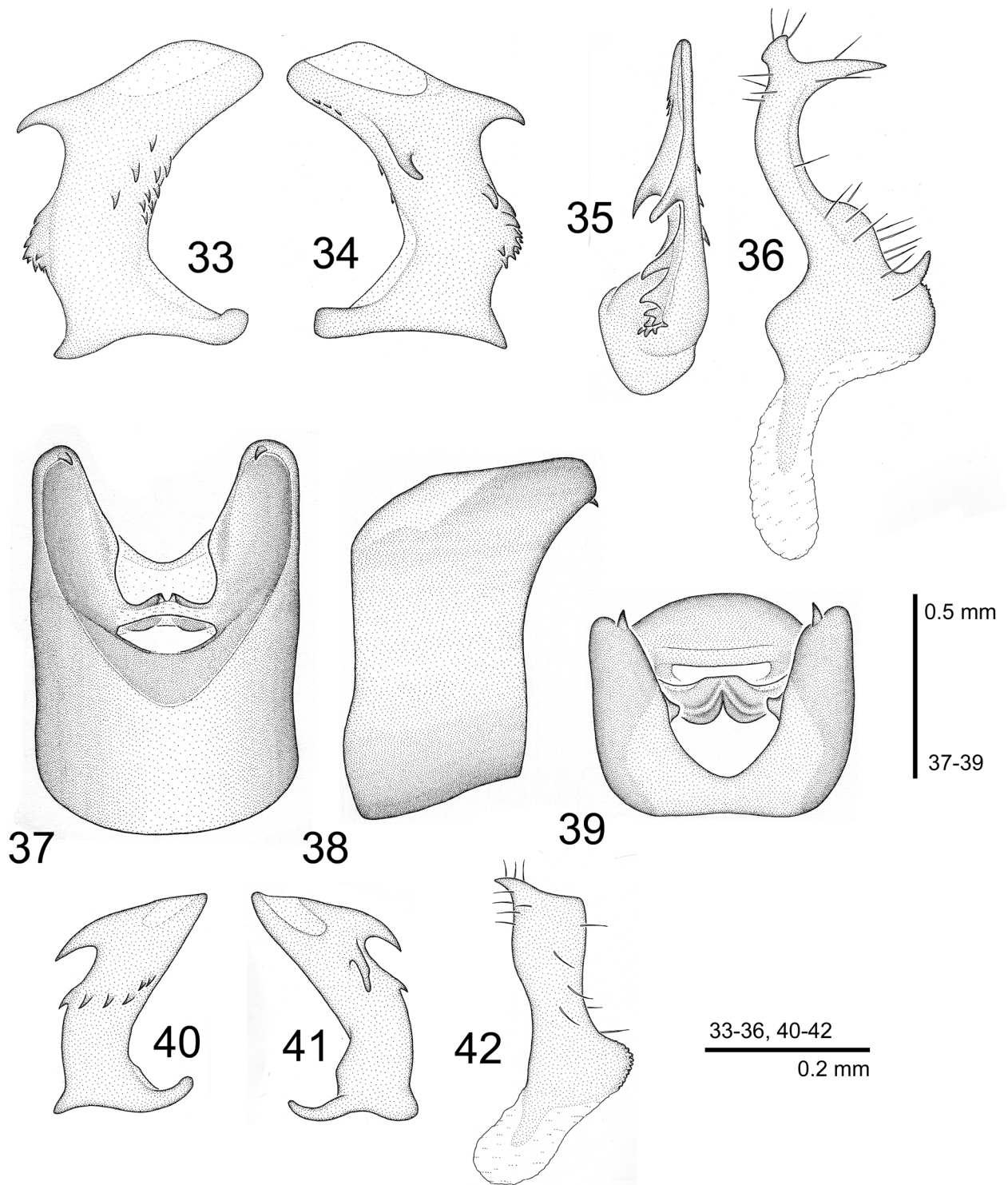
the left, in others on the right side (Figs 27, 28, 30, 31, 144–147, 150–158). One specimen is found also in a more northwestern region (Dep. Saone-et-Loire) (Figs 76, 148, 149). 40 specimens with intermediate characters were examined on the whole: 22 had an aedeagus with phallotreme on the left side and 18 an aedeagus with phallotreme on the right side. 31 specimens were from the same locality (St. Béat), 17 of which had an aedeagus with phallotreme on the left side and 14 with phallotreme on the right side.

The pygofer morphology is illustrated in Figs 198–200, 216–218, 243–248.

Females are undistinguishable from *D. remaniaca* and *D. hamata* females.

Dicranotropis zenata Logv.: stout, curved style shape with very long preapical tooth (Fig. 36), a robust aedeagus with phallotreme on the left side (Figs 33–35), and a pygofer similar to that of *D. remaniaca* (Figs 37–39; see also Fig. 1 in Logvinenko 1969). Females: The genital scale is quite large and displays a proportionally short and very narrow caudal incision (Fig. 47). Gonocoxae VIII similar to those of *D. hamata*.

Remark: The record of *D. hamata* from Caucasus (Georgia: Kodžori, two males) by Dlabola (1958, Figs 43, 44) refers apparently to this taxon. The figures of the styles show a long preapical tooth as is typical for this taxon (the lack of the subbasal thorn in these figures is probably due to the fact that Dlabola apparently did not

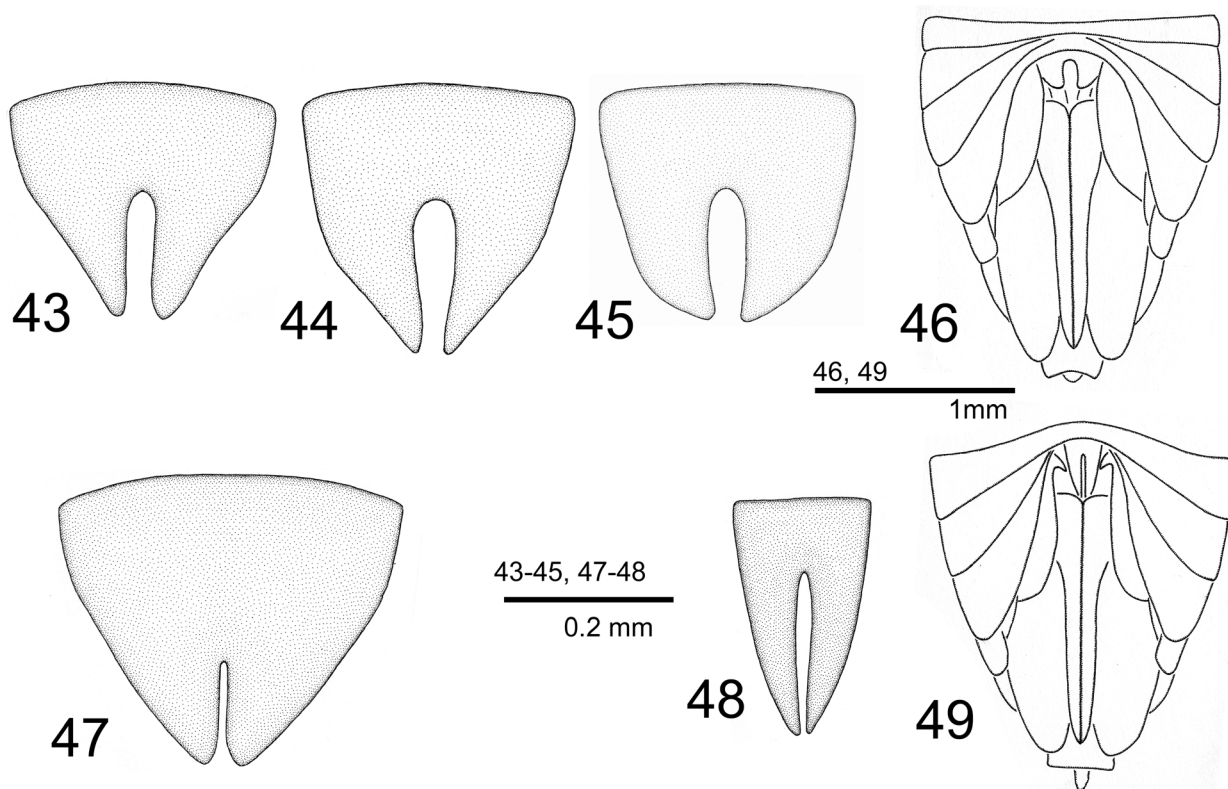


Figures 33–39. *Dicranotropis zenata* Logv. (Georgia, Goderdsi). **33:** Aedeagus, left lateral view. **34:** Aedeagus, right lateral view. **35:** Aedeagus, dorsal view. **36:** Right genital style from inside. **37:** Pygofer, ventral view. **38:** Pygofer, left lateral view. **39:** Pygofer, caudal view. **40–42.** *Dicranotropis sagata* Logv. (Georgia, Sasaredneo). **40:** Aedeagus, left lateral view. **41:** Aedeagus, right lateral view. **42:** Right genital style from inside.

dissect the genital apparatus and therefore the base of the styles were not well visible for him).

Dicranotropis sagata Logv.: small and short styles without preapical tooth and without basal spine shaped

protuberance (Fig. 42), and a small aedeagus with low number of teeth on both sides and phallotreme on the right side (Figs 40, 41, see also Figs 25–27 in Logvinenko 1976). The species lacks the large dorso-caudally protruding pygofer protuberances present in



Figures 43–49. *Dicranotropis hamata* group, females. **43:** *Dicranotropis hamata* (Boheman) (Bulgaria, Western Rhodopes, Elesh-nica), genital scale. **44:** *Dicranotropis remaniaca* sp. n. (Slovenia, Nova Gorica), genital scale. **45:** *Dicranotropis remaniaca* sp. n. (Italy, Umbria, Lago di Piediluco), genital scale. **46:** *Dicranotropis remaniaca* sp. n. (Italy, Basilicata, M. Sirino), abdomen, ventral view. **47:** *Dicranotropis zenata* Logv. (Georgia, Goderdsi, Advigeki), genital scale. **48:** *Dicranotropis sagata* Logv. (Georgia, Sasaredneo), genital scale. **49:** *Dicranotropis sagata* Logv. (Georgia, Sasaredneo), abdomen, ventral view.

D. hamata and *D. zenata*, but shares with these taxa the small tooth on the inner side of the dorsocaudal pygofer margin. Females display a small elongate genital scale with very long apical incision (Fig. 48). The gonocoxae VIII are narrowed basad and basally abruptly protruding mediad (Fig. 49).

Unfortunately, our knowledge on both taxa from the Caucasus region is based only on very few specimens, thus the range of variability in these taxa is unknown.

Discussion

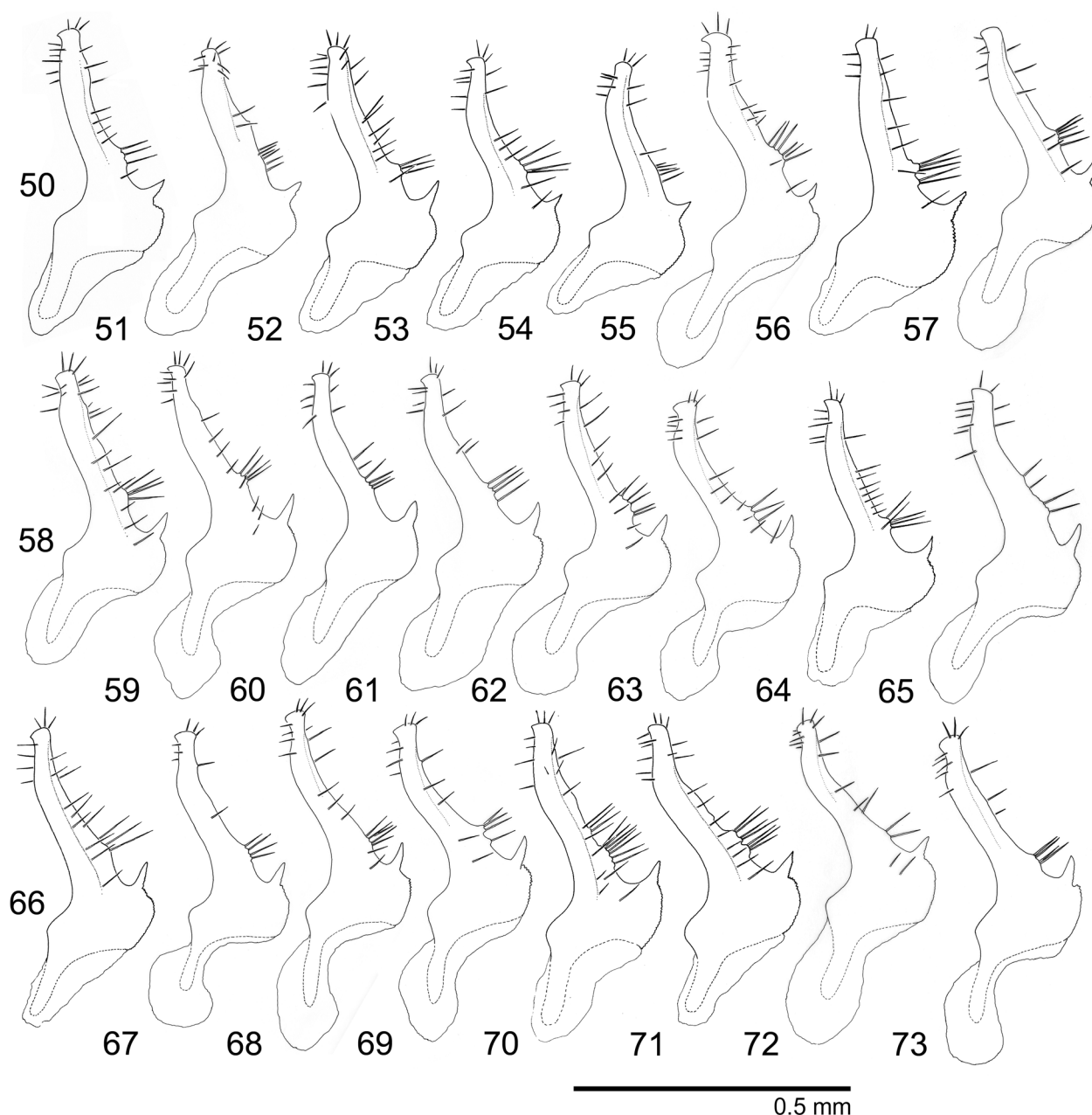
Chiral dimorphism (antisymmetry)

Besides the different shape of the genital styles in *D. hamata* and *D. remaniaca*, the most distinct difference between both taxa consists in their aedeagus morphology with this structure in one taxon being the mirror image of the other (Figs 1, 18). Exceptions, i.e. aedeagi with phallotreme on the right side in *D. hamata* (Fig. 118, 119, 138, 139) or with phallotreme on the left side in *D. remaniaca* (Figs 183, 184), are found in both taxa but they are not very common. It makes approximately 1% in *D. remaniaca*, and ca. 4% for *D. hamata*, but for the latter species should be considered that most of the

reverse specimens were from localities peripheric within the area of that species and not far from the area of *D. remaniaca*.

For the explanation of this situation we may go back to a period when the areas of the ancestors of both recent taxa were separated and speciation was in progress.

But before we have to make some considerations: The asymmetry of the aedeagus in Delphacidae (as in most of the other insect groups with asymmetric genital structures) is in most cases directional, i.e. only one of the two mirror symmetric possibilities is observed (rare exceptions are found in many taxa). There are, however, several cases in delphacids where the aedeagus asymmetry is not directional and both possible aedeagus types are present in a proportion of 50:50. This phenomenon was recorded for example for *Stiroma affinis* Fieber (De Jong 1985) and *Chloriona vasconica* Ribaut (Guglielmino and Bückle 2010). It is called chiral dimorphism, mirror image dimorphism or antisymmetry, and the two possible mirror images are termed enantiomorphs (Schilthuizen 2013). Apparently, this situation provides no disadvantage for the species and has no impact for the mating ability. In several taxa of insects, species of the same genus differ in the direction of chirality (Schilthuizen 2007, 2013; Huber et al. 2007). This implies that intermediate



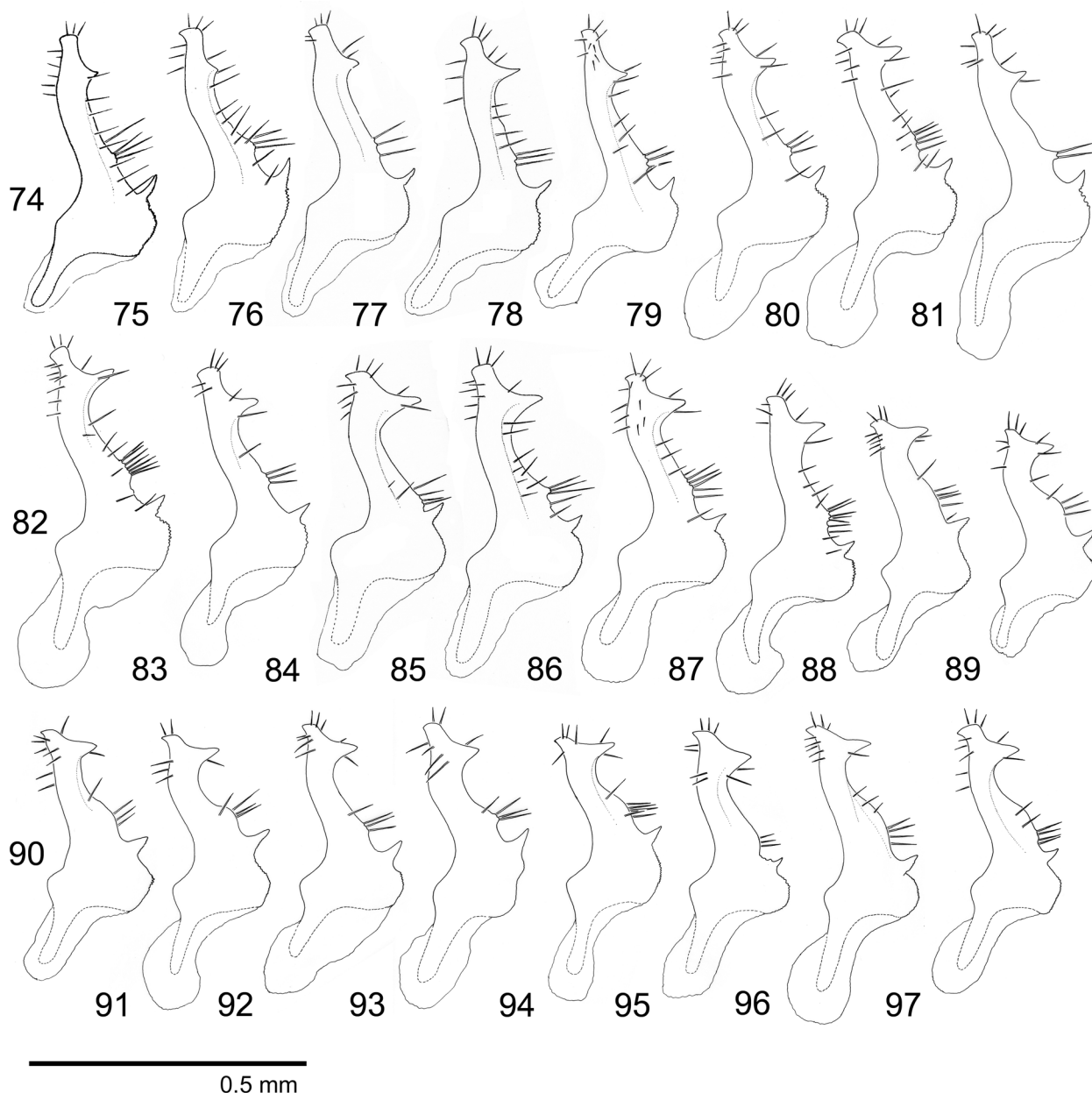
Figures 50–73. *Dicranotropis hamata* (Boheman), right genital style from inside. **50:** France, Hérault. **51:** France, Nantes. **52:** France, Jura. **53:** France, Ardèche. **54:** France, Vaucluse. **55:** Finland. **56:** Denmark. **57:** Switzerland, Jura. **58:** Germany, Baden-Württemberg, Tübingen. **59:** Germany, Bayern, Berchtesgaden. **60:** Austria, Kärnten, Woerthersee. **61:** Austria, Steiermark, Leibnitz. **62:** Austria, Niederösterreich, Himberg. **63:** Czech Republic, Moravia, Mikulov. **64:** Hungary, Velence. **65:** Slovenia, Zgornje Jezersko. **66:** Serbia, Džep. **67:** Macedonia, Strumica distr.. **68:** Bulgaria, Goce Delchev. **69:** Bulgaria, Western Rhodopes, Eleshnica. **70:** Greece, Katara region, Pindos. **71:** Greece, Katara region, Pindos (other specimen). **72:** Ukraine, Crimea. **73:** Russia, Krasnodar.

stages of chiral dimorphism must have existed, either during cladogenesis or during anagenesis.

The aedeagus morphology in *D. hamata* and *D. remaniaca* with one species representing the mirror image to the other may be interpreted in the same way, with a transitional stage of antisymmetry and a subsequent return to a directional asymmetry opposite to the original one. As such processes are more likely to occur in small populations, possibly this happened in the ancestor populations of one of the two taxa during a situation where

their area was distinctly more limited than now due to climate constraints.

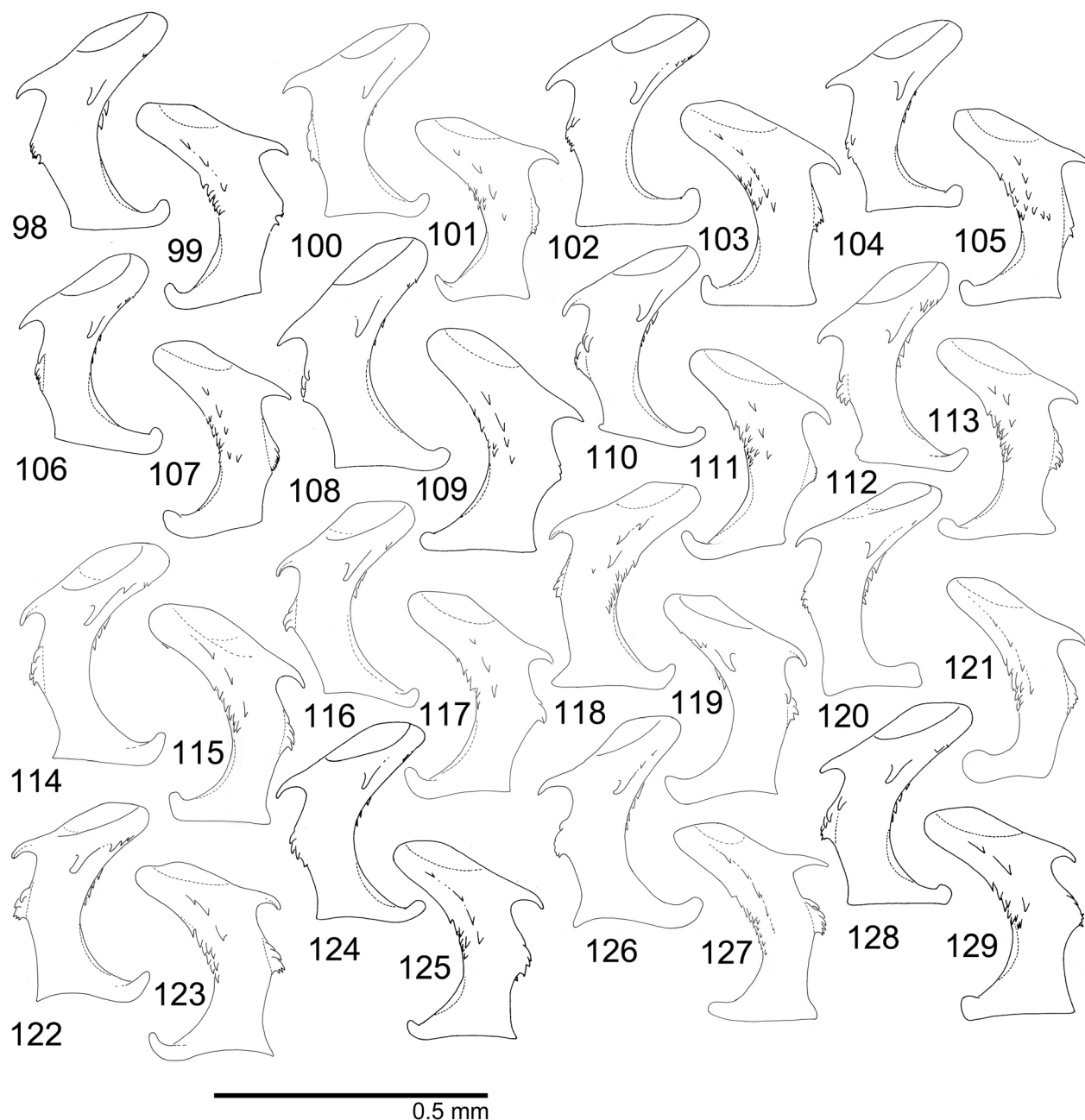
A striking parallel case is to be mentioned in another delphacid genus, *Chlorionidea* Löw. In central and eastern Europe and central Asia occurs *C. flava* Löw, on the Apennines *C. apenninica* Guglielmino and Bückle. Both species differ mostly by differences in the morphology of their anal tube and in their aedeagus morphology with this organ being in one species the mirror image in respect to the other (Guglielmino and Bückle 2010).



Figures 74–97. *Dicranotropis hamata* group, right genital style from inside. *Dicranotropis hamata* (?). **74:** Poland, Zdory. **75–83.** Transitional forms between *D. hamata* (Boheman) and *D. remaniaca* sp. n. (hybrids?). **75:** France, Gard. **76:** France, Saone-et-Loire. **77:** France, Ariège. **78:** France, Aude, Laroque de Fa. **79:** France, Toulouse. **80:** France, Haute-Garonne, St. Bât. **81:** France, Tarn, Albi. **82:** France, Pyrénées Orientales, Mt. Louis. **83:** France, Haute-Garonne, Arlos. **84–97.** *Dicranotropis remaniaca* sp. n.. **84:** Spain, Teruel. **85:** Spain, Lerida. **86:** Spain, Girona, Ripoll. **87:** Germany, Bayern, Füssen, Trauchberg. **88:** Switzerland, Canton Ticino. **89:** Switzerland, Canton Ticino, Monteggio. **90:** Switzerland, Canton Ticino, Monteggio (other specimen). **91:** Slovenia, Bovec. **92:** Slovenia, Nova Gorica. **93:** Slovenia, Vogrsko. **94:** Italy, Valle d'Aosta, Monte Avic. **95:** Italy, Abruzzo, Sella di Corno. **96:** Italy, Abruzzo, Campotosto. **97:** Italy, Basilicata, Monte Sirino.

Chiral dimorphism is observed also in other groups of insects as in the mantid genus *Ciulfina*. Populations of four species belonging to this genus were investigated. In one of them a proportion near 50% between both enantiomorphs was observed, in a second one only one enantiomorph was present (directional asymmetry). For two species, however, the proportions of both enantiomorphs were far from 50:50 and unequal among the populations of the same species (Holwell and

Herberstein 2010). A completely different situation is found in the snail *Partula suturalis* Pfeiffer. This species is polymorphic for the direction of coiling. Populations with directional asymmetry are prevailing. Mixed populations are generally small and unstable. As mating between snails of opposite coil is difficult there is apparently a strong selection against chirally dimorphic populations which exist only under special conditions (Johnson et al. 1990).



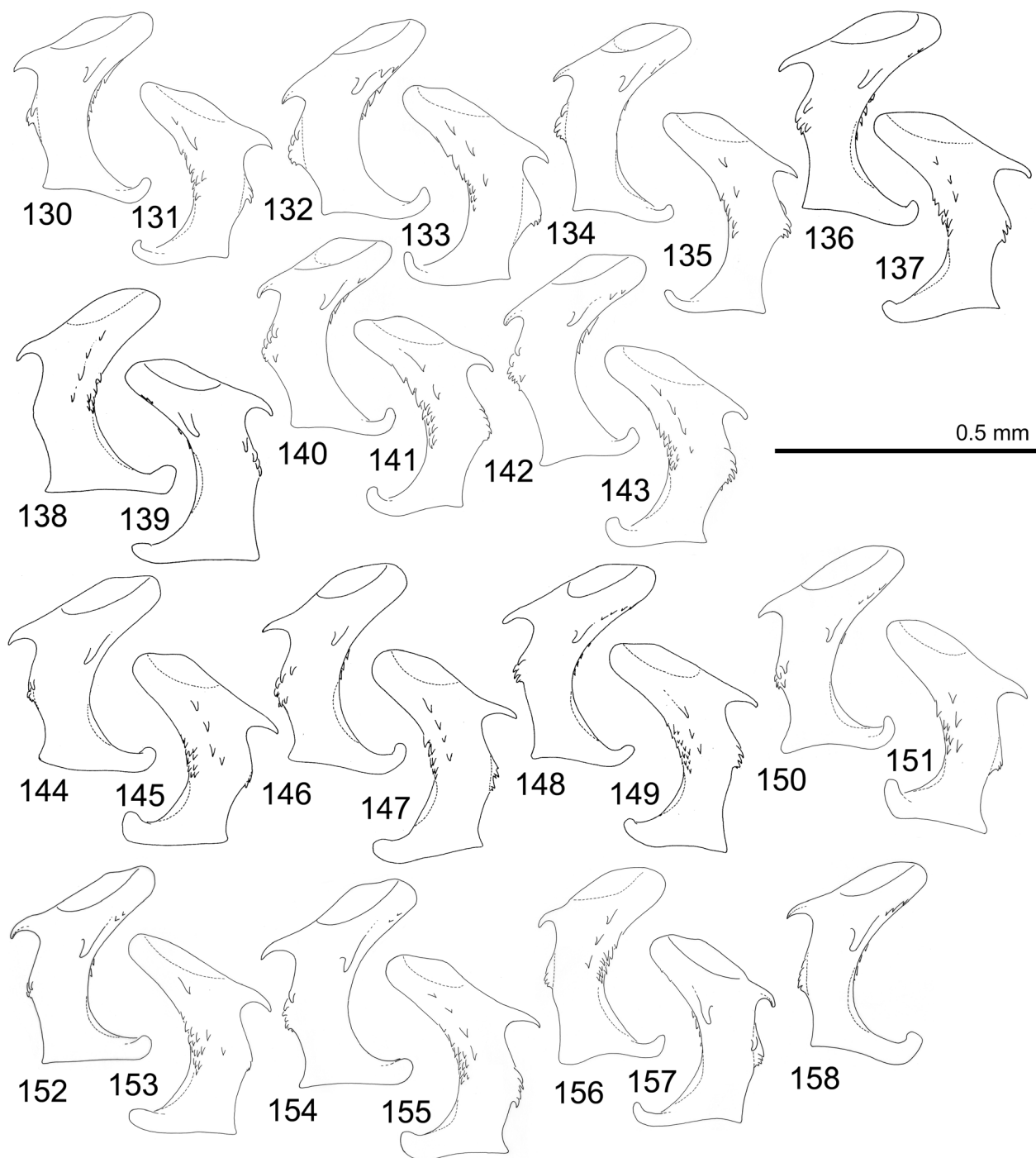
Figures 98–129. *Dicranotropis hamata* (Boheman), aedeagus, left and right lateral view. **98, 99:** France, Jura. **100, 101:** France, Nantes. **102, 103:** France, Hérault. **104, 105:** France, Ardèche. **106, 107:** France, Vaucluse. **108, 109:** Denmark. **110, 111:** Switzerland, Jura. **112, 113:** Germany, Baden-Württemberg, Tübingen. **114, 115:** Germany, Bayern, Berchtesgaden. **116, 117:** Austria, Niederösterreich, Himberg. **118, 119:** Austria, Steiermark, Leibnitz. **120, 121:** Austria, Kärnten, Woerthersee. **122, 123:** Czech Republik, Moravia, Mikulov. **124, 125:** Hungary, Velence. **126, 127:** Slovenia, Zgornje Jezersko. **128, 129:** Serbia, Džep.

Hybrid area in southwestern France?

Preliminary remark: The existence of supposed hybrids between *Dicranotropis hamata* and *D. remaniaca* taxa north of the Pyrenees may imply to describe them on a subspecies level. However, in other contact regions between both taxa (South Germany, Slovenia, Switzerland) to date no specimens were observed that present unequivocally intermediate characters in their genital

morphology or a mixture of both possible enantiomorphic aedeagus types. In those areas, the species show no signs of hybridisation.

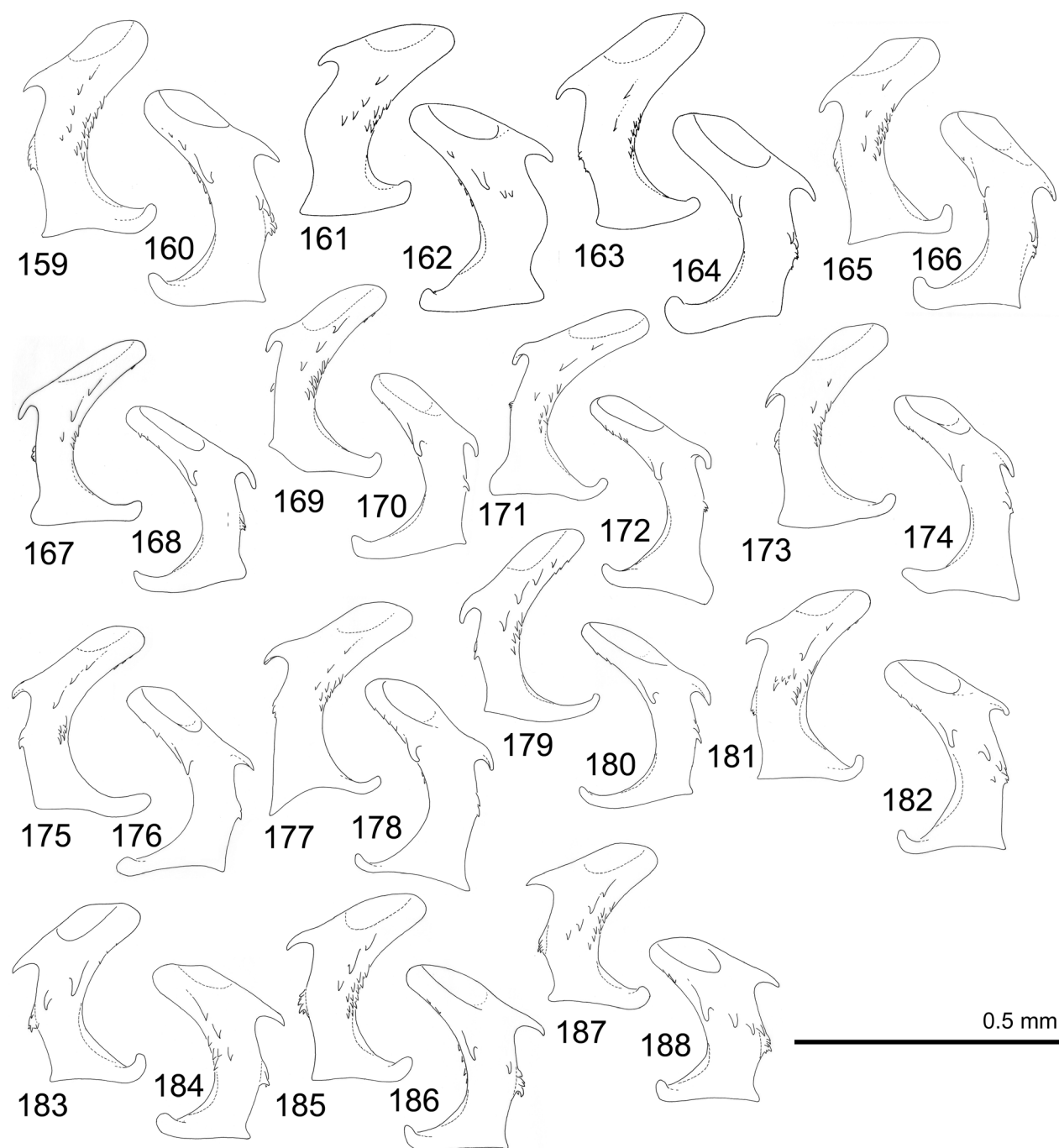
In southwestern France *Dicranotropis* specimens were found with genital styles (Figs 75, 77–83) that lie in between the shapes of *D. hamata* and *D. remaniaca*. Geographically, they are situated between an area with apparently pure *D. remaniaca* populations on the one side (the Iberian Peninsula, Figs 84–86) and pure *D. ha-*



Figures 130–157. *Dicranotropis hamata* group, aedeagus, left and right lateral view. **130–143.** *Dicranotropis hamata* (Boheman). **130, 131:** Macedonia, Strumica distr.. **132, 133:** Bulgaria, Western Rhodopes, Eleshnica. **134, 135:** Bulgaria, Goce Delchev. **136, 137:** Greece, Katara region, Pindos. **138, 139:** Greece, Katara region, Pindos (other specimen). **140, 141:** Ukraine, Crimea. **142, 143:** Russia, Krasnodar. **144–157.** Transitional forms between *D. hamata* (Boheman) and *D. remaniaca* sp. n. (hybrids?). **144, 145:** France, Ariège. **146, 147:** France, Gard. **148, 149:** France, Saone-et-Loire. **150, 151:** France, Aude, Laroque de Fa. **152, 153:** France, Haute-Garonne, St. B  at. **154, 155:** France, Tarn, Albi. **156, 157:** France, Haute-Garonne, Arlos. **158:** Transitional forms between *D. hamata* (Boheman) and *D. remaniaca* sp. n. (hybrids?), aedeagus, left lateral view, France, Toulouse.

mata populations on the other (southeastern and central France, Figs 52–54). Of course, the Pyrenees were an interface between populations of numerous species which expanded from separate glacial refugia. During postglacial expansions, the Pyrenees formed a barrier for pop-

ulations on both sides of these mountains. The contact between southern *D. remaniaca* and northern *D. hamata* populations may have been hindered for a long time, until *D. remaniaca* populations from the South succeeded in surmounting this barrier and mixed with *D. hamata*

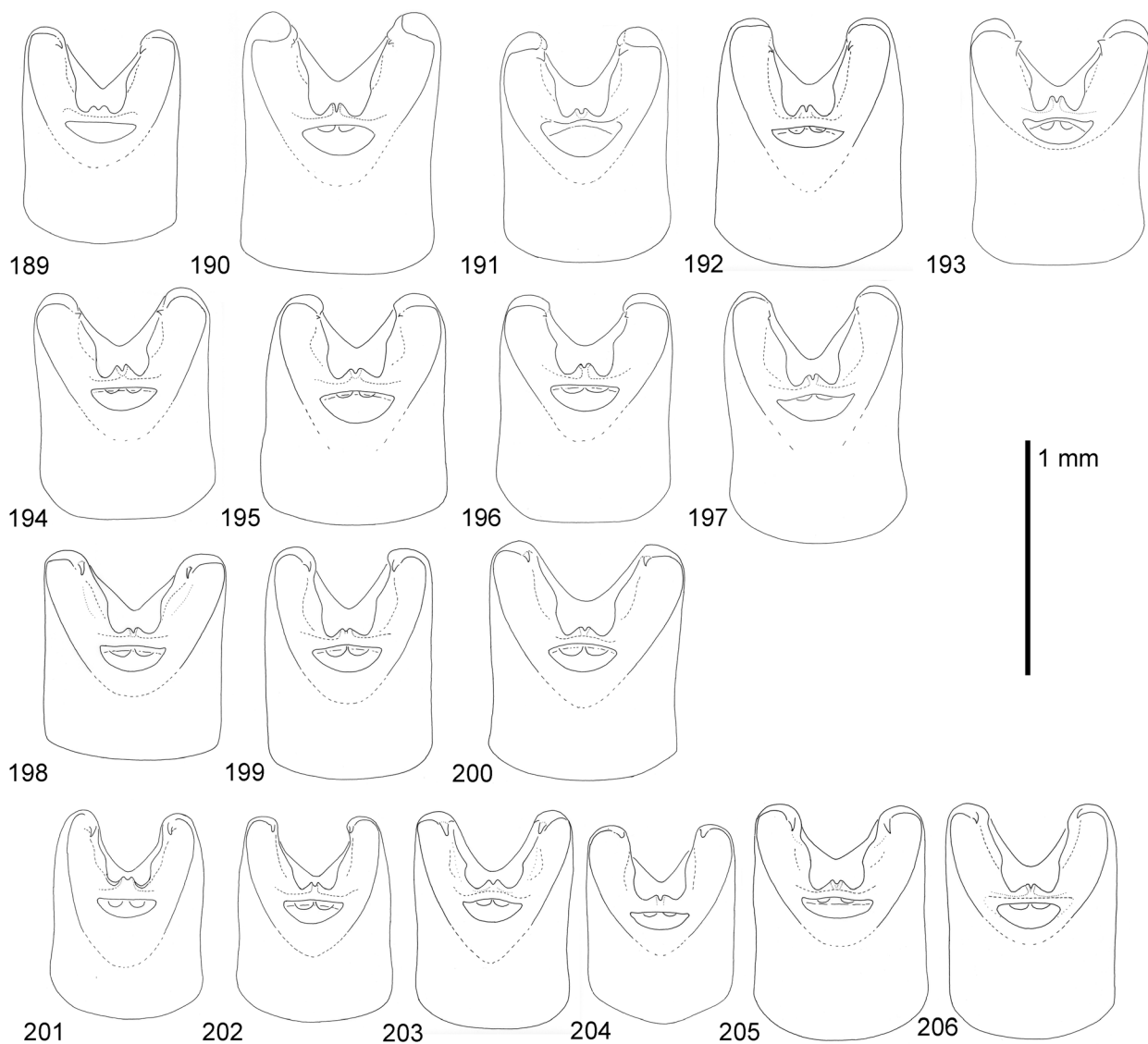


Figures 159–188. *Dicranotropis remaniaca* sp. n., aedeagus, left and right lateral view. **159, 160:** Spain, Girona, Ripoll. **161, 162:** Spain, Teruel. **163, 164:** Spain, Lerida. **165, 166:** Germany, Bayern, Füssen, Trauchberg. **167, 168:** Switzerland, Canton Ticino, Monteggio. **169, 170:** Switzerland, Canton Ticino, Monteggio. **171, 172:** Switzerland, Canton Ticino. **173, 174:** Slovenia, Bovec. **175, 176:** Slovenia, Nova Gorica. **177, 178:** Slovenia, Vogrsko. **179, 180:** Italy, Valle d'Aosta, Monte Avic. **181, 182:** Italy, Abruzzo, Campotosto. **183, 184:** Italy, Abruzzo, Sella di Corno. **185, 186:** Italy, Abruzzo, Sella di Corno (other specimen). **187, 188:** Italy, Basilicata, Monte Sirino.

populations from the North. Therefore, we interpret the intermediate characters in the genital morphology of the populations immediately north of the Pyrenees as due to hybridization of populations of both species.

In these supposed hybrid populations, aedeagi with phallotreme on the left side (Fig. 30, as in *D. hamata*) and with phallotreme on the right side (Fig. 28, as

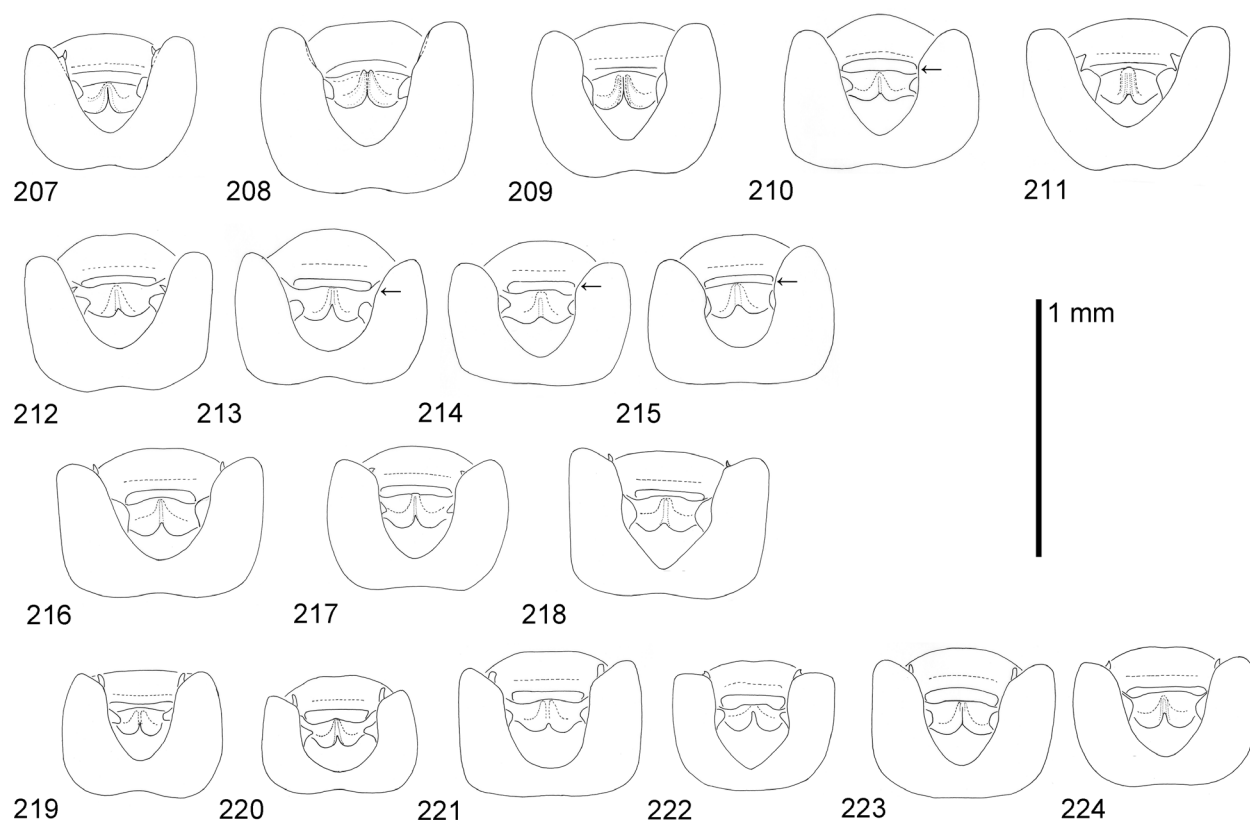
in *D. remaniaca*) are present. Both aedeagus types are not rare. The proportion, based on 40 specimens, is not far from 50:50 (the phallotreme on the left side, i. e. the “*hamata*-type”, is slightly prevailing). Two scenarios are possible: (1) the fixation of directional asymmetry is lost and the supposed hybridisation resulted in a real anti-symmetry (i.e. a not fixed direction of the (asymmetric)



Figures 189–206. *Dicranotropis hamata* group, pygofer, ventral view. **189–197:** *Dicranotropis hamata* (Boheman). **189:** France, Nantes. **190:** Finland. **191:** Switzerland, Jura. **192:** Germany, Baden-Württemberg, Kaiserstuhl. **193:** Germany, Bayern, Berchtesgaden. **194:** Austria, Niederösterreich, Himberg. **195:** Slovenia, Zgornje Jezersko. **196:** Macedonia, Strumica distr.. **197:** Russia, Krasnodar. **198–200:** Transitional forms between *D. hamata* (Boheman) and *D. remaniaca* sp. n. (hybrids?). **198:** France, Haute-Garonne, St. B  at. **199:** France, Aude, Laroque de Fa. **200:** France, Haute-Garonne, Luchon. **201–206.** *Dicranotropis remaniaca* sp. n.. **201:** Switzerland, Canton Ticino. **202:** Switzerland, Canton Ticino, Monteggio. **203:** Slovenia, Vogrsko. **204:** Italy, Basilicata, Monte Sirino. **205:** Germany, Bayern, F  ssen, Trauchberg. **206:** Spain, Girona, Ripoll.

aedeagus shape and consequently a 50:50 proportion of both aedeagus types); (2) each specimen has its individual aedeagus orientation not by chance, as in true anti-symmetry, but due to special genetic constraints based on the combination of its genetic heritage as the result of hybridisation between populations each of which had their fixed aedeagus directionality. Thus, the hybrid populations consist of a mixture of specimens with different directionally asymmetric aedeagi. In this case, the proportion of the two aedeagus types may be different from the 50:50 proportion, moreover it may be varying between different areas of the hybrid area. This condition may be named “pseudo-antisymmetry”.

We may mention in this context a similar case in the *Zyginidia pullula* group in northwestern Italy. Maz-zoglio and Arzone (1993) found hybrids including a vast spectrum of intermediate forms between *Z. pullula* (Boheman, 1845) and *Z. ribauti* Dworakowska, 1970 in Liguria, and Bocca et al. (1988) describe hybrids between *Z. pullula* and *Z. scutellaris* (Herrich-Sch  ffer, 1838) in the Aosta Valley. Della Giustina (1989) considers the possibility of *Zyginidia ribauti* (present in the whole Apennine Peninsula) being a hybrid between *Z. pullula* (present in north Italy and eastern Central Europe) and *Z. scutellaris* (present in Western Europe and Sardinia).



Figures 207–224. *Dicranotropis hamata* group, pygofer, caudal view. **207–215:** *Dicranotropis hamata* (Boheman). **207:** France, Nantes. **208:** Finland. **209:** Switzerland, Jura. **210:** Germany, Baden-Württemberg, Kaiserstuhl. **211:** Germany, Bayern, Berchtesgaden. **212:** Austria, Niederösterreich, Himberg. **213:** Slovenia, Zgornje Jezersko. **214:** Macedonia, Strumica distr.. **215:** Russia, Krasnodar. **216–218:** Transitional forms between *D. hamata* (Boheman) and *D. remaniaca* sp. n. (hybrids?). **216:** France, Haute-Garonne, Luchon. **217:** France, Aude, Laroque de Fa. **218:** France, Haute-Garonne, St. Bât. **219–224:** *Dicranotropis remaniaca* sp. n.. **219:** Switzerland, Canton Ticino. **220:** Switzerland, Canton Ticino, Monteggio. **221:** Slovenia, Vogrsko. **222:** Italy, Basilicata, Monte Sirino. **223:** Germany, Bayern, Füssen, Trauchberg. **224:** Spain, Girona, Ripoll. (the arrows in Figures 210, 213–215 indicate the position of the preapical tooth)

Biogeographical aspects (Fig. 257)

There is little doubt that the division of *D. hamata* and *D. remaniaca* from each other happened not long ago, probably during the last glaciation. The two taxa have a nearly identical aedeagus shape (except for the opposite orientation of one taxon in respect of the other, see above), with only some barely discernable differences in the pygofer morphology and the different shape of the central and apical parts of the genital styles, i.e. differences that certainly need a relatively short time to evolve.

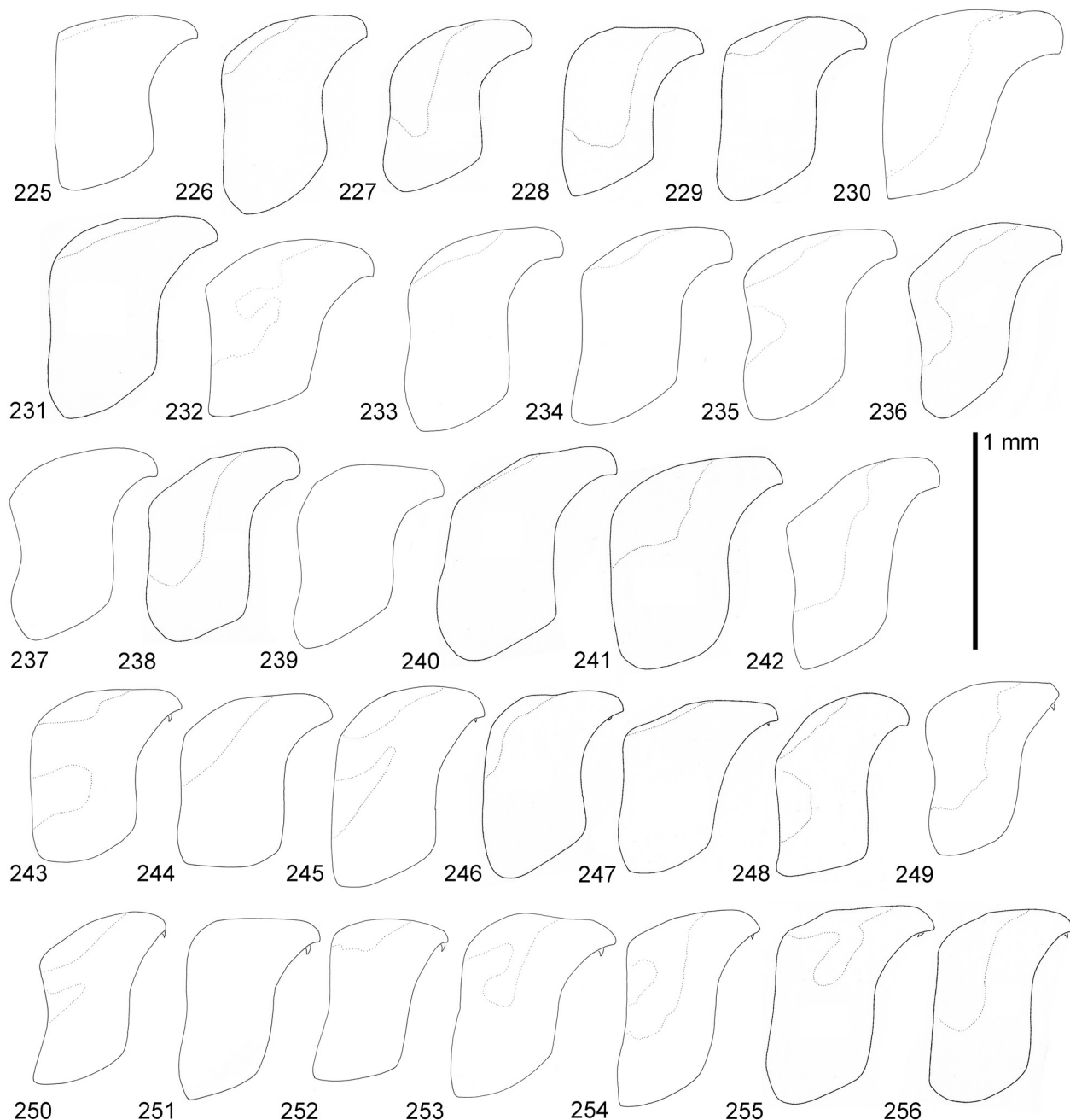
We suppose that the area of the common ancestor of both taxa was restricted during a cold climate period, and finally divided in two separate areas, which was the basal situation for a speciation process towards the presently observed two taxa. During a following warmer period both groups may have extended their areas, and developed a hybrid area where they got in contact with each other.

The present disjunct distribution of *D. remaniaca*, occurring on parts of the Iberian Peninsula on the one and continental Italy with some adjacent areas on the other hand requires further explanation.

One scenario is the colonisation of the Iberian Peninsula directly from Italian mainland or, less probably, viceversa via drifted macropterous specimens crossing the Mediterranean Sea. Generally macropterous specimens are found quite frequently within *D. hamata* and *D. remaniaca* populations, even though brachypterous ones prevail by far. Thus, this possibility cannot be completely excluded. On the other side it is noticeable that for *D. remaniaca*, in spite of the flight ability of macropterous specimens, there are no records from Sicily and Sardinia, though it is present on the entire peninsular Italy until Calabria.

In our opinion another scenario is more probable: we suppose that the taxon in former times had a continuous distribution in the Westmediterranean region (and possibly not only there) including at least southern France. A following restriction of its area due to climatic changes may have resulted in the division in two separated areas on the two Peninsulas, respectively.

Finally, *D. hamata* populations might have extended their area in southwestern direction, filled in southeastern France the gap between *D. remaniaca* populations in Italy and Spain and hybridized with *D. remaniaca* north of the Pyrenees.



Figures 225–256. *Dicranotropis hamata* group, pygofer, left lateral view. **225–242:** *Dicranotropis hamata* (Boheman). **225:** France, Nantes. **226:** France, Hérault. **227:** France, Ardèche. **228:** France, Vaucluse. **229:** France, Jura. **230:** Finland. **231:** Denmark. **232:** Switzerland, Jura. **233:** Germany, Baden-Württemberg, Kaiserstuhl. **234:** Germany, Bayern, Berchtesgaden. **235:** Austria, Niederösterreich, Himberg. **236:** Hungary, Velence. **237:** Slovenia, Zgornje Jezersko. **238:** Serbia, Džep. **239:** Macedonia, Strumica distr.. **240:** Greece, Katara region, Pindos. **241:** Greece, Katara region, Pindos (other specimen). **242:** Russia, Krasnodar. **243–248:** Transitional forms between *D. hamata* (Boheman) and *D. remaniaca* sp. n. (hybrids?). **243:** France, Haute-Garonne, St. Béal, **244:** France, Aude, Laroque de Fa. **245:** France, Haute-Garonne, Luchon. **246:** France, Ariège. **247:** France, Saone-et-Loire. **248:** France, Gard. **249–256:** *Dicranotropis remaniaca* sp. n. **249:** Switzerland, Canton Ticino. **250:** Switzerland, Canton Ticino, Monteggio. **251:** Slovenia, Vogrsko. **252:** Italy, Basilicata, Monte Sirino. **253:** Germany, Bayern, Füssen, Trauchberg. **254:** Spain, Girona, Ripoll. **255:** Spain, Lerida. **256:** Spain, Teruel.

In the central part of the Alps *D. remaniaca* apparently passed the barrier of the main Alpine chains and established itself in a small part of south Germany (probably it is present also in the western parts of Austria: Tirol and

Vorarlberg). On the other side *D. hamata* occurs in a small part of the southern Alps in northern Friuli-Venezia Giulia; north of this area in Carinthia *D. hamata* is found as well, whereas in western Slovenia *D. remaniaca* occurs.



Figure 257. Outline map of the distribution of the species of the *Dicranotropis hamata*-group. **1** = *Dicranotropis remaniaca* sp. n.; **2** = *Dicranotropis hamata* (Boheman); **1/2** = transitional forms between *D. remaniaca* and *D. hamata* (hybrids?); **2!** = *D. hamata* specimens from northern Poland with particular style shape; **3** = *D. zenata* Logv.; **(2)** *D. hamata* specimen from northern Friuli, checked by Manfred Asche; **(2!)** *D. hamata* specimen figured by Ossiannilsson (1978).

Phylogenetic aspects

It is quite evident that *D. sagata* differs distinctly from the other taxa treated in this study. The large protruding dorsocaudal protuberances of the pygofer are less developed, the styles (Fig. 42) are small and devoid of a basal spine shaped process, the gonocoxae VIII (Fig. 49) have a distinct basal protuberance. Nevertheless it shares with the three other taxa the general morphology of the aedeagus (even though in a smaller and more simple version, Figs 40, 41), the deep caudal incision in the genital scale of females (Fig. 48) and a small thorn near the caudolateral part of the pygofer. These features might represent a synapomorphy of all four taxa.

D. hamata, *D. remaniaca* and *D. zenata* are very closely related taxa. They share with each other (1) the general shape of their pygofer (Figs 7, 23, 38) with its dorsolateral parts distinctly protruding caudad, (2) their aedeagus shape (Figs 1, 2, 17, 18, 33, 34) including the arrangement of spines and teeth on both sides, and (3) the subbasal thorn on their genital styles (Figs 5, 21, 36).

D. zenata differs from *D. remaniaca* only slightly in the more robust aedeagus (Figs 33, 17), the longer tooth on the genital style (Figs 36, 21), and in the shape of the genital scale (Figs 47, 45). Both species have as a common character an aedeagus with its phallotreme

on the right side. They share this aedeagus directionality with *D. sagata* (Fig. 40), what suggests that this is the plesiomorphic condition and the phallotreme on the left side of the aedeagus in *D. hamata* is apomorphic. Furthermore, they have generally a shorter pygofer (Figs 38, 23) than *D. hamata* (Fig. 7), but this character is quite variable. The genital styles with their distinctly bent central part and the robust preapical tooth is structurally similar in *D. zenata* and *D. remaniaca* as well (Figs 36, 21), even if this tooth is distinctly longer in *D. zenata*. Possibly this preapical tooth is a synapomorphic character of both taxa, and *D. zenata* and *D. remaniaca* are sister species, and together the sister group to *D. hamata*. Alternatively, it may represent an apomorphic character of the common ancestor of the three *hamata* group taxa, which is lost in *D. hamata*. In this case it is a plesiomorphic character of the three *hamata* group species and does not support monophyly of *D. remaniaca* + *D. zenata*.

The small preapical tooth in two *D. hamata* specimens from northern Poland (Fig. 74) can be interpreted as a residue of the preapical tooth which is generally lost in *D. hamata* but was possibly present in its ancestor populations, or it may be a result of hybridisation in the past. Presently these populations are apparently surrounded exclusively by areas with pure *D. hamata* populations.

Further research

For a better understanding of the distribution of *D. hamata* and *D. remaniaca* it would be necessary to collect more material above all from the region where the areas of both taxa are adjacent to each other, specifically in the Alpine region, Slovenia, southern Germany, western Alps and southeastern France, but also in Spain, northeastern Europe, and, of course, around the supposed hybrid area in southwestern France.

Furthermore, it would be interesting to compare morphological data, gathered in the presented paper and in future studies, with bioacoustic and molecular data, in order to get further hints on how the present disjunct area of *D. remaniaca* may be explained, and to assess the hypothesis of a hybrid area in southwestern France.

Crossing experiments between populations from the latter region, and the examination of the offspring of left side phallotreme and right side phallotreme males would as well furnish interesting results.

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References

- Bocca M, Vidano C, Arzone A (1988) *Zyginidia* in the Aosta Valley, Italy (Rhynchota Auchenorrhyncha). Proceedings of the 6th Auchenorrhyncha Meeting, Turin, Italy, 7–11 Sept. 1987, 387–396.
- Boheman CH (1845) Nya Svenska Homoptera. Öfversigt af Kongliga Svenska Vetenskaps-Akademiens Förhandlingar. Stockholm, 154–165.
- Boheman CH (1847) Nya Svenska Homoptera. Handlingar. Kongliga Svenska Vetenskaps Akademien. Stockholm, 23–67.
- Della Giustina W (1989) Homoptères Cicadellidae, 3 (Faune de France, 73). Fédération Française des Sociétés de Sciences Naturelles et INRA, Paris, 350 pp.
- De Jong KAG (1985) Aedeagal mirror symmetry in a Dutch population of *Stiroma affinis* Fieber, 1866 (Homoptera Auchenorrhyncha Delphacidae). K. A. G. de Jong, The Hague, The Netherlands, 1–12. [Published by the author]
- Dlabola J (1958) Zikaden-Ausbeute vom Kaukasus (Homoptera Auchenorrhyncha). Acta entomologica Musei Nationalis Pragae 32: 317–353
- Dworakowska I (1970) On the genus *Zyginidia* Hpt. and *Lublinia* gen. n. (Auchenorrhyncha, Cicadellidae, Typhlocybinae). Bulletin de l'Académie Polonaise des Sciences Cl. II, 8(10): 625–632.
- Fieber FX (1866) Grundzüge zur generischen Theilung der Delphacini. Verhandlungen der Kaiserlich-Königlichen Zoologisch-botanischen Gesellschaft in Wien 16: 517–534.
- Guglielmino A, Bückle C (2010) Revision of *Chlorionidea* Löw (Hemiptera: Delphacidae) with the description of two new species from Italy, and comments on anti-symmetry in male genitalia of Delphacidae. Journal of Natural History 44(45–48): 2737–2759. doi: 10.1080/00222933.2010.512399
- Herrich-Schäffer GAW (1838) *Jassus preysleri*, *Bythoscopus microcephalus*, *Typhlocyba quercus*, *Typhlocyba nitidula*, *Typhlocyba albostriella*, *Typhlocyba adspersa*, *Typhlocyba scutellaris*, *Typhlocyba viridula*, *Typhlocyba cruenta*, *Tettigonia nigrolineata*, *Jassus lineatus*, *Eupelix spathulata*, *Jassus 6-notatus* etc.. Deutschlands Insecten 164: 7–21.
- Holwell GI, Herberstein ME (2010) Chirally dimorphic male genitalia in praying mantids (*Ciulfina*: Liturgusidae). Journal of Morphology 271: 1176–1184. doi: 10.1002/jmor.10861
- Horváth G (1884) Diagnoses Hemipterorum II. Természettajzi Füzetek 8: 315–320.
- Horváth G (1897) Homoptera nova ex Hungaria. Természettajzi Füzetek 20: 620–643.
- Huber BA, Sinclair BJ, Schmitt M (2007) The evolution of asymmetric genitalia in spiders and insects. Biological Reviews of the Cambridge Philosophical Society 82: 647–698. doi: 10.1111/j.1469-185X.2007.00029.x
- Johnson MS, Clarke B, Murray J (1990) The coil polymorphism in *Paratula suturalis* does not favor sympatric speciation. Evolution 44(2): 459–464. doi: 10.2307/2409424
- Kirkaldy GW (1907) Leafhoppers supplement (Hemiptera). Bulletin of the Hawaiian Sugar Planter's Association, Division of Entomology 3: 1–186. [pls. 1–20]
- Kirschbaum CL (1868) Die Cicadinen der Gegend von Wiesbaden und Frankfurt A. M. nebst einer Anzahl neuer oder schwer zu unterscheidender Arten aus anderen Gegenden Europa's Tabellarisch Beschrieben. Jahrbücher des Vereins für Naturkunde im Herzogthum Nassau. Wiesbaden 21: 1–202.
- Logvinenko VN (1969) New and not popular representatives of the Cixiidae family (Homoptera, Auchenorrhyncha) of the Caucasus and Transcaucasian. Vestnik Zoologii 1: 53–59.
- Logvinenko VN (1976) New leafhopper species of the superfamily Fulgoroidea (Auchenorrhyncha) from the Caucasus. Entomologicheskoe Obozrenie 55(3): 69–74.
- Mazzoglio PJ, Arzone A (1993) Hybrid zones between *Zyginidia pullula* (Boh.) and *Z. ribauti* Dwor. in the Ligurian Alps and Apennines (Rhynchota Auchenorrhyncha). A first survey. In: Drosopoulos S, Petrakis PV, Claridge MF, de Vrijer PWF (Eds) Proceedings of the 8th Auchenorrhyncha Congress, Delphi, Greece, 9–13 August, 100–102.
- Ossiannilsson F (1978) The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark. Part I. Fauna Entomologica Scandinavica 7(1): 1–222.

- Schilthuizen M (2007) The evolution of chirally dimorphic insect genitalia. *Tijdschrift voor Entomologie* 150: 347–354. doi: 10.1163/22119434-900000234
- Schilthuizen M (2013) Something gone awry: unsolved mysteries in the evolution of asymmetric animal genitalia. *Animal Biology* 63: 1–20. doi: 10.1163/15707563-00002398
- Wagner W (1963) *Dynamische Taxionomie, angewandt auf die Delphaciden Mitteleuropas*. *Mitteilungen des Hamburger Zoologischen Museums und Instituts* 60: 111–180.

Supplementary material 1

Detailed list of study materials

Authors: Adalgisa Guglielmino, Vera D'Urso, Christoph Bückle
Data type: Excel

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Revision of the genus *Trichrysis* Lichtenstein, 1876 from China, with description of three new species (Hymenoptera, Chrysididae)

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Abstract

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Key Words

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new species

new synonym

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The Chinese species of the genus *Trichrysis* Lichtenstein, 1876 are revised for the first time. Thirteen species are recorded, of which three species are new for science, *T. coeruleamaculata* Rosa, Wei & Xu, **sp. n.**, *T. tridensnotata* Rosa, Wei & Xu, **sp. n.**, and *T. yu-ani* Rosa, Feng & Xu, **sp. n.** Two species are revalidated: *T. tonkinensis* (Mocsáry, 1914) and *T. formosana* (Mocsáry, 1912). Two new synonymies are proposed, *T. formosana* (Mocsáry, 1912) = *T. sauteri* (Mocsáry, 1912), **syn. n.** = *T. taial* (Tsuneki, 1970), **syn. n.** The lectotype of *Chrysis pellucida* du Buysson, 1887 is designated.

Introduction

The genus *Trichrysis* Lichtenstein, 1876 belongs to the tribe Chrysidini (Hymenoptera, Chrysididae). *Trichrysis* has been traditionally considered as a subgenus of *Chrysis* Linnaeus, 1761 (Lichtenstein 1876; Mocsáry 1889; Bischoff 1910, 1913; Trautmann 1927; Balthasar 1953, etc.). Linsenmaier (1959) considered *Trichrysis* and *Chrysidea* Bischoff, 1913 as two subgenera in the genus *Chrysis* Linnaeus, 1761, separated by shape and position of S2 black spots and outer veins of fore wing discoidal cell. Later, Linsenmaier (1968, 1984) moved all the species included in the subgenus *Chrysis* (*Chrysidea*) into the subgenus *Chrysis* (*Trichrysis*) because shape of S2 black spots and wing venations are variable when considering species outside the Palearctic Region. Bohart and Kimsey (1980) elevated *Trichrysis* to generic rank; Bohart (1987) presented a key to twenty species of this genus and Kimsey and Bohart (1991) gave a checklist

of twenty six known species. Linsenmaier (1994, 1997) moved the *inops* species-group and *lusca* species-group from the subgenus *Praestochrysis* Linsenmaier, 1968 into the subgenus *Trichrysis* based on morphological characteristics and trophic relationships with their hosts, and subdivided the Palearctic and Oriental *Trichrysis* into three species-groups: *T. cyanea* species-group, *T. lusca* species-group and *T. pumila* species-group; the *T. lusca* species-group includes species with five teeth on apex of T3, while the *T. cyanea* species-group with three teeth on apex of T3. Strumia (2009) described a new species from the Mediterranean region. Rosa and Xu (2015) assigned the *T. pumila* species-group to the genus *Chrysidea*, following Bohart (1988), Kimsey and Bohart (1991). Therefore, thirty three valid species were known in the genus before this study (Kimsey and Bohart 1991; Linsenmaier 1994, 1997; Rosa 2006; Strumia 2009; Madl and Rosa 2012).

In China, eight species were previously recorded (Rosa et al. 2014): *Trichrysis cyanea* (Linnaeus, 1758), *T. im-*

periosa (Smith, 1874), *T. lusca* (Fabricius, 1804), *T. luzonica* (Mocsáry, 1889), *T. pellucida* (du Buysson, 1887), *T. secernenda* (Mocsáry, 1912), *T. triacantha* (Mocsáry, 1889) and *T. trigona* (Mocsáry, 1889). In this study, thirteen Chinese species of *Trichrysis* are keyed and revised, of which three species are new for science, two species are revalidated, and two synonymies are proposed.

The current species number of *Trichrysis* in the World now increases to thirty eight species.

Materials and methods

All specimens were examined and described under stereomicroscope (Leica MZ125). Photographs of specimens from South China Agricultural University (SCAU) were taken with a digital camera (Cool SNAP) attached to a Zeiss Stemi 2000-CS stereomicroscope. Images were processed using Image-Pro Plus software. Images of types from other museums were taken with Nikon D-80 connected to stereomicroscope Tegal SCZ and stacked with software Combine ZP, white balance was calibrated using photo-camera settings to reduce blue effect of fluorescent light of Tegal microscope.

Morphological terminology follows Kimsey and Bohart (1991). Abbreviations used in the descriptions as follows: **BOL**=brow-ocellar line, the shortest distance between mid ocellus and transversal frontal carina; **F1**, **F2**, **F3**=flagellomeres 1, 2, 3; **l/w**=length/ width; **MOD**=mid ocellar diameter; **MS**=malar space, the shortest distance between base of mandible and margin of compound eye; **OOL**= oculo-ocellar line, the shortest distance between lateral ocellus and compound eye; **P**=pedicel; **PD**=puncture diameter; **POL**=the shortest distance between posterior ocelli; **S2** black spots=two black spots on metasomal sternite 2; **T1**, **T2**, **T3**=metasomal tergites 1, 2, 3; **TF-C**=transverse frontal carina.

Types and other specimens are deposited in the following institutions:

BMNH	Natural History Museum, London, UK.
EIHU	Entomology Institute, Hokkaido University, Hokkaido, Japan.
HNHM	Hungarian Natural History Museum, Budapest, Hungary.
HUM	Entomology Institute, Hokkaido University Museum, Japan.
ISEA-PAN	Invertebrate collections of the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences in Krakow, Poland.
LS	The Linnean Society of London, UK.
MNHN	National Museum of Natural History, Paris, France.
MNHU	Museum of Natural History of the Humboldt-Universität, Berlin, Germany.
MSNG	Museum of Natural History "G. Doria", Genoa, Italy.

NHMW	Natural History Museum, Vienna, Austria.
NIAS	Laboratory of Insect Systematics, National Institute of Agro-Environmental Sciences, Kannondai, Tsukuba, Ibaraki, Japan.
NMLS	Natur-Museum Luzern, Switzerland.
OMNH	Osaka Museum of Natural History, Osaka, Japan.
PRC	Paolo Rosa Collection, Bernareggio, Italy.
SCAU	Hymenopteran Collection, South China Agricultural University, Guangzhou, China.
USNM	United States National Museum of Natural History, United States National Entomological Collection, Washington DC, USA.
ZIN	Zoological Institute, St. Petersburg, Russia.

Specimens collected with Malaise traps or conserved in alcohol till they are completely dehydrated may change colours when they were prepared: blue metallic colour turns into dark blue, green turns into blue, yellow turns into greenish and red becomes more yellowish. Specimens collected by net and preserved in other way, usually change their colour less considerably. Most of the examined specimens have been collected on field by net.

Citations and synonyms in text are related to important works and relevant articles for the studied area. The material examined is listed with coordinates and depositories; in case of type specimens and other historical material examined in museums, data reported on different labels are separated from each other by a slash.

Results

Genus *Trichrysis* Lichtenstein, 1876

Chrysis (*Trichrysis*) Linnaeus: Lichtenstein, 1876: 27. Type species: *Sphex cyanea* Linnaeus, 1758: 572.

Chrysis (*Trichrysis*) Linnaeus: Mocsáry 1889: 319; Tsuneki 1947: 55; 1950: 70; 1953a: 25; 1953b: 58; Linsenmaier 1959: 169; 1968: 107; 1994: 192; 1997: 284.

Trichrysis (*Trichrysis*) Lichtenstein: Bohart and Kimsey 1980: 138, 147.

Trichrysis Lichtenstein: Kimsey and Bohart 1991: 568; Rosa 2006: 322; Kurzenko and Lelej 2007: 1006; Ha et al. 2008: 73; Strumia 2009: 589; Madl and Rosa 2012: 125.

Description. Head broader than high. Scapal basin concave, striate or punctate. TFC various, usually single and medially raised, sometimes double, downcurved along eye margin, or with branches upward extended to ocellar area. MS usually about 1 MOD. Pronotum with distinct and complete sublateral carina, sometimes incomplete or weak. Mesopleuron with broad episternal sulcus and scrobal sulcus. Metasoma usually with geminate punctures. T2 usually with median carina. T3 with three or five teeth; lateral teeth in some species can be merely angle-shaped. S2 with black spots usually fused medially, rarely separated by a narrow line, never connected to lateral margins.

Biology. Species of *Trichrysis* are known to be parasitoids of sphecids or crabronid wasps (Dufour and Perris 1840; García Mercet 1911; Alfken 1915; Enslin 1921; Trautmann 1927; Grandi 1931, 1936; Danks 1971; Groot 1971; Lomholdt 1975; Morgan 1984; Kimsey and Bohart

1991; Asís et al. 1994; Kunz 1994; Strumia 1997; Rosa 2006). Recently Pärn et al. (2014) included also some Pompilidae species as potential hosts for *Trichrysis*.

Distribution. Palearctic, Afrotropical, Oriental and Australian Regions.

Key to Chinese species of *Trichrysis* Lichtenstein

The key is mostly based on females. Males from China are known only for six species (*T. cyanea*, *T. formosana*, *T. lusca*, *T. secernenda*, *T. triacantha*, and *T. yuani* sp. n.), and are recognizable by subtruncate apex of T3, shorter apical teeth and usually darker colouration dorsally.

- 1 Apex of T3 with five teeth (*T. lusca* species-group)..... 2
- Apex of T3 with three teeth (*T. cyanea* species-group)..... 3
- 2 Vertex, pronotum, mesoscutum, mesoscutellum, metanotum, mesopleuron, T1 and T2 laterally metallic coppery, in contrast with metallic blue body colouration (Figs 31–36); F1 only partially metallic green to blue (Fig. 34); S2 black spots fused medially (Fig. 98); pit row of T3 with deep and mostly fused pits (Fig. 36)..... *T. imperiosa* (Smith)
- Body metallic green to blue; T2 with greenish to golden or golden-red spot laterally (Figs 37–42); F1 fully metallic green to blue (Fig. 40); S2 black spots fused medially or separated by narrow metallic line (Fig. 99); pit row of T3 with smaller and well defined pits (Fig. 42) *T. lusca* (Fabricius)
- 3 S2 black spots ovoid, separated medially by narrow metallic line (Figs 60, 102) *T. secernenda* (Mocsáry)
- S2 black spots fully or partially fused 4
- 4 Tegula brown, without metallic reflection; if with feeble metallic reflection, then apex of T3 with blunt lateral teeth (Figs 12, 18, 54, 93) 5
- Tegula entirely with metallic reflection; if with feeble metallic reflection, then apex of T3 with sharp lateral teeth (Figs 5, 23, 47, 73–75, 81, 87)..... 8
- 5 Body robust, 7.0–10.0 mm in length; pit row of T3 with large and deep pits, sometimes fused (Figs 54, 93); median tooth prominent and elongate, lateral tooth blunted (Figs 54, 93)..... 6
- Body slender, 4.0–7.0 mm in length; pit row of T3 with smaller shallow and separated pits (Figs 12, 65); median tooth small and short in *T. cyanea* (Figs 12, 18), lateral tooth sharp in *T. tonkinensis* (Fig. 65)..... 7
- 6 Body length 9.0–10.0 mm; in lateral view, distance from anterior margin of pit row to apical margin of median tooth >3 MOD (Fig. 49); in dorsal view, T3 with median tooth sharp (Fig. 54); S2 black spots see Fig. 101; body usually dark blue to violet (Fig. 49), occasionally dark green *T. pellucida* (du Buysson)
- Body length 7.0–7.5 mm; in lateral view, distance from anterior margin of pit row to apical margin of median tooth=2 MOD (Fig. 88); in dorsal view, T3 with median tooth blunt (Fig. 93); S2 black spots see Fig. 107; body light blue (Fig. 88) *T. yuani* sp. n.
- 7 Body usually dark green or blue, sometimes with blackish areas dorsally on mesosoma and metasoma, especially in males; Chinese specimens frequently blue with dark blue areas dorsally (Figs 7–18); T2 and T3 usually without median carina; T3 with blunt lateral tooth (Fig. 12); S2 black spots see Fig. 97; T3 in male with short and blunt median tooth (Fig. 18)..... *T. cyanea* (Linnaeus)
- Body colour usually metallic green or light greenish-blue, with characteristic olive green to blackish mat areas on interspaces between punctures on pronotum, mesoscutum and on mesoscutellum antero-medially (Figs 61–66); T2 and T3 with median carina (Fig. 65); T3 with sharp lateral tooth (Fig. 65); S2 black spots see Figs 66, 103; male unknown *T. tonkinensis* (Mocsáry)
- 8 T3 with convex interval between median tooth and lateral tooth (Figs 71, 73–75)..... *T. triacantha* (Mocsáry)
- T3 with straight to concave interval between median tooth and lateral tooth 9
- 9 S2 black spots subtrapezoid (Figs 100, 105)..... 10
- S2 black spots subtriangular (Figs 96, 106) 12
- 10 Body metallic blue without contrasting colour pattern (Figs 76–81); interval between median tooth and lateral tooth deeply concave (Fig. 81)..... *T. tridensnotata* sp. n.
- Body metallic green-blue, with contrasting greenish to golden stripes laterally on metasoma; interval between median tooth and lateral tooth straight..... 11
- 11 TFC without upward branches directed to ocellar area (Fig. 20); in lateral view, median bridge of pit row distinctly depressed, leaving apical tooth hook-like (Fig. 24)..... *T. formosana* (Mocsáry)
- TFC with two upward branches directed to ocellar area (Fig. 44); in lateral view, median bridge of pit row straight, at most slightly depressed (Fig. 43)..... *T. luzonica* (Mocsáry)

- 12 Scapal basin punctate (Fig. 2); punctuation of mesosoma with wide and punctate interspaces (Fig. 3); metasoma with punctate interspaces (Fig. 4); T2 with two large dark blue areas fused medially along longitudinal carina (Fig. 5); S2 with two large black spots as in Figs 6, 96 *T. coeruleamaculata* sp. n.
- Scapal basin striate medially and punctate laterally (Fig. 83); punctuation of mesosoma almost without interspaces, with exception of mesoscutum laterally, or with wrinkled interspaces (Fig. 84); metasoma without interspaces or with wrinkled interspaces (Fig. 85); T2 with two small dark blue areas separated from longitudinal carina (Fig. 87); S2 with two small black spots as in Fig. 106 *T. trigona* (Mocsáry)

***Trichrysis coeruleamaculata* Rosa, Wei & Xu, sp. n.**

<http://zoobank.org/9E74BB03-B89B-4923-83A5-6EC68506AB54>

Figs 1–6, 96

Material examined. Holotype, ♀: CHINA: Fujian, Fuzhou, Jingshan (26°17'12"N 118°58'52"E), 21.VIII.2004, leg. C-m. Liu (SCAU).

Diagnosis. *Trichrysis coeruleamaculata* sp. n. is similar to *T. trigona* (Mocsáry, 1889) and *T. hexapholis* Bohart, 1987, from Sri Lanka. It can be separated from *T. trigona* by the following characteristics: body punctuation with large interspaces, 0.2–1.0 PD; scapal basin punctate; pit row with large pits; pit row sunken with deep pits, and post pit row area impunctate; T1 and T3 each with two dark blue spots, T2 dark blue dorsally; tegula brown or with feeble metallic reflections; S2 with large black spots as in Fig. 96. It can be separated from *T. hexapholis* by blue colouration without bright purple and gold markings; TFC straight and not as inverted V.

Description. *Female.* Holotype. Body length 8.0 mm.

Head. Scapal basin deep and punctate. TFC single and straight (Fig. 2). Frons slightly raised between TFC and scapal basin. Relative length of P:F1:F2:F3=1.0:1.3:0.7:0.6; F1 l/w=2.9; OOL=1.2 MOD; BOL=1.7 MOD; POL=2.0 MOD; MS=1.2 MOD; clypeus incised medially.

Mesosoma. Pronotal groove deep, almost extending to posterior margin of pronotum (Fig. 3); sublateral carina incomplete, well developed only anteriorly. Punctuation on pronotum, mesoscutum and mesoscutellum with large interspaces between punctures, 0.2–1.0 PD (Fig. 3); interspaces shining and punctate. Episternal sulcus and scrobal sulcus with large areolate punctures.

Metasoma. Metasoma with large geminate punctures and punctate interspaces (Fig. 4). T2 with weak median carina (Fig. 4). T3 prepit bulge slightly convex; pit row distinct, with large pits; post pit row area flat and impunctate (Fig. 5). Apex of T3 with three sharp teeth (Fig. 5); interval between median tooth and lateral tooth concave. S2 black spots subtriangular, elongated longitudinally and fused medially (Figs 6, 96).

Colouration. Body metallic blue (Fig. 1), with dark blue spots on vertex, pronotum, mesoscutum, mesoscutellum, and metanotum medially; with two dark blue, large and symmetrical spots on T1, T2 and T3, respectively (Fig. 4); with green reflections on face, lateral fields of mesoscutum. Scape, pedicel and only base of F1 metallic bluish-green, rest of flagellum black. Tegula brown, with

weak metallic reflections. Legs metallic bluish-green, with tarsi brown.

Male. Unknown.

Distribution. China (Fujian).

Etymology. The specific name derives from Latin adjective *coerulea* (= blue) and Latin past participle *maculata* (= spotted) and refers to blue spots on T3 before pit row.

***Trichrysis cyanea* (Linnaeus, 1758)**

Figs 7–18, 97

Sphex cyanea Linnaeus, 1758: 572. Lectotype, ♂, designated by Morgan 1984: 10; Europe (LS) (examined).

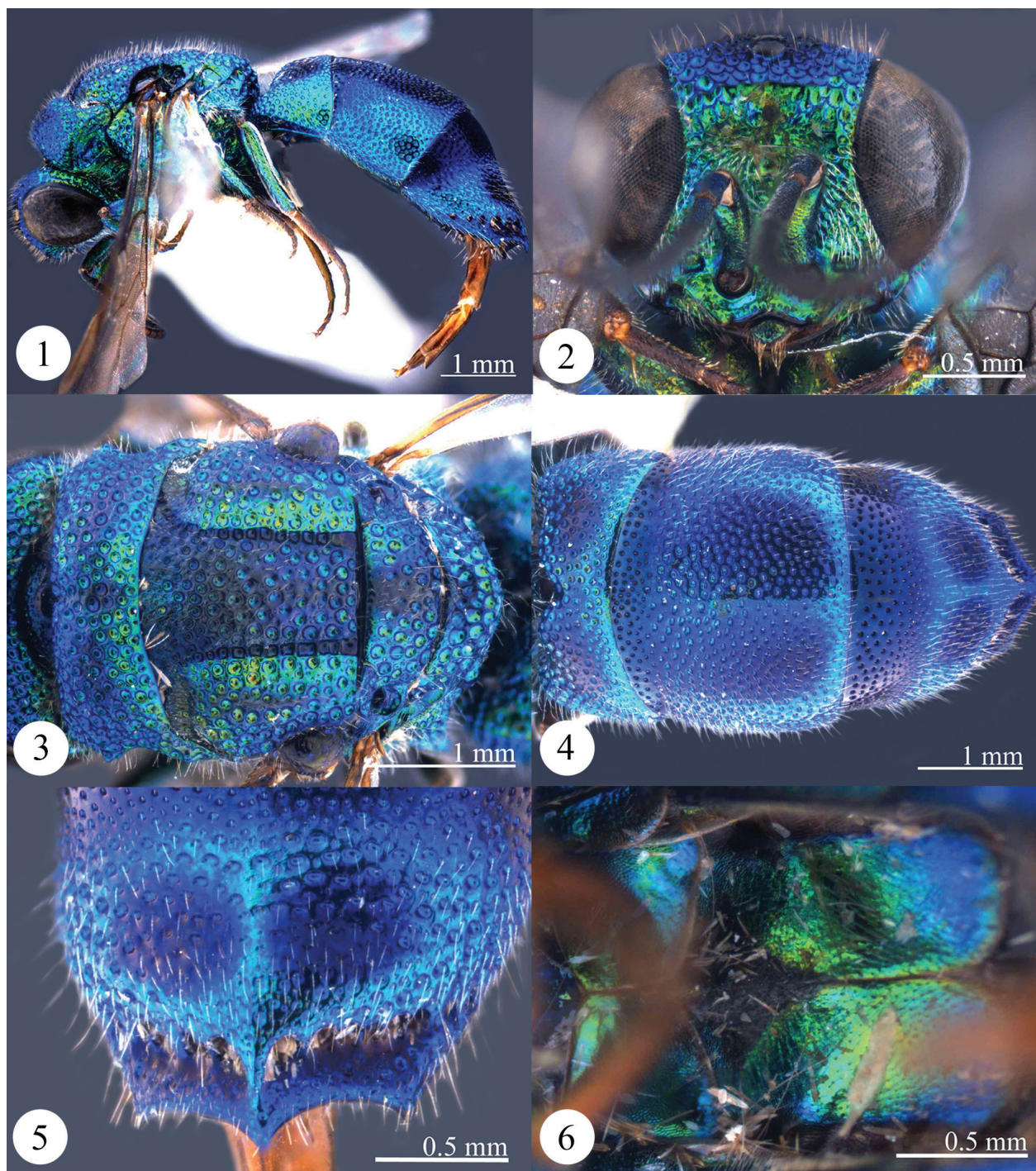
Chrysis (Trichrysis) cyanea (Linnaeus): Lichtenstein 1876: 27; Tsuneki 1947: 55; 1950: 70; 1953a: 25; 1953b: 58; Linsenmaier 1959: 169.

Trichrysis (Trichrysis) cyanea (Linnaeus): Kimsey and Bohart 1980: 77.

Trichrysis cyanea (Linnaeus): Kimsey and Bohart 1991: 571; Rosa 2006: 323; Ha et al. 2008: 73; Rosa et al. 2014: 75.

Material examined. “EUROPE”: Lectotype / Lectotype ♂ *Sphex cyanea* L., det. D. Morgan 1983 / ♂ *Trichrysis cyanea* (L.) det. D. Morgan 1983. CHINA: 1♀, Ningxia, Liupanshan Forest Park (34°22'N 106°18'E), 21.VI–14.VII.2008, leg. J-m. Yao (SCAU); 1♀, Ningxia, Liupanshan Forest Park, 3–4.VII.2009, leg. H-y. Chen (SCAU); 1♂, Liaoning, Laotuziding Nature Reserve (41°19'7"N 124°52'27"E), 18.VII.2011, leg. K-x. Zhao (SCAU); 1♀, Gansu, Xiahe, Labrang, 1–15.VI.1998, leg. V. Major (PRC); 1♀, Hebei, Mt. Xiaowutai, Yangjiapin, 20.VIII.2005, leg. M. Shi (SCAU); 1♀, Hunan, Mt. Huping, Nianzigou (29°55'38"N 110°48'48"E), 9.VII.2009, leg. Y-l. Tang et al. (SCAU); 2♀♀, Yunnan, Dali, Shimen (25°41'26"N 100°10'13"E), 3.V.2006, leg. H-s. Wang (SCAU); 3♀♀, Yunnan, Lincang, Fengxiang (23°52'37"N 100°5'15"E), 5.X.2004, leg. J-x. Liu (SCAU); 1♀, Yunnan, Jingdong, Jinping (24°27'14"N 100°50'4"E), 28.IV.2005, leg. H-s. Wang (SCAU); 1♀, Yunnan, Lincang (23°52'37"N 100°4'46"E), 5.X.2005, leg. K. Wu (SCAU).

Diagnosis. *Trichrysis cyanea* (Linnaeus, 1758) is similar to *T. secernenda* (Mocsáry, 1912) and *T. triacantha*. However it can be separated from *T. secernenda* by small and fused black spots on S2 (Fig. 97) (large and separated in *T. secernenda*); it can be separated from *T. triacantha* by angle-shaped lateral teeth on T3 (sharp in *T. triacantha*).



Figures 1–6. *Trichrysis coeruleamaculata* sp. n., holotype (female). **1.** Habitus, lateral view; **2.** Head, frontal view; **3.** Mesosoma, dorsal view; **4.** Metasoma, dorsal view; **5.** Apex of T3, dorsal view; **6.** S2, ventral view.

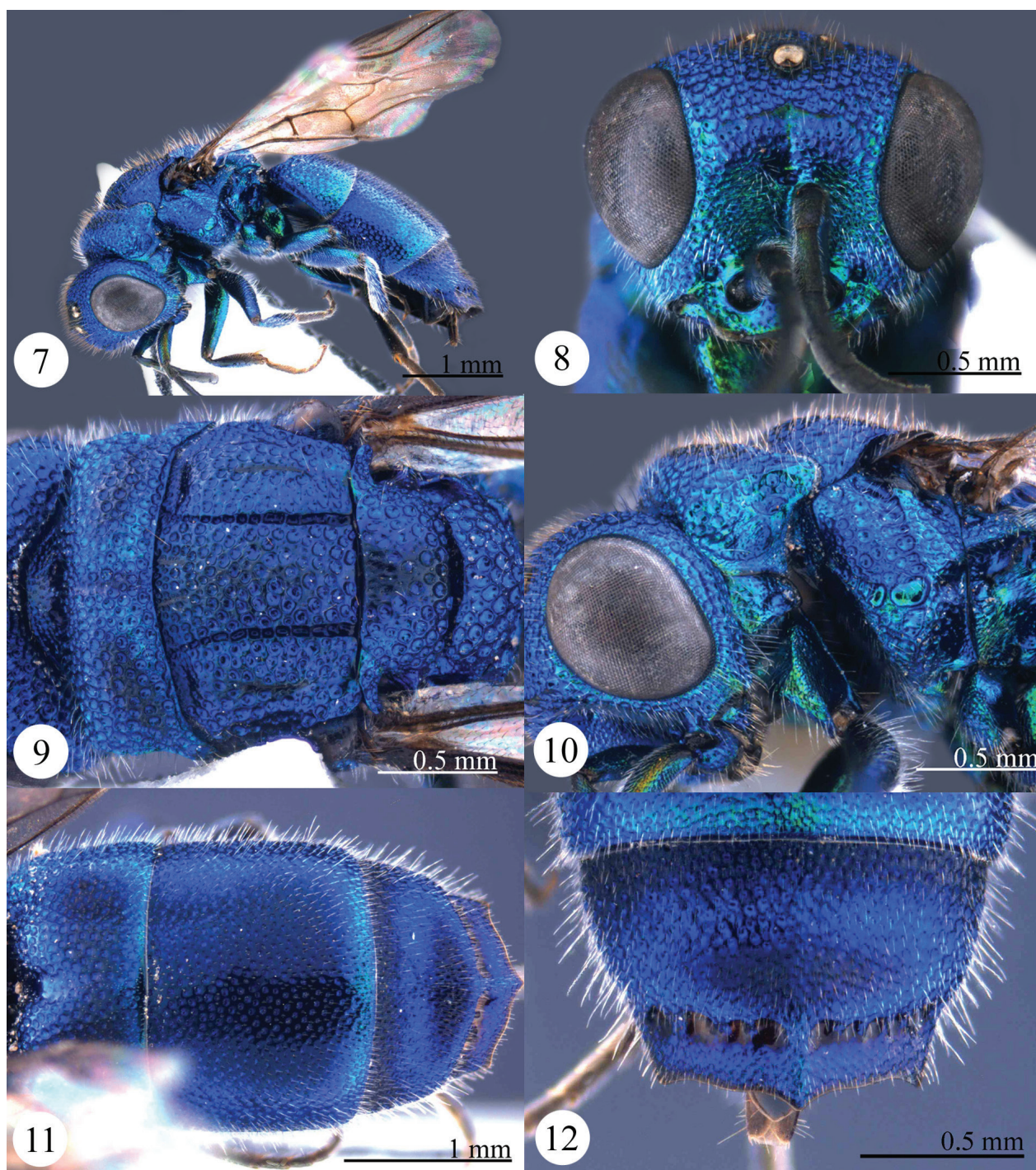
tha) and single TFC, without branches (raised with or without distinct branches in *T. triacantha*).

Description. *Female.* Body length 4.2–7.0 mm.

Head. Scapal basin deep, densely punctate (Fig. 8). TFC single, straight or slightly inverted V-shape. Frons between TFC and scapal basin not raised. Relative length of P:F1:F2:F3=1.0:1.5–1.8:0.8–1.0:0.6–0.8; F1 l/w=3.3; OOL=1.8–2.4 MOD; BOL=1.5 MOD; POL=2.0–2.4 MOD; MS=1.0 MOD; clypeus slightly concave medially.

Mesosoma. Pronotal groove deep, almost extending to posterior margin (Fig. 9); sublateral carina distinct and usually complete. Punctuation on pronotum, mesoscutum and mesoscutellum with uniform punctures subequally interspaced; interspaces usually punctate. Metanotum with large foveate punctures, contiguous without interspaces. Episternal sulcus and scrobal sulcus with large transversal foveae.

Metasoma. Punctures on T1 and T2 distinctly geminate, micropunctate on interspaces (Fig. 11). T2 and T3



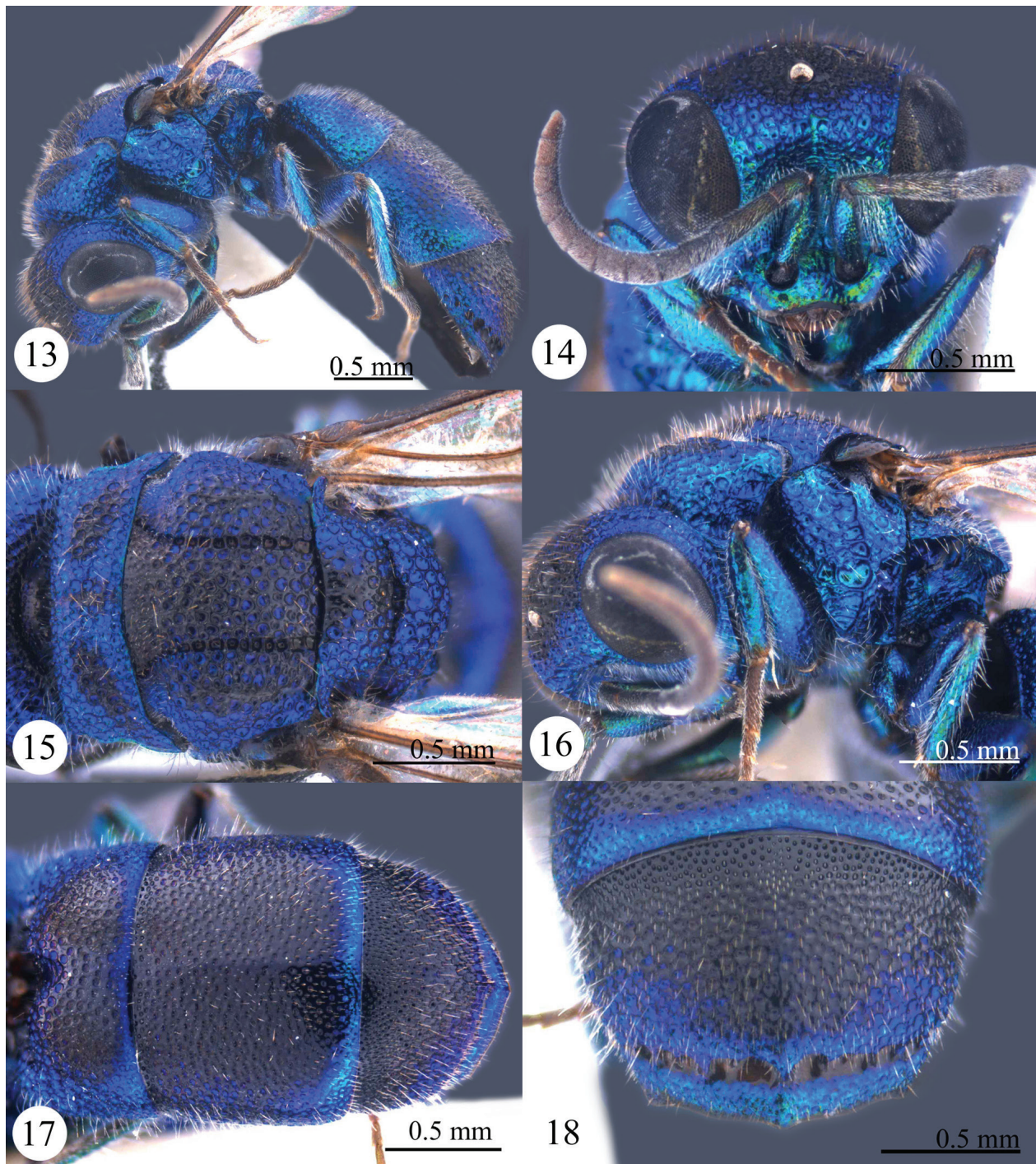
Figures 7–12. *Trichrysis cyanea* (Linnaeus), China: Ningxia (female). 7. Habitus, lateral view; 8. Head, frontal view; 9. Mesosoma, dorsal view; 10. Head, pronotum, mesopleuron, lateral view; 11. Metasoma, dorsal view; 12. T3, dorsal view.

usually without median carina. T3 prepit bulge slightly convex, especially medially; pit row distinct, with large, round and close pits, not fused. Apex of T3 with three distinct teeth similar in size, in dorsal view (Fig. 12); lateral teeth angle-shaped, in lateral view; interval between median tooth and lateral tooth variable, from straight to slightly convex. S2 black spots diamond shaped, medially fused.

Colouration. Body colouration variable, usually light blue to dark blue, or green to dark green with darker areas

dorsally. Scape and pedicel metallic blue, flagellum black. Tegula usually brown, without metallic reflection. Legs metallic blue, with tarsi black.

Male. Body length 4.6–5.5 mm. Male differs from female as follows: apex of T3 with teeth shorter (Fig. 18), sometimes only median tooth is distinctly visible; pre pit row area not bulged (Fig. 18); interval between median tooth and lateral tooth straight; body usually more greenish than that of female, and with blackish area dorsally (Figs 13, 18).



Figures 13–18. *Trichrysis cyanea* (Linnaeus), China: Liaoning (male). **13.** Habitus, lateral view; **14.** Head, frontal view; **15.** Mesosoma, dorsal view; **16.** Mesosoma, lateral view; **17.** Metasoma, dorsal view; **18.** T3, dorsal view.

Biology. Collected from April to October, possibly with more than one generation. In the West Palearctic it is known as a parasitoid of crabronid wasps (Tormos et al. 1996; Gathmann and Tschamtk 1999; Rosa 2006; Pärn et al. 2014).

Variation. *Trichrysis cyanea* (Linnaeus, 1758) is a variable species due to its wide distribution through Palearctic and Oriental Regions. Some differences can be observed between the Chinese specimens and western

Palearctic specimens. For example, western Palearctic specimens have scapal basin striate medially, sometimes with small aligned punctures within striae (densely punctate in Chinese specimens); pronotum with weak pronotal carina and tegula usually brown, without or with weak metallic reflections (metallic in some Chinese specimens from Yunnan). Nevertheless, in Yunnan more specimens have been collected with and without metallic colouration on tegulae, therefore we consider this character as

variable in this species. For other *Trichrysis* species (as already observed by Bohart (1987)), the colouration of tegulae seems to be a fix and reliable diagnostic character.

Distribution. China (Liaoning, Beijing, Inner Mongolia, Ningxia, Gansu, Hebei, Hunan, Yunnan); widespread in the Holarctic Region (Kimsey and Bohart 1991; Ha et al. 2008: 73; Rosa et al. 2013, 2014).

***Trichrysis formosana* (Mocsáry, 1912), status revived**

Figs 19–30

Chrysis (*Trichrysis*) *formosana* Mocsáry, 1912: 380. Lectotype, ♀, Taiwan: Takao [= Kaohsiung], designated by Bohart in Bohart and French 1986: 341; Taiwan: Takao [= Kaohsiung] (HNHM) (examined).

Chrysis (*Trichrysis*) *sauteri* Mocsáry, 1912: 381. Holotype, ♂, Taiwan: Takao [= Kaohsiung] (HNHM) (examined). **Syn. n.**

Chrysis (*Trichrysis*) *formosana* Mocsáry: Bischoff 1913: 45; Mocsáry 1913b: 614; Uchida 1927: 151; 1933: 3; Tsuneki 1970: 11.

Chrysis (*Trichrysis*) *sauteri* Mocsáry: Mocsáry 1913b: 614; 1913c: 289; Uchida 1927: 151; Tsuneki 1970: 13.

Chrysis (*Trichrysis*) *taial* Tsuneki, 1970: 11. Holotype, ♀, Taiwan: Nanton: Puli (OMNH, not NIAS). **Syn. n.**

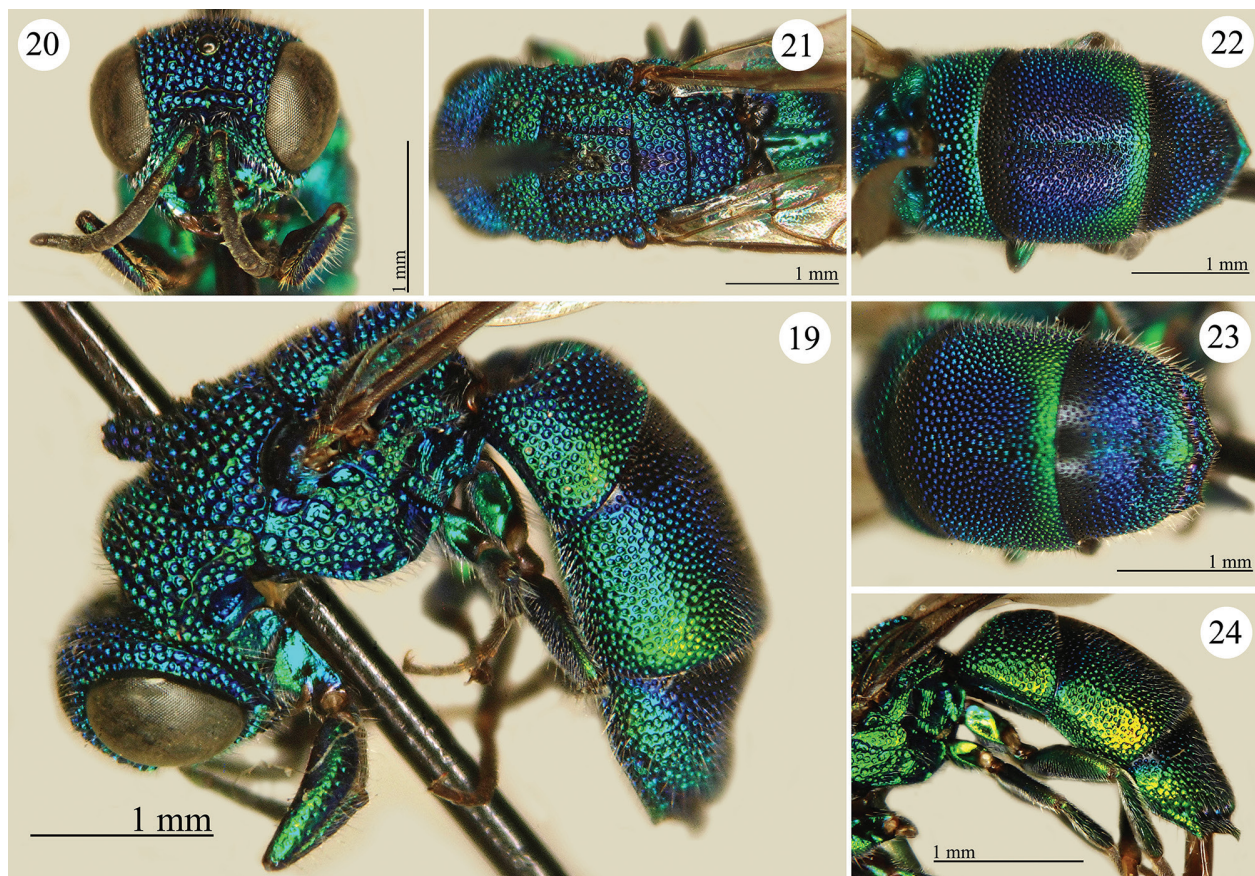
Material examined. CHINA: ♀, Formosa [= Taiwan] Sauter / Takao 1907 / *formosana* Mocs. det. Mocsáry typ. <handwritten in red> / red label / Lectotypus *Chrysis formosana* Mocs., ♀ RM Bohart <red label> / id nr. 135546 HNHM Hym. coll.; ♂, Formosa [= Taiwan] Sauter / Takao 1907 / *Sauteri* Mocs. det. Mocsáry typ. <handwritten in red> / red label / Holotypus *Chrysis sauteri* Mocs. ♂ RM Bohart / id nr. 135548 HNHM Hym. coll.; 2♀♀, Kankau (Koshun) Formosa [= Taiwan] H. Sauter / IX.1912 / 12.VII.1907 / *C. formosana* Trautmann det.. PHILIPPINES: 1♀, South Leyte <without further data> (PRC); 1♀, Mt. Makiling Luzon Baker / Ins. Philipp. (HNHM).

Diagnosis. *Trichrysis formosana* (Mocsáry, 1912) is similar to *T. luzonica* (Mocsáry, 1889). It can be easily separated from the latter by median bridge of pit row sharply depressed, leaving median tooth hook-like (Fig. 24), and TFC without branches.

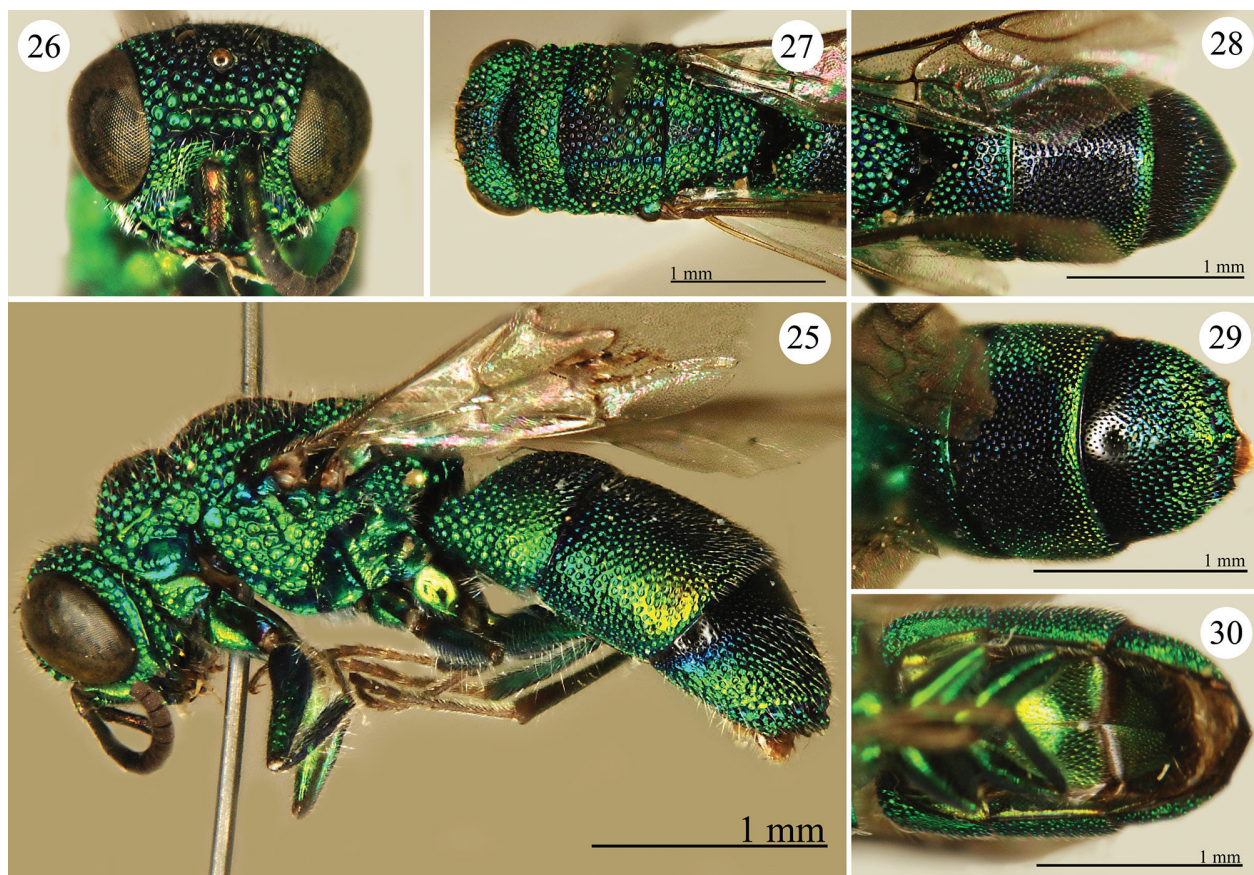
Description. *Female.* Body length 5.0–6.0 mm.

Head. Scapal basin punctate. TFC double, with lower one weakly developed. Relative length of P:F1:F2:F3=1.0:1.2:0.9:0.6; F1 l/w=2.2; OOL=1.5 MOD; BOL=1.5 MOD; POL=1.7 MOD; MS=0.9 MOD; clypeal apex medially truncated.

Mesosoma. Pronotal groove weak; sublateral carina distinct and complete (Fig. 21). Punctuation on pronotum, mesoscutum and mesoscutellum with consistent



Figures 19–24. *Trichrysis formosana* (Mocsáry), lectotype (female). 19. Habitus, lateral view; 20. Head, frontal view; 21. Mesosoma, dorsal view; 22. Metasoma, dorsal view 23. T2 and T3, dorsal view; 24. Mesosoma, lateral view.



Figures 25–30. *Trichrysis sauteri* (Mocsáry), holotype (male). **25.** Habitus, lateral view; **26.** Head, frontal view; **27.** Head and mesosoma, dorsal view; **28.** Metasoma, dorsal view; **29.** T2 and T3, dorsal view; **30.** Metasoma, ventral view.

punctures subequally interspaced; interspaces punctate. Metanotum with large punctures, without interspaces. Episternal sulcus and scrobal sulcus with large transversal foveae (Fig. 19).

Metasoma. Punctures on T1 and T2 distinctly geminate; interspaces punctate laterally. T2 and T3 with weak median carinae. T3 prepit bulge medially convex; pit row distinct, with large, deep and round pits, close, but not fused (Fig. 23); median bridge of pit row sharply depressed, leaving apical tooth hook-like in lateral view (Fig. 24). Apex of T3 with three teeth similar in size; interval between median tooth and lateral tooth straight. S2 black spots small and round, fused medially.

Colouration. Body blue to bluish-green, with pair of symmetric blue spots on T1, T2 and T3, respectively. Tegula fully metallic blue to bluish-green. Legs metallic blue to bluish-green, with tarsi black or blackish-brown.

Male. Body length 4.5 mm (Fig. 25), more greenish. Different from female as follow: apex of T3 with teeth slightly shorter (Fig. 29); T3 without prepit bulge; pronotum, mesoscutum and mesoscutellum dark metallic blue or black; metasoma dark metallic blue to blackish dorsally (Figs 27, 28).

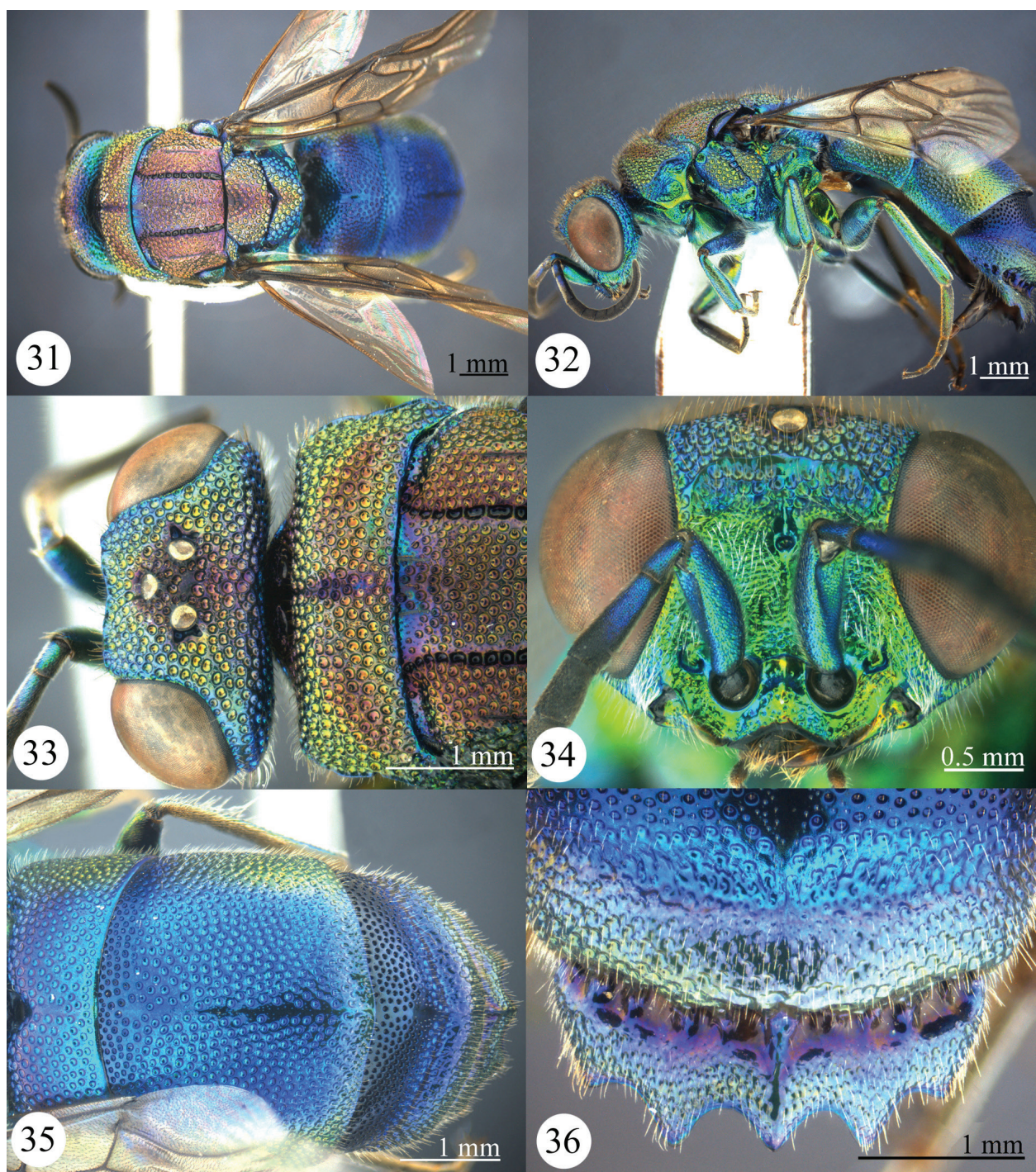
Distribution. China (Taiwan); Philippines (new record).

Remarks. The interpretation of *T. formosana* by different authors was sometimes erroneous (Tsuneki 1970;

Hanada 1989), and referable to other species. Kimsey and Bohart (1991) placed *T. formosana* in synonymy with *T. triacantha*. These two species are clearly distinguishable by: body colouration, blue to bluish-green, with contrasting blue area dorsally and greenish to golden-green strips laterally and posteriorly on T1, T2 and T3 (uniform blue in *T. triacantha*); apex of T3 with straight interval between median tooth and lateral tooth (convex in *T. triacantha*); and median bridge of pit row sharply depressed, leaving apical tooth hook-like (median bridge of pit row straight or slightly depressed in *T. triacantha*). We here revalidate *T. formosana* (Mocsáry, 1912) from the previous synonymy.

T. sauteri (Mocsáry, 1912) was described on a male collected by Sauter in July 1907, together with the female type specimens of *T. formosana* at Taiwan (Formosa, Takao [currently Kaohsiung]); the two species share the same main diagnostic characteristic of median bridge of pit row depressed. Therefore, we here consider *T. sauteri* (Mocsáry, 1912) as synonym of *T. formosana* (Mocsáry, 1912).

T. taial Tsuneki, 1970 was synonymised by Kimsey and Bohart (1991) with *T. luzonica* based on median bridge of pit row sharply depressed, leaving apical tooth hook-like. However, this characteristic is valid for *T. formosana* and not for *T. luzonica*, therefore we consider *Chrysis* (*Trichrysis*) *taial* Tsuneki, 1970 as a synonym of *T. formosana* (Mocsáry, 1912).



Figures 31–36. *Trichrysis imperiosa* (Smith), China: Guangdong (female). **31.** Habitus, dorsal view; **32.** Habitus, lateral view; **33.** Head, pronotum, dorsal view; **34.** Head, frontal view; **35.** Metasoma, dorsal view; **36.** Apex of T3, dorsal view.

Trichrysis imperiosa (Smith, 1874)

Figs 31–36, 98

Chrysis imperiosus Smith, 1874: 460. Lectotype, ♀, designated by Bohart in Kimsey and Bohart 1991: 533. Australia: Queensland, Moreton Bay (BMNH) (examined).

Chrysis imperiosa Smith: du Buysson 1898a: 536; du Buysson 1899: 168; Bingham 1903: 479.

Chrysis (Pentachrysis) imperiosa Smith: Mocsáry 1913b:

619; Uchida 1927: 152; Tsuneki 1970: 18.

Chrysis (Trichrysis) imperiosa Smith: Linsenmaier 1959: 170; Linsenmaier 1994: 193.

Praestochrysis imperiosa (Smith): Kimsey and Bohart 1991: 533; Strumia 1996: 62.

Trichrysis imperiosa (Smith): Rosa et al. 2014: 76.

Material examined. AUSTRALIA: Lectotype / ♀ / Australia / *Chrysis imperiosus* type Smith <handwrit-

ten by Smith > / B.M. Type Hym. 13.146 / Lectotype *Chrysis imperiosus* F. Smith R.M. Bohart / BMNH(E) ♀ 970896. CHINA: 1♀, Hunan, Mt. Huping, Nianzigou (29°55'38"N 110°48'48"E), 9.VII.2009, leg. Y-l. Tang (SCAU); 12♀♀, Guangdong, Chebaling National Nature Reserve (24°42'N 114°11'E), 22–28.VII.2008, leg. Z-f. Xu (SCAU); 1♀, idem, 27.VII.2002 (SCAU); 1♀, Guangdong, Guangzhou, Liuxihe Forest Park (23°44'31"N 113°47'0"E), 20.VI.2004, leg. Z-f. Xu (SCAU); 1♀, idem, 29.VIII.2004 (SCAU); 1♀, Guangdong, Shaoguan, Yunjishan Provincial Natural Reserve (24°4'37"N 114°10'14"E), 19.VII.2003, leg. Z-f. Xu (SCAU); 1♀, Guangdong, Meizhou, Fengxi (24°31'43"N 116°16'45"E), 30.VII.2003, leg. J-x. Liu & P-c. Li (SCAU); 1♀, Guangdong, Meizhou, Meixian (24°16'2"N 116°4'58"E), 14–29.VII.2006, leg. C-h. Xie & W-x. Xie (SCAU); 1♀, Guangdong, Heishiding Provincial Nature Reserve (23°27'42"N 111°54'33"E), 1–2.X.2003, leg. W-q. Fan (SCAU); 1♀, Hainan, Bawangling National Nature Reserve (19°7'31"N 109°14'6"E), 7–11.VII.2006, leg. J-x. Liu & L-q. Weng (SCAU); 1♀, Hainan, Bawangling National Nature Reserve, 21–21.VI.2007, leg. J-m. Yao (SCAU); 5♀♀, Hainan, Yinggeling National Nature Reserve (19°0'52"N 109°32'47"E), 17–20.VII.2010, leg. H-y. Chen (SCAU). INDONESIA: 1♀, Dutch New Guinea Cyclops Mts. Sabron. 930 ft IV.1936 L.E. Cheesman / B.M. 1936-271 (NMLS). NEPAL: 1♀, West Nepal 13.VI. Myagdi District, Shikha Tatopani (28°28'N 83°40'E) C. Holzschuh (NMLS). PAPUA NEW GUINEA: 1♀, UPNG Waigani Nat. Cap. District 18.III.1916 T. Mala (NMLS); 1♀, Neth. Ind. American-New Guinea Expedition, Mountain slope above Bernhard Camp 100 m, 9.IV.1939 L. J. Toxopeus (NMLS); 1♀, 6 mile Pt. Moresby 9.VII.1967 S. Swanson (NMLS); 1♀, Kokoda 1200 ft IV.1933 L.E. Cheesman / B.M. 1933-42 (NMLS). THAILAND: 1♀, Chiang Dao Hill Reserve 100 km N Chiang Mai, 650 m, 28.V–8.VI.2009 leg. S. Murzin (PRC); 2♀♀, 100 km N Chiang Mai 600 m, 20–31.VII.2008 leg. S. Murzin (PRC).

Diagnosis. *Trichrysis imperiosa* (Smith, 1874) is similar to *T. lusca* (Fabricius, 1804) and it was synonymised with the latter by Kimsey and Bohart (1991). However, it can be easily separated from the latter by: body metallic coppery dorsally on mesosoma; TFC simple, without branches upwards to ocellar area; T2 ending in a raised carina; T3 pre pit row area strongly overhanging over pit row; pit row broad and distinct, with large pits partly fused; S2 black spots small and fused (Fig. 98).

Description. *Female.* Body length 8.4–10.6 mm.

Head. Scapal basin deep and punctate (Fig. 34). TFC distinct, single and mostly straight, with two ends bending downwards. Relative length of P:F1:F2:F3=1.0:2.0:1.0:0.8; F1 l/w=3; OOL=2.0 MOD; BOL=1.2 MOD; POL=1.6 MOD; MS=1.0 MOD; clypeal apex concave medially.

Mesosoma. Pronotal groove deep, almost extending to posterior margin of pronotum (Fig. 33); sublateral carina distinct and complete. Mesoscutellum and metanotum

with anterior depression polished (Fig. 31). Episternal sulcus with foveae transversally elongated; scrobal sulcus with large and irregular areolae (up to 3 PD) (Fig. 32).

Metasoma. T1 and T2 with uniform punctuation; punctures with same diameter of punctures on mesoscutum, equally interspaced (0.5–1.0 PD). T2 with strong median carina; T2 posterior margin raised (Fig. 35). T3 pit row area beneath strongly overhanging pre pit fold; pit row enlarged sunken and broad, with large pits partly fused (Fig. 36). Apex of T3 with five teeth. S2 black spots small, diamond-shaped, fused medially (Fig. 98).

Colouration. Body metallic greenish-blue to blue. Face with golden reflections. Vertex with metallic coppery reflection; violet in ocellar area. Scape, pedicel and F1 bluish-green to green, rest of flagellum black. Pronotum, mesoscutum, mesoscutellum, metanotum medially, mesopleuron over scrobal sulcus, and metapleuron mostly metallic coppery. Pronotal groove dark blue to violet. Tegula metallic greenish-copper. Legs metallic green, with tarsi blackish-brown. T1 and T2 metallic coppery laterally.

Male. Unknown.

Distribution. China (Taiwan, Hunan, Guangdong, Hainan) (Tsuneki 1970); Australia, Myanmar, India, Sri Lanka (Bingham 1903); Vietnam (Kimsey and Bohart 1991); Indonesia, Nepal, Papua New Guinea, Thailand (new records).

Remarks. Kimsey and Bohart (1991) placed this species in the genus *Praestochrysis* Linsenmaier, 1959, because it bears five teeth on apex of T3. However, as already observed by Linsenmaier (1994) and Madl and Rosa (2012), some important morphological and biological characteristics of the species are indeed typical of the genus *Trichrysis* Lichtenstein, 1876. Apex of T3 with five teeth can be considered as an extreme variation of convex interval between median tooth and lateral tooth, which is variable in the genus *Trichrysis*.

Trichrysis lusca (Fabricius, 1804)

Figs 37–42, 99

Chrysis lusca Fabricius, 1804: 171. Holotype, ♀, Italy (accidentally introduced) (ZMU) (examined).

Chrysis lusca Fabricius: du Buysson 1898a: 536; du Buysson 1899: 168.

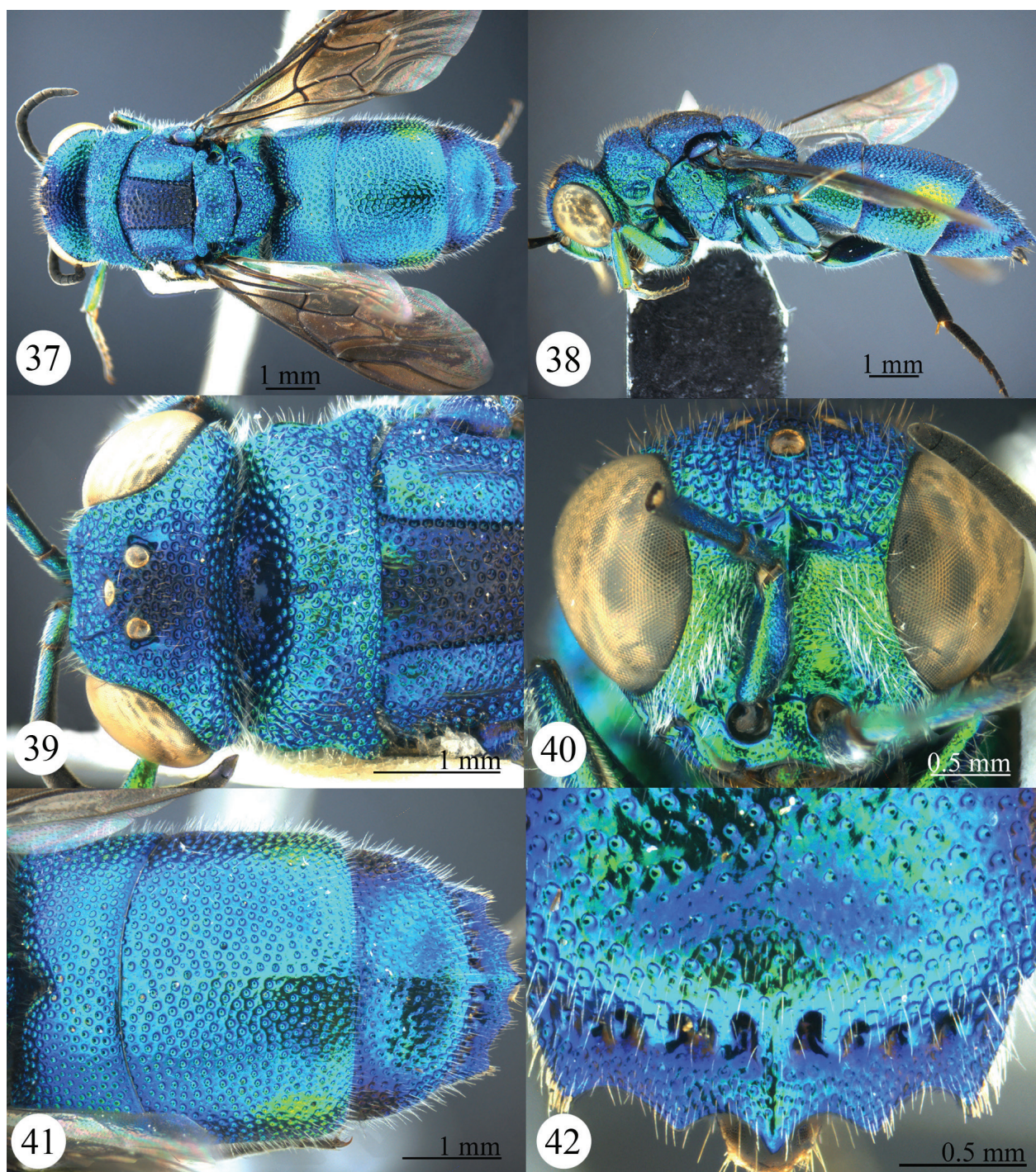
Chrysis (Pentachrysis) dolichoceras Bischoff, 1910: 485. Holotype, ♀, Japan (MNHU) (synonymised by Kimsey and Bohart 1991: 533).

Chrysis (Pentachrysis) lusca Fabricius: Bischoff 1910: 486; Mocsáry 1913a: 11; 1913b: 619; Uchida 1927: 152; Tsuneki 1953b: 28; 1955: 35; 1970: 17.

Chrysis extraniensis Rohwer, 1921: 68. Holotype, ♀, USA: Hawaii (USNM) (synonymised by Kimsey and Bohart 1991: 533).

Chrysis occulta Mader, 1939: 93. Holotype, ♀, Italy (accidentally introduced) (NHMW) (synonymised by Linsenmaier 1959).

Pentachrysis lusca (Fabricius): Hammer 1950: 2.



Figures 37–42. *Trichrysis lusca* (Fabricius), China: Guangdong (female). **37.** Habitus, dorsal view; **38.** Habitus, lateral view; **39.** Head, pronotum, dorsal view; **40.** Head, frontal view; **41.** Metasoma, dorsal view; **42.** Apex of T3, dorsal view.

Praestochrysis lusca (Fabricius): Kimsey and Bohart 1991: 533; Kurzenko and Lelej 2007: 1006; Ha et al. 2008: 73. *Chrysis* (*Trichrysis*) *lusca* Fabricius: Linsenmaier 1994: 193. *Trichrysis lusca* (Fabricius): Rosa et al. 2014: 76.

Material examined. ITALY: Schlanbusch (?)/ holotype / ♀/ Mus: T: Lund *Chrysis lusca* Fabr. [label in error after re-writing (Zimsen 1964)] / type <red label> (ZMU). JAPAN: 1♀, Nangasaki / *Pentachrysis dolichoceras*

Bischoff (MNHU). CHINA: 1♀, Kosempo Formosa [= Taiwan] 1911 H. Sauter (MNHU); 2♀♀, Taiwan Chipon VIII.1935 K. Iwata / det. Enslin (NMLS); 1♀, Taiwan Sozan VIII.1935 K. Iwata / det. Linsenmaier (NMLS); 1♂, Formosa Pingtung Hsien, Ssuehungchi, 5.VIII.1968 S. Suzuki (PRC); 1♂, Formosa, Taipei Hsien, Wulai 19.VII.1968 S. Suzuki (PRC); 74♀♀, Guangdong, Guangzhou, Liuxihe Forest Park (23°44'31"N, 113°47'0"E), 13–14.IV.2002, leg. Z.-f. Xu (SCAU); 7♀♀, idem,

20.VI.2002 (SCAU); 4♀♀, idem, 29.VIII.2004 (SCAU); 11♀♀, idem, 1–4.VI.2007 (SCAU); 16♀♀, idem, 12.VI.2008 (SCAU); 81♀♀, Guangdong, Guangzhou, Wangzishan Forest Park (23°34'49"N, 113°13'21"E), 20.V.2006, leg. Z.-f. Xu & J.-j. Chen (SCAU); 1♀, Guangdong, Guangzhou, campus of SCAU (23°9'31"N, 113°20'41"E), 5.VII.2007, leg. C.-j. Zeng (SCAU); 1♀, idem, 8.IV.2009 (SCAU); 8♀♀, Guangdong, Nanling National Nature Reserve (24°55'43"N, 113°1'1"E), 16–18.IV.2004, leg. Z.-f. Xu (SCAU); 3♀♀, Guangdong, Meizhou, Meixian (24°16'2"N, 116°4'58"E), 14–29.VII.2006, leg. C.-h. Xie & W.-y. Xie (SCAU); 1♀, Guangdong, Heishiding Provincial Nature Reserve (23°27'42"N, 111°54'433"E), 4.VI.2007, leg. Z.-f. Xu (SCAU); 1♀, Kouy Tchéou [= Guizhou] 1921 Cavalair (NMLS); 1♀, Yunnan, Hekou, Nanxi (22°37'31"N 103°56'53"E), 16.V. 2006, leg. Z.-f. Xu; 1♂, Yunnan, Jingdong, Wenjing (24°18'9"N 100°55'53"E), 29.IV.2005, leg. H.-s. Wang (SCAU). BANGLADESH: Dacca, Bhawal National Park 27.V.1983 Melon (PRC). CAMBODIA: 1♀, Pailin 200 m, 11–15.V.2009 leg.. S. Murzin (PRC). INDONESIA: 1♀, Borneo, Balikpapan 1947/48 W.A. Mohler (NMLS); 1♀, Java Bandoeng [= Bandung] 760 m XI.1936 E. Jacobson (NMLS); 1♀, Bandoeng [= Bandung] 750 m XI.1937 E. Jacobson / ex clay nest of wasp (!) (NMLS); 1♀, Java Bandoeng [= Bandung] 750 m 12.IX.1937 F.C. Drescher (NMLS); 1♀, Java Buitenzorg [= Bogor] 11.X.1929 van der Vecht (NMLS); 1♀, Java Buitenzorg [= Bogor] 10.X.1932 R.A. Muller (NMLS); 1♀, West Java Djampang Tengah 1934 M.E. Walsh (NMLS); 1♀, Java, Soekaboemi [= Sukabumi] 14.3.1938 M.E. Walsh (NMLS); 1♀, West Java, Soekane-gara 400–1000 m II.1940 (NMLS); 1♀, Sumatra, Siantar XI.1954 Otto-Surbeck (NMLS); 2♀♀, Siantar I–III.1960 Otto-Surbeck (NMLS); 1♀, Siantar Dolok Ulu I.1960 Otto-Surbeck (NMLS); the following specimens were collected at Sumatra, Medan by E. Diehl (NMLS): 3♀♀, 9–20.IV.1967; 2♀♀, 2–12.V.1967; 1♀, 9.X.1967; 3♀♀, 8.VI–15.VII.1969; 6♀♀, 1–20.III.1970; 1♀, 28.I.1971; 1♀, 28.I.1973; 2♀♀, 7–18.V.1973; 1♀, 22.VI.1973; 2♀♀, 3.X.1991; 1♀, 15.III.1992; 1♀, 6.IV.1992; 1♀, 21.VII.1994; the following specimens were collected at Sumatra, Medan, Dolok Merangir by E. Diehl (NMLS): 12♀♀, 4.III–30.V.1967; 1♀, 2.II.1968; 1♀, 20.I.1969; 1♀, 30.VII.1969; 1♀, 5.II.1970; 1♀, IX.1971. MALAYSIA: 1♀, Malacca Selangor (PRC); 1♀, Sarawak Kuching IX.1961 C.R. Wallace (NMLS); 1♀, Kuala Lumpur 8.I.1931 H.M. Pendlebury (NMLS); 1♀, Kuala Lumpur VII.1938 H.M. Pendlebury (NMLS); 1♀, Kuala Lumpur 4.IV.1928 H.T. Pagden (NMLS); 1♀, Kuala Lumpur 4.VIII.1936 H.M. Pagden. SRI LANKA: 1♀, Ceylon, Beuil Oya 20.II.1954 (NMLS); 1♀, Kalutara 1910 E. Comber (NMLS). VIETNAM: 4♀♀, Tonkin, Hoa Binh Province 1926–1928 A. de Cooman (NMLS); 4♀♀, Tonkin Hoa Binh XII.1934 A. de Cooman (NMLS); 1♂, Central Tonkin 1911 A. Krempf (NMLS).

Diagnosis. *Trichrysis lusca* (Fabricius, 1804) resembles *T. imperiosa* (Smith, 1874), but it can be easily sep-

arated from the latter by: body uniformly blue to green, with golden lateral spot on T2; TFC with branches upwards to ocellar area; T2 without apical raised carina; prepit bulge slightly convex, not strongly overhanging over pit row; pit row with single, small and separated pits; S2 with black spots large and partly separated.

Description. *Female.* Body length 6.4–10.6 mm.

Head. Scapal basin deep, rugose and punctate (Fig. 40). TFC single, forming slightly inverted V-shape, with two branches upwards to ocellar area. Relative length of P:F1:F2:F3=1.0:1.9:0.9:0.6; F1 l/w=3.7; OOL=1.7 MOD; BOL=1.5 MOD; POL=1.7 MOD; MS=1.0 MOD; clypeal apex concave medially.

Mesosoma. Pronotal groove deep, almost extending to posterior margin of pronotum (Fig. 39); sublateral carina distinct and complete. Mesoscutellum and metanotum with anterior depression polished and not distinctly depressed. Metanotum with large contiguous punctures. Episternal sulcus and scrobal sulcus with transversal foveae up to 2 PD (Fig. 38).

Metasoma. T1 and T2 with large punctures equally interspaced (0.5–1.0 PD) (Fig. 41). T2 with median carina. T3 prepit bulge slightly convex; pit row distinct, with small, deep pits clearly separated. Apex of T3 with five teeth (Fig. 42). S2 black spots fused medially or partially to fully separated by narrow metallic line (Fig. 99).

Colouration. Head metallic bluish-green, with green-golden reflection on face and dark blue spot on vertex. Scape, pedicel and F1 metallic bluish-green, rest of flagellum black. Mesosoma metallic bluish-green to green, with mesoscutum medially dark blue to purple, distinctly darker than lateral lobes. Metasoma bluish-green to blue, with golden spots on T2 postero-laterally. Tegula metallic blue. Legs metallic bluish-green, with tarsi black.

Male. Body length 8.3–9.8 mm. Male differs from female as follows: body green, with dark blue in ocellar area, on mesoscutum and on T3 antero-laterally and apically; F2 partially metallic; T3 median tooth and lateral tooth short and blunted.

Distribution. China (Hubei, Hunan, Taiwan, Fujian, Guangdong, Macao, Hainan, Guizhou, Yunnan) (Tsuneki 1953a); Australia, India, Japan, Korea, Madagascar, Myanmar, Philippines, Thailand (Kimsey and Bohart 1991); Bangladesh, Cambodia, Indonesia, Malaysia, Sri Lanka, Vietnam (new records). Afrotropical: Mauritius and Réunion (Azevedo et al. 2010).

Remarks. Similarly to *Trichrysis imperiosa*, this species was included in the genus *Praestochrysis* by Kimsey and Bohart (1991). Species in the genus *Praestochrysis* are parasites of moths in the family Limacodidae (de Joannis 1896; du Buysson 1898b, 1901; Piel 1933; Parker 1936; Edney 1954; Iwata 1963; Yamada 1980, 1990; Polazek 1987; Kimsey and Bohart 1991; Strumia 1996; Komeda and Hisamatsu 2005). However *T. lusca* is known to be parasitoid of Sphecidae, as *Sceliphron fabricator* Smith (Mocsáry 1889, 1912; Linsenmaier 1959), *S. inflexus* Sickmann (Tsuneki 1955) and unidentified Eu-

menids (Kimsey and Bohart 1991). We collected *T. lusca* on mud walls of old houses where sphecids and eumenid wasps built nests. For this trophic differentiation and morphological characteristics, such as developed pronotal carina, we agree with the interpretation given by Linsenmaier (1994) and Madl and Rosa (2012) and include *lusca* and related species in the genus *Trichrysis*, as well as the Afrotropical species included in the *inops* group. We consider as *Praestochrysis* only the species parasitoid of Limacodid moths, independently from number of apical teeth on T3.

Trichrysis luzonica (Mocsáry, 1889)

Figs 43–48, 100

Chrysis (*Trichrysis*) *luzonica* Mocsáry, 1889: 328. Holotype, ♀, Philippines: Luzon (ISEA-PAN) (examined).

Chrysis (*Trichrysis*) *bakeri* Mocsáry, 1913c: 290. Holotype, ♂, Philippines: Luzon (HNHM) (examined) (synonymised by Kimsey and Bohart 1991: 572).

Trichrysis luzonica (Mocsáry): Bohart 1987: 348; Kimsey and Bohart 1991: 572; Rosa et al. 2014: 76.

Material examined. PHILIPPINES: ♀, Lucon / 275 / *lusonica* Moc <handwritten by Radoszkowski> / Holotypus *Chrysis luzonica* Mocsáry det. P. Rosa 2012

(ISEA-PAN); ♂, Los Baños Baker / *Trichrysis bakeri* Mocs det. Mocsáry typ. <handwritten in red> / Holotypus *Chrysis bakeri* Mocs. ♂ RM. Bohart / id nr. 135553 HNHM Hym. coll. (HNHM); 3♀♀1♂, Ins. Philipp. / Mt. Makiling Luzon Baker (HNHM).

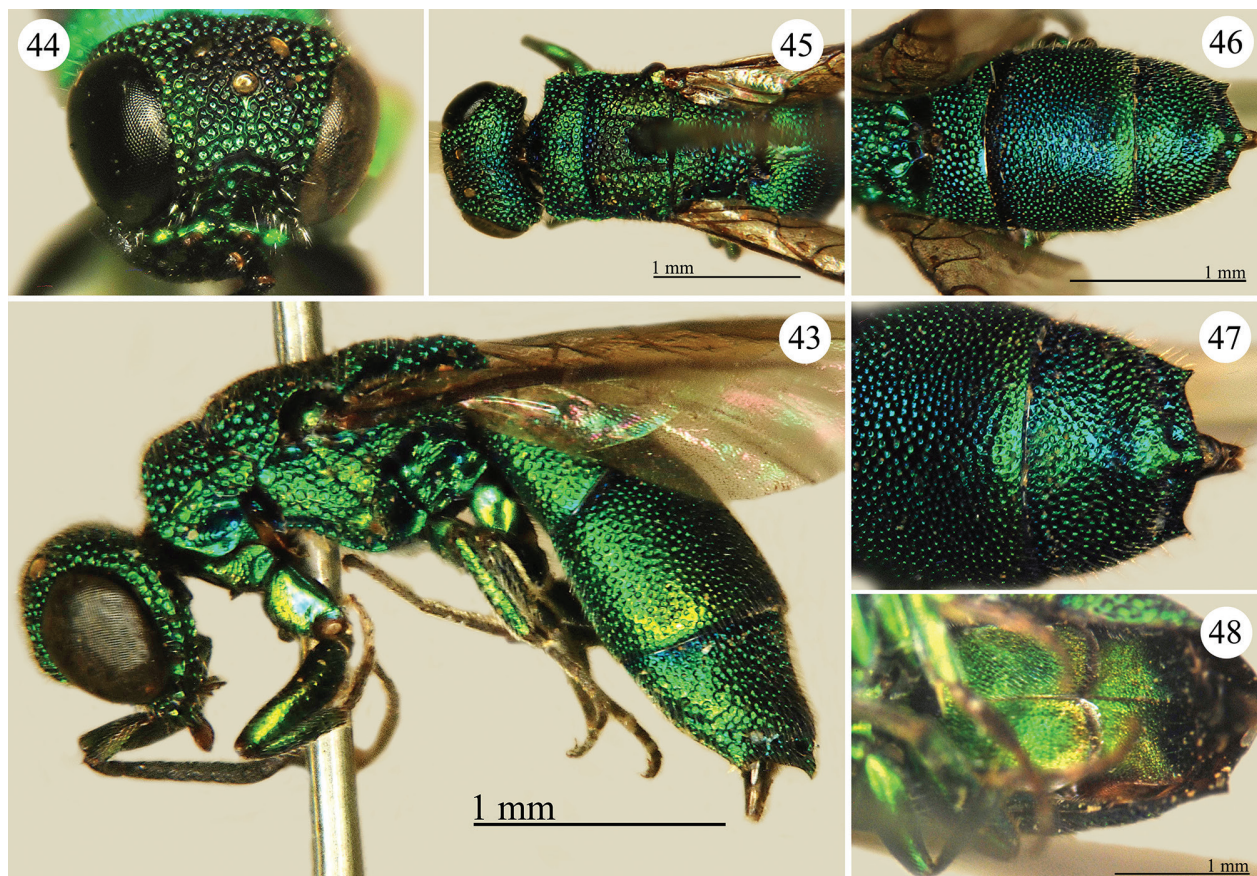
Diagnosis. *Trichrysis luzonica* (Mocsáry, 1889) is similar to *T. formosana* (Mocsáry, 1912), but can be separated from the latter by: median bridge of pit row straight, at most slightly depressed, subdividing pit row; TFC with weak branches.

Description. *Female.* Body length 4.5–5.0 mm (Fig. 43).

Head. Scapal basin deep, striate medially. TFC single, slightly inverted V-shaped, with two weak dorsal branches upwards to ocellar area (Fig. 44). Relative length of P:F1:F2:F3=1.0:1.4:0.7:0.6; F1 l/w=2.5; OOL=1.5 MOD; BOL=2.0 MOD; POL=2.0 MOD; MS=0.8 MOD; clypeal apex slightly incised.

Mesosoma. Pronotal groove deep, extending to 3/4 length of pronotum; sublateral carina distinct and complete (Fig. 45). Episternal sulcus and scrobal sulcus with large foveae.

Metasoma. Dense punctuation on T1 and T2, with large geminate punctures. T2 with weak median carina. T3 prepit bulge slightly convex medially (Fig. 46). Pit row with relatively small pits equally interspaced (Fig. 47); in lateral view, median bridge of pit row straight to slightly depressed, dividing pit row in two parts. Apex



Figures 43–48. *Trichrysis luzonica* (Mocsáry), Philippines: Los Baños (female). 43. Habitus, lateral view; 44. Head, frontal view; 45. Head and mesosoma, dorsal view; 46. Metasoma, dorsal view; 47. T2 and T3, dorsal view 48. Metasoma, ventral view.

of T3 with three teeth, lateral tooth sharper than median tooth (Fig. 47). Interval between median tooth and lateral tooth straight. S2 black spots suboval, fused medially (Fig. 100).

Colouration. Head and mesosoma metallic bluish-green to green, with golden reflections. Scape, pedicel and F1 metallic bluish-green to green, rest of flagellum black. Tegula fully metallic green. Legs metallic bluish-green, with tarsi brown. Metasoma metallic bluish-green to green, with anterior margins of T2 and T3 dark blue and posterior margin of T2 lighter green to golden-green.

Male. Body length 4.5–5.0 mm. Male differs from female as follows: body mostly darker coloured; vertex, pronotum, mesoscutum, T2 and T3 dark metallic bluish to black; teeth on apex of T3 shorter compared to female.

Distribution. China (Taiwan?, Hong Kong?) (Tsuneki 1970; Kimsey and Bohart 1991); Philippines (Mocsáry 1889).

Remarks. This species was reported for China (Hong Kong and Taiwan) by Kimsey and Bohart (1991). Nevertheless, their interpretation was confused with *T. formosana* (Mocsáry), based on shape of T3 (Bohart 1987). Mocsáry's (1889) original description of T3 as follow: “*tertio [segmento] convexo, supra seriem calloso, foveolis paucis, 6 tantum, magnis ac profundis rotundisque per carinulam medianam in spinam brevem acutam triangularem productam interruptis [...]*” (third tergite convex, bulged on pre pit row, with six large, deep and round pits, medially interrupted by median carina extended to short, acute and triangular spine [= median tooth]). Therefore, no available records are currently known from China. However, it is possible that this species could be misidentified in collections and we here list and key it together with other Chinese species.

Trichrysis pellucida (du Buysson, 1887)

Figs 49–54, 101

Chrysis pellucida du Buysson, 1887: 183. Syntypes, ♂♂♀, China, Turkey (MNHN).

Chrysis (Trichrysis) buyssoni Mocsáry, 1889: 323. Replacement name for *Chrysis pellucida* du Buysson 1887 nec *Brugmoia pellucida* Radoszkowski, 1877.

Chrysis pellucida du Buysson: du Buysson 1898a: 525; du Buysson 1899: 164; du Buysson 1900: 144.

Chrysis (Trichrysis) pellucida du Buysson: Bischoff 1913: 46; Tsuneki 1953b: 25; Linsenmaier 1959: 169.

Chrysis (Trichrysis) mongolica Mocsáry, 1914: 24. Lectotype, ♀, designated by Bohart in Kimsey and Bohart 1991: 571; Mongolia (HNHM) (examined) (synonymised by Kimsey and Bohart 1991: 571).

Chrysis (Monochrysis) coreana Uchida, 1927: 153. Syn-type, ♀, Korea: Suigen (EIHU) (synonymised by Tsuneki 1947: 47).

Chrysis (Trichrysis) neptunia Semenov, 1967: 162. Holotype, ♀, Korea: Pal'Makh (ZIN) (examined) (synonymised by Kimsey and Bohart 1991: 571).

Trichrysis buyssoni (Mocsáry): Kimsey and Bohart 1991: 571; Ha et al. 2008: 73.

Trichrysis coreana (Uchida); Kimsey and Bohart 1991: 571; Ha et al. 2008: 73.

Trichrysis pellucida (du Buysson): Rosa et al. 2014: 77.

Material examined. CHINA: Lectotype ♀ (here designated): Chine <deposited in the Abeille de Perrin collection> / Lectotypus *Chrysis pellucida* Buyss. ♀ P. Rosa vidit 2016 (MNHN); KOREA: [Kor: Pal'Makh 19.VI.900], sp. n. pr. *Pellucidam* Buyss., ♀ *neptunia* A. Semenov-Tian-Shansky det. XI.09 / holotypus (ZIN); 12♀♀, Keikido Shoyozan 2.VII.1943 K. Tsuneki (NMLS). MONGOLIA: Mongolia / *mongolica* Mocs. det. Mocsáry typ. <handwritten in red> / red label / *Chrysis* L. *pellucida* Buyss. Linsenmaier det. 59 / Lectotypus *Chrysis mongolica* Mocs. ♀ RM Bohart / id nr. 135554 HNHN Hym. Coll. (HNHN). CHINA: 1♀, Liaoning, Shenyang Froest Park (42°01'64"N, 123°43'38"E), 15.VII.2011, leg. C-j. Yan et al. (SCAU); 1♀, Liaoning, Laotuziding Nature Reserve (41°19'7"N, 124°52'27"E), 18.VII.2011, leg. K-x. Zhao (SCAU); 1♀, Hunan, Ningxiang, Huangcai woodland, VII.1981 (SCAU).

Diagnosis. *Trichrysis pellucida* (du Buysson, 1887) is similar to *T. yuani* sp. n. for habitus, but it can be easily separated from the latter by: body length 9.0–10.0 mm; body dark blue to violet, or occasionally dark green with bluish areas; apex of T3 with sharp median tooth (Fig. 54); F1 l/w = 3.5.

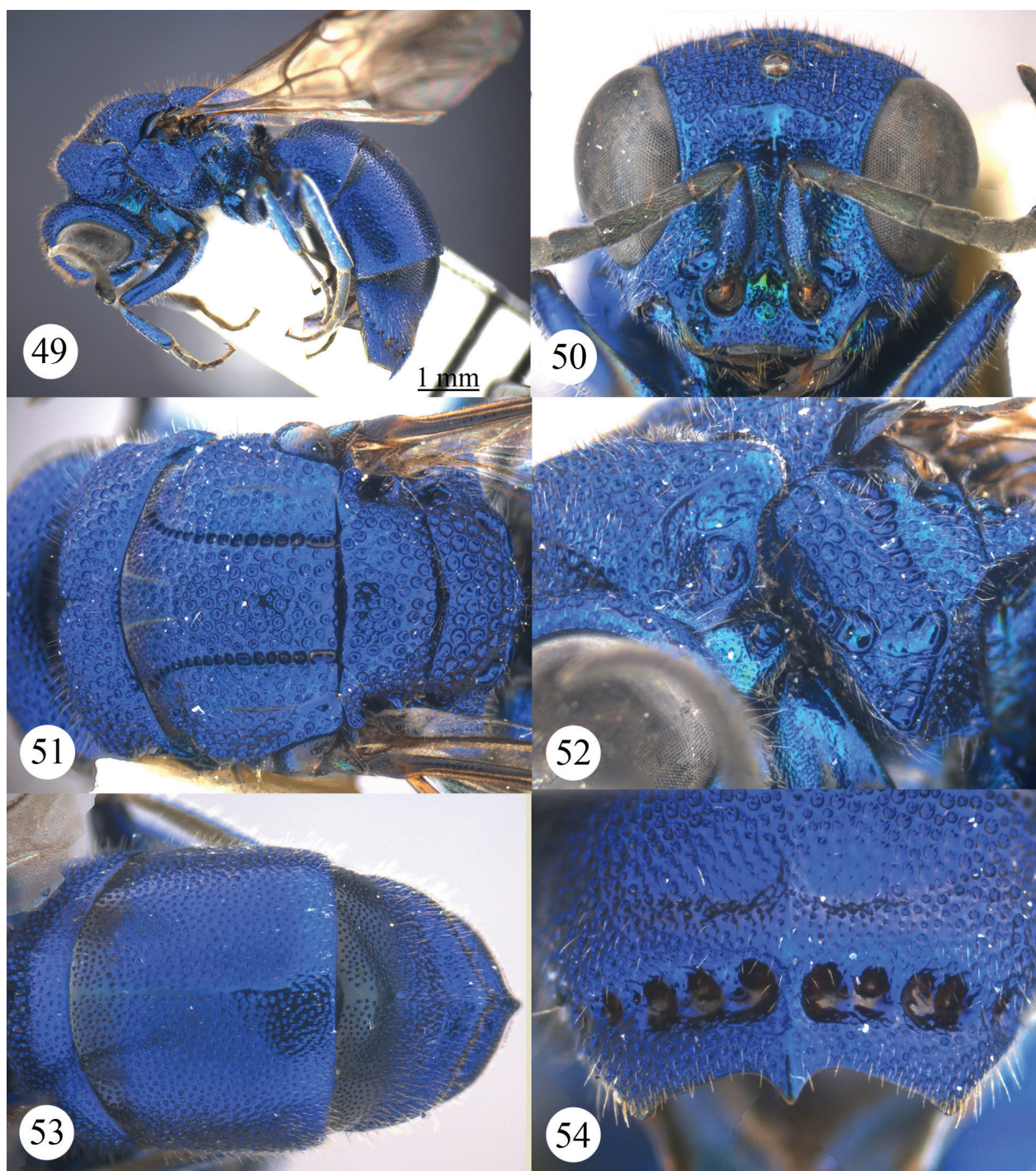
Description. *Female.* Body length 9.0–10.0 mm.

Head. Scapal basin deep and punctate (Fig. 50). TFC single, slightly inverted V-shaped. Relative length of P:F 1:F2:F3=1.0:1.7–1.8:1.0:0.6–0.7; F1 l/w=3.5; OOL=2.0–2.4 MOD; BOL=1.5 MOD; POL=1.9–2.0 MOD; MS=1.2 MOD; clypeal apex almost truncate.

Mesosoma. Pronotal groove deep, extending to 3/4 length of pronotum; sublateral carina distinct and complete (Fig. 51). Punctuation on mesosoma dense, with consistent punctures relatively deep and small (about 0.5 MOD), subequally interspaced; interspaces punctate. Deep episternal sulcus with large foveate punctures; scrobal sulcus with large transversal areolate punctures (Fig. 52). Hind basitarsus l/w = 5.

Metasoma. Punctures on T1 and T2 geminate, smaller than punctures on mesosoma (Fig. 53); interspaces punctate. T2 and T3 with median carinae. T3 with coarse punctuation and strigate sculpture on depression before pre pit row; T3 prepit bulge markedly convex; pit row with round pits, remarkably large and deep, not fused; post pit row area deep and elongated (Fig. 49). Apex of T3 with one sharp median tooth and two blunt lateral teeth; interval between median tooth and lateral tooth usually straight (Fig. 54). S2 black spots medially fused (Fig. 101).

Colouration. Body dark blue to violet; rarely dark green with blackish areas. Scape blue to violet, pedicel and flagellum black. Tegula blackish-brown, with metallic reflections partly. Legs metallic bluish-green, with



Figures 49–54. *Trichrysis pellucida* (du Buysson), China: Liaoning (female). **49.** Habitus, lateral view; **50.** Head, frontal view; **51.** Mesosoma, dorsal view; **52.** Pronotum and mesopleuron, lateral view; **53.** Metasoma, dorsal view; **54.** Apex of T3, dorsal view.

tarsi blackish-brown, without metallic reflections, or with occasionally weak reflections. Sternites greenish-blue.

Male. Not available for this study.

Distribution. China (Liaoning, Inner Mongolia, Hebei, Beijing, Hunan); Middle East to China and Russian Far East (Kimsey and Bohart 1991; Kurzenko and Lelej 2007).

Remarks. The description of *Chrysis pellucida* du Buysson was based on one female collected in China and two males collected in Turkey, all originated from

the Abeille de Perrin collection. At MNHN, one Turkish male is deposited in the general collection (ex du Buysson collection); the other Turkish male and the Chinese female are deposited in the Abeille de Perrin collection. We here select the female specimen labelled as “Chine” as the lectotype. It matches the current interpretation of the species and it is in perfect condition.

Chrysis (Trichrysis) buyssoni Mocsáry, 1889 is a replacement name for *Chrysis pellucida* du Buysson, 1887

nec *Brugmoia pellucida* Radoszkowski, 1877. Mocsáry (1889) included the two species in the genus *Chrysis*: subgenera *Trichrysis* Lichtenstein and *Euchroeus* Latreille (1809). However, *Chrysis pellucida* du Buysson and *Brugmoia pellucida* Radoszkowski are not congeneric, and after Mocsáry (1889) nobody else considered *Euchroeus* (or *Brugmoia*) as a synonym or a subgenus of *Chrysis*. According to the Code (ICZN 1999: Art. 59), we use the original name *T. pellucida* (du Buysson), following the interpretation given by Linsenmaier (1959).

T. coreana Uchida, 1927 was considered as a valid taxon by Kimsey and Bohart (1991). However, we follow Tsuneki's (1953b) interpretation of this taxon. Tsuneki (1947) examined Uchida's collection and placed *T. coreana* in synonymy with *T. pellucida*. This synonymy is also confirmed by the original description and drawing given by Uchida (1927).

Trichrysis secernenda (Mocsáry, 1912)

Figs 55–60, 102

Chrysis (*Trichrysis*) *secernenda* Mocsáry, 1912: 376. Lectotype, ♂, designated by Bohart in Bohart and French 1986: 342). Uzbekistan: Gouldsha (type series: China: Xinjiang, paralectotypes) (HNHM) (examined).

Trichrysis secernenda (Mocsáry): Kimsey and Bohart 1991: 573; Rosa et al. 2014: 78.

Material examined. UZBEKISTAN: ♀, Gouldsha Ferghana 1905 Korb / *secernenda* Mocs. det. Mocsáry typ. <handwritten in red> / red label / Lectotypus *Chrysis secernenda* ♂ Mocs. RM Bohart / id nr. 135539 HNHM Hym. coll.. CHINA: 1♂, Ningxia, Liupanshan Forest Park (34°22'N 106°18'E), 21.VI–14.VII.2008, leg. J-m. Yao (SCAU). AFGHANISTAN: 1♀, Kabul 23.VII.1970 Y. Arita (PRC).

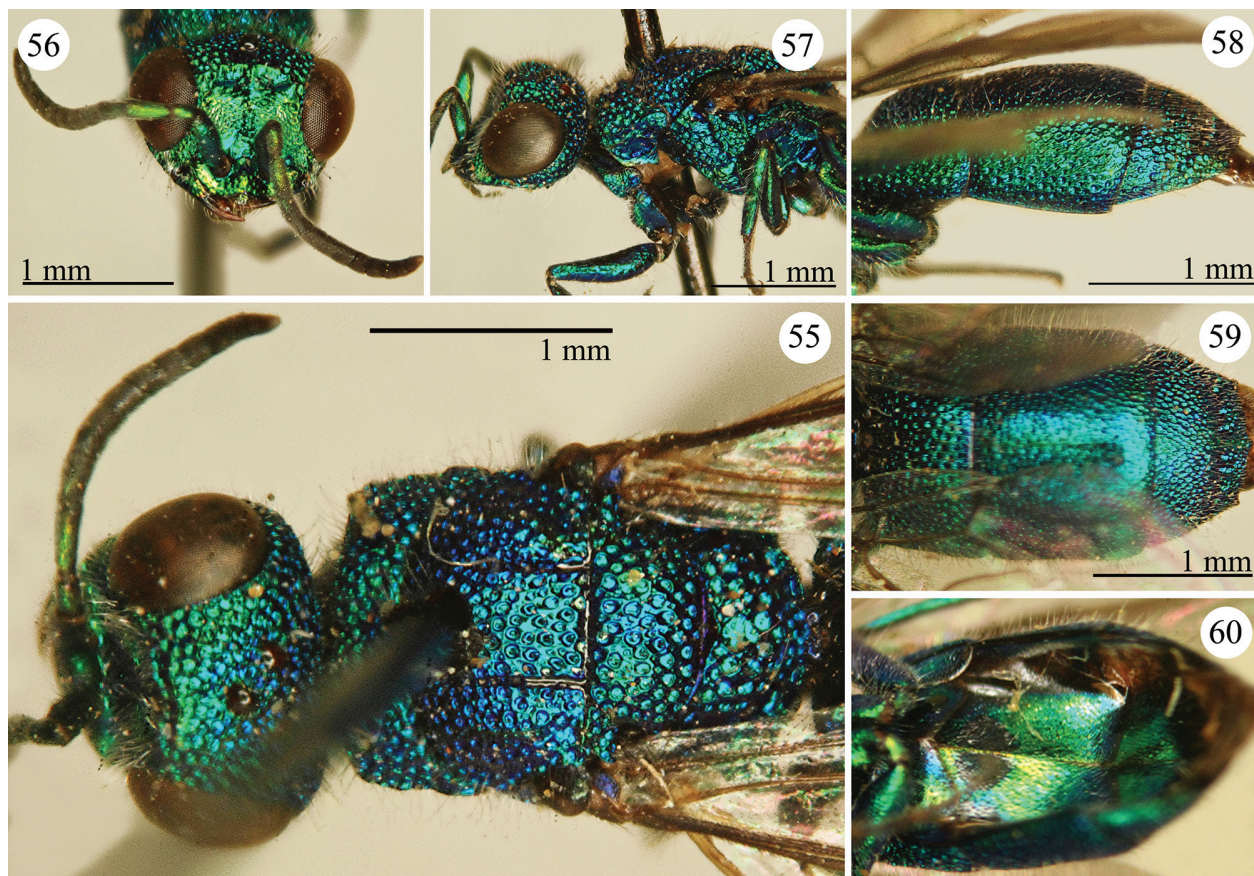
Diagnosis. *Trichrysis secernenda* (Mocsáry, 1912) is similar to *T. cyanea* (Linnaeus, 1758) for habitus, geminate punctures on metasoma and tegula brown; but it can be separated from the latter by: black spots on S2 distinctly large and separated by narrow metallic line (Fig. 102); female F1 fully metallic and F2 partially metallic.

Description. *Female.* Body length 5.6 mm.

Head. Scapal basin deep, wrinkled and punctate (Fig. 56). TFC single, straight or slightly inverted V-shape. Relative length of P:F1:F2:F3=1.0:2.6:1.4:0.9; F1 l/w=3.5; OOL=1.8 MOD; BOL=1.4 MOD [data taken from pictures]; MS=1.1 MOD; clypeal apex concave.

Mesosoma. Pronotal groove deep; sublateral carina weak and incomplete. Metanotum with large antero-median depression (Fig. 55). Episternal sulcus and scrobal sulcus with irregular large foveate punctures (Fig. 57).

Metasoma. Punctuation geminate, on T1 with large punctures; on T2 with smaller punctures and interspaces large and smooth (about 1 PD). T2 without median cari-



Figures 55–60. *Trichrysis secernenda* (Mocsáry), holotype (female). 55. Head and mesosoma, dorsal view; 56. Head, frontal view; 57. Head and mesosoma, lateral view; 58. Metasoma, lateral view; 59. Metasoma, dorsal view; 60. Metasoma, ventral view.

na. T3 without prepit bulge; pit row with small and isolated pits. Apex of T3 with three short teeth, and straight interval between median tooth and lateral tooth. S2 black spots large and elongated, separated by narrow metallic line medially (Fig. 60).

Colouration. Body green to bluish-green. Scape, pedicel, F1 and F2 basally metallic green, rest of flagellum black. Tegula brown, with few metallic hints. Legs metallic bluish-green, with tarsi brown.

Male. Differs from female as follows: F1 fully metallic, F2 black; antennal segments shorter, P:F1:F2:F3=1.0:1.5:0.7:0.6; F1 l/w=2.3; BOL=1.7 MOD; OOL=2.0 MOD; MS=1.0 MOD.

Distribution. China (Xinjiang, Ningxia), Uzbekistan; Afghanistan (new record).

Trichrysis tonkinensis (Mocsáry, 1914), status revived

Figs 61–66, 103

Chrysis (*Trichrysis*) *tonkinensis* Mocsáry, 1914: 25. Holotype, ♀ [not ♂], Vietnam: Tonkin (HNHM) (examined).

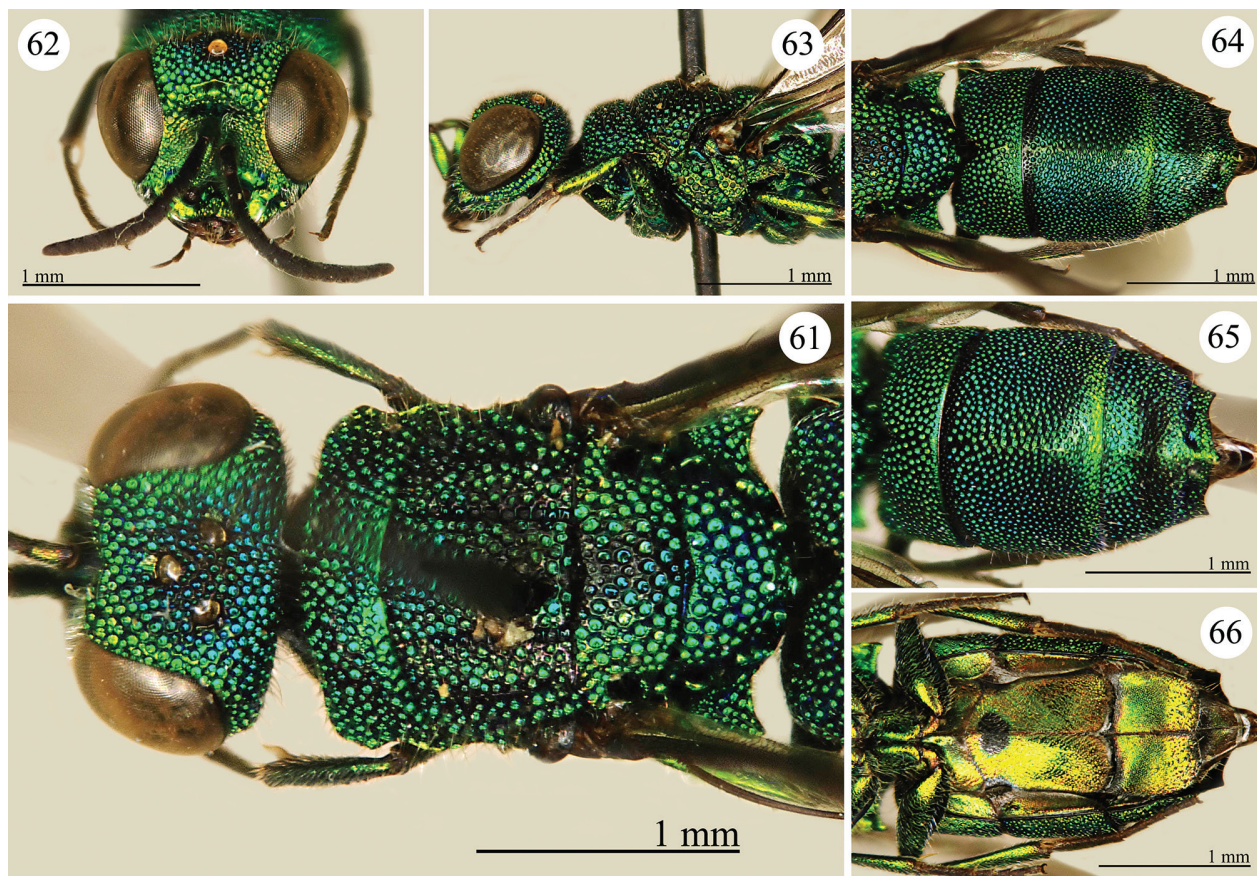
Chrysis (*Trichrysis*) *tonkinensis* var. *cyanescens* Mocsáry, 1914: 26. Holotype, ♀, China: Poo Chow [= Fuzhou] (BMNH).

Chrysis (*Trichrysis*) *tonkinensis* Mocsáry: Linsenmaier 1959: 169.

Chrysis (*Trichrysis*) *rossi* Linsenmaier, 1984: 207. Holotype, ♀, Philippines (not Chile!) (NMLS) (examined).

Material examined. VIETNAM: ♀, Tonkin China / *tonkinensis* Mocs. det. Mocsáry typ. <handwritten in red> / red label / Holotypus *Chrysis tonkinensis* Mocs. ♀ RM Bohart / id. nr. 135549 HNHM Hym.coll. (HNHM). PHILIPPINES: ♀, San José Mindoro P.I. II.45 F.E. Skinner / *Chrysis* (*Trichrysis*) *rossi* Lins. det. Linsenmaier 1973 (NMLS). CHINA: 2♀♀, Yunnan, Jingdong, Jinping (24°27'14"N 100°50'4"E), 28.IV.2005, leg. H-s. Wang (SCAU); 1♀, Yunnan, Jingdong, 10–14.VII.1990, S. Bečvár (PRC). INDIA: 1♀, Nedungadu X.1932 P.S. Nathan (NMLS). INDONESIA: 60♀♀, from various localities and collectors housed in NMLS: Java: Bandung, Blawan, Bogor, Jampang Tengah; Lebak, Medan, Dolok Merangir, Semarang, Sukabumi. MALAYSIA: 2♀♀, Sabah, Tuaran 24–30. III.1973 K.M. Guichard (NMLS); 1♀, Sabah, Poring Springs 1600 ft 10.V.1973 K.M. Guichard (NMLS); 1♀, Kota Kinabalu 20.III.1992 Inderbitzin (NMLS).

Diagnosis. *Trichrysis tonkinensis* (Mocsáry, 1914) is similar to *T. cyanea* (Linnaeus, 1758); however it can be separated from the latter by: sharp lateral tooth of T3; dense punctuation on metasoma; body usually metallic green or light greenish-blue, with some characteristic olive green to blackish mat areas on mesosoma and metasoma; different shape of S2 black spots (Fig. 103).



Figures 61–66. *Trichrysis tonkinensis* (Mocsáry), holotype (female). 61. Head and mesosoma, dorsal view; 62. Head, frontal view; 63. Head and mesosoma, lateral view; 64. Metasoma, dorsal view; 65. T2 and T3, dorsal view; 66. Metasoma, ventral view.

Description. *Female.* Body length 6.0–7.0 mm.

Head. Scapal basin deep, punctate laterally and striate medially (Fig. 62). TFC single, short, slightly inverted V-shape. Area between TFC and scapal basin slightly raised. Relative length of P:F1:F2:F3=1.0:1.6:0.7:0.6; F1 l/w=2.9; OOL=2.0 MOD; BOL=1.7 MOD; POL=1.8 MOD; MS=1.0 MOD; clypeal apex slightly concave.

Mesosoma. Pronotal groove deep, extending to 3/4 length of pronotum; lateral margins of pronotum concave medially; sublateral carina distinct and complete (Fig. 61). Metanotum depressed antero-medially. Punctuation contiguous on metanotum. Episternal sulcus and scrobal sulcus with large areolate punctures (Fig. 63).

Metasoma. Punctures on T1 and T2 geminate, with punctate interspaces (Fig. 64); punctuation decreasing in diameter toward posterior margin on T2. T2 and T3 with weak median carinae. T3 prepit bulge medially convex; pit row with small and round separated pits. Apex of T3 with three teeth similar in size, with interval between median tooth and lateral tooth straight or occasionally slightly convex (Fig. 65). S2 black spots small (Figs 66, 103), medially fused.

Colouration. Body metallic bluish-green to green, with golden reflection on face and sternites. Scape and pedicel metallic green, flagellum black. Tegula brown, with weak metallic reflections. Legs metallic green, with tarsi black.

Male. Unknown.

Biology. One specimen in NMLS labelled as collected from nest of *Pison obliteratum* Smith, 1858 (Crabronidae) by J. van der Vecht.

Distribution. China (Fujian, Yunnan); Vietnam (Mocsáry 1914); Philippines (Linsenmaier 1984); India, Indonesia, Malaysia (new records).

Remarks. Tsuneki (1961: 374) gave the description and line drawings of *C. (Trichrysis) tonkinensis* based on one specimen collected in Thailand (Doi Inthanon), without checking its type. The drawings do not match the type. The characteristics given by Tsuneki (1961) more closely resemble *T. luzonica* (Mocsáry) or *T. triacantha* (Mocsáry). Therefore the synonym proposed by Tsuneki, *T. bicarinata* (Tsuneki) = *T. tonkinensis* is incorrect.

Linsenmaier (1984) described *Chrysis (Trichrysis) rossi* based on a specimen collected at San José, Mindoro P.I. [Philippine Islands]. Linsenmaier (1984) erroneously considered locality San José as a Chilean locality. Later Kimsey and Bohart (1991) recognized right locality, and placed *T. rossi* and *T. tonkinensis* in synonymy with *T. triacantha* (Mocsáry) without type examination of the latter. *T. tonkinensis* and *T. triacantha* are similar, but can be separated by different colouration, with a characteristic olive green or bluish matt colouration dorsally on *T. tonkinensis* and non metallic tegula (fully metallic in *T. triacantha*); TFC simple, without branches (double and usually with branches in *T. triacantha*); and different shape of S2 black spots (Figs 66, 72, 103, 104). We here revalidate *T. tonkinensis* (Mocsáry, 1914).

Trichrysis triacantha (Mocsáry, 1889)

Figs 67–75, 104

Chrysis (Trichrysis) triacantha Mocsáry, 1889: 325. Syn-types, ♀♀, Indonesia: Sumatra (NHMW) (examined).

Chrysis (Trichrysis) sumbawamba Mocsáry, 1912: 378. Holotype, ♀, Indonesia: Sumbawa Isl. (HNHM) (synonymised by Kimsey and Bohart 1991: 573).

Chrysis (Trichrysis) transmutata Mocsáry, 1914: 26. Lectotype, ♀, designated by Bohart in Bohart and French 1986, Myanmar: Tenasserim (HNHM) (examined) (synonymised by Kimsey and Bohart 1991: 574).

Chrysis (Trichrysis) saohime Tsuneki, 1950: 68. Holotype, ♀, Japan: Nagano (HUM, not NIAS) (synonymised by Kimsey and Bohart 1991: 574).

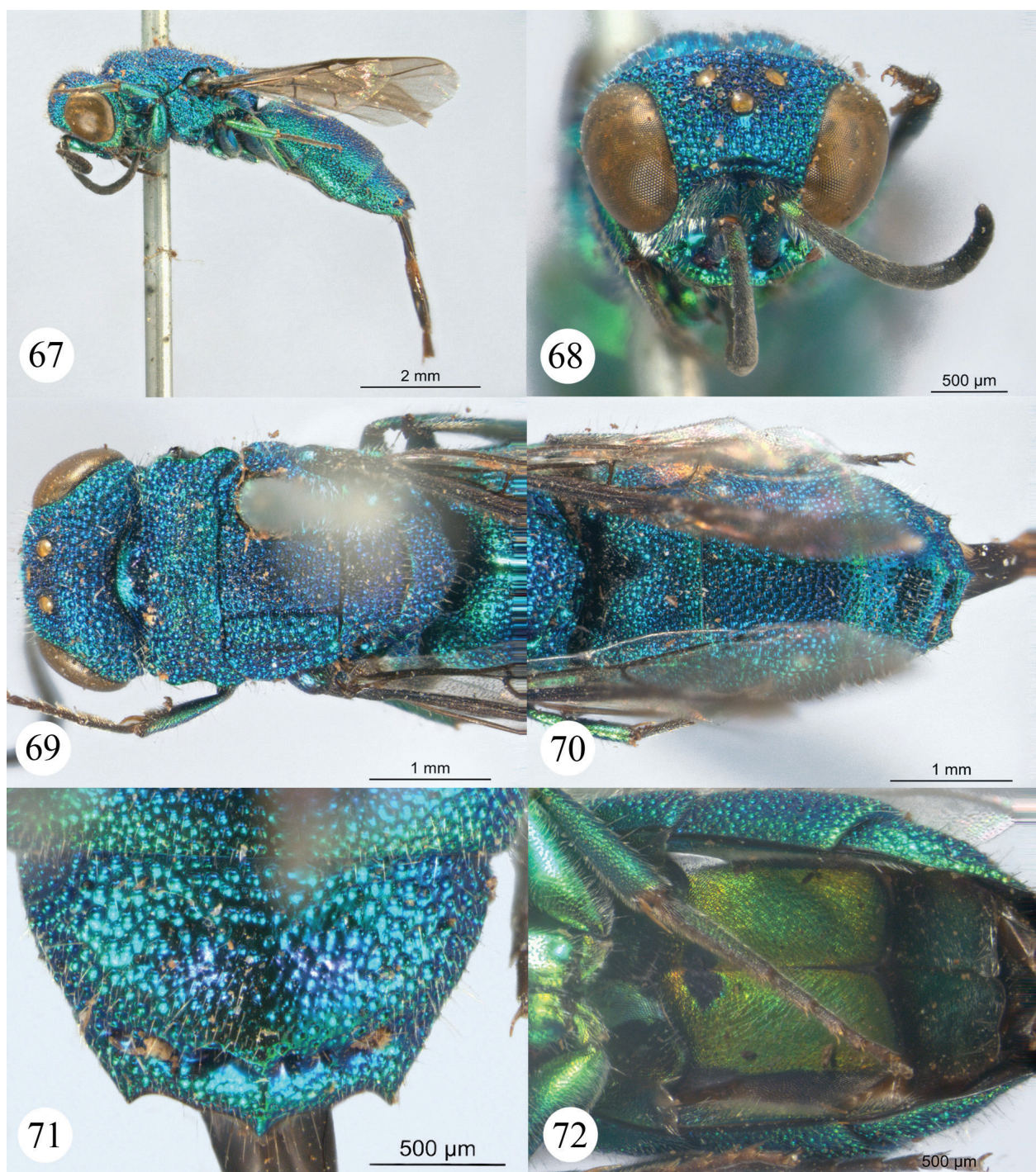
Chrysis (Trichrysis) bicarinata Tsuneki, 1950: 69. Holotype, ♀, China: Hong Kong (EIHU) (synonymised by Kimsey and Bohart 1991: 574).

Chrysis (Trichrysis) transmutata Mocsáry: Tsuneki 1950: 70; 1961: 374.

Trichrysis triacantha (Tsuneki): Kimsey and Bohart 1991: 573; Rosa et al. 2014.

Material examined. INDONESIA: 1♀, Plason Sumatra 877-2 / *triacantha* det. Mocsáry Type <handwritten in red>; 1♀, Sumatra, *triacantha* det. Mocsáry <handwritten in red> (NHMW); MYANMAR: 1♀, Lower Burma Tenasserim Haundraw Valley 5.98 Bingham Coll. / *transmutata* Mocs., det. Mocsáry typ <handwritten in red> / Coll. Bingham / red label / Lectotypus *Chrysis transmutata* Mocs. ♀ RM Bohart / id nr. 135542 HNHM Hym. Coll. (HNHM). CHINA: 3♀♀, Guangdong, Qingyuan (24°8'31"N 112°55'15"E), 9.IX.2014, leg. Z-f. Xu (SCAU); 2♀♀, Guangdong, Nankunshan Provincial Nature Reserve (23°39'28"N 113°55'23"E), 2.VII–3.IX.2005, leg. Z-f. Xu (SCAU); 1♀, Guangdong, Nanling National Nature Reserve (24°55'43"N 113°1'1"E), 16–18.IV.2004, leg. Z-f. Xu (SCAU); 1♀, Guangdong, Folang, Mt. Guanyin (23°57'57"N 113°33'55"E), 15–16.IX.2007, leg. Z-f. Xu (SCAU); 1♀, Guangdong, Zhaoqing, Fenghuang, Tonggu (23°13'26"N 112°31'55"E), 14–15.VII.2007, leg. Z-f. Xu (SCAU); 1♀, Guangdong, Guangzhou, Liuxihe Forest Park (23°44'31"N, 113°47'0"E), 13–14.IV.2002, leg. Z-f. Xu (SCAU); 1♂, Guangdong, Huizhou, Rengtu (23°10'50"N, 114°35'1"E), 27.VIII.2008, leg. H-y. Chen (SCAU); 2♀♀, Hainan, Bawangling National Nature Reserve (19°7'31"N 109°14'6"E), 7–11.VII.2006, leg. J-x. Liu & L-q. Weng (SCAU); 1♀, Hainan, Bawangling National Nature Reserve, 1–3.V.2008, leg. C-d. Hong (SCAU); 1♀, Yunnan, Jingdong, Jinping (24°27'14"N 100°50'4"E), 28.IV.2005, leg. H-s. Wang (SCAU); 1♀, Yunnan, Jinggu, Weiyuan (23°29'30"N 100°42'29"E), 4.X.2004, leg. J-x. Liu & W-q. Fan (SCAU); 1♀, Yunnan, Hekou, Nanxi (22°37'31"N 103°56'53"E) 21.VII.2003, leg. T-j. Li (SCAU).

Diagnosis. *Trichrysis triacantha* (Mocsáry, 1889) can be separated from all other Chinese species by follow-



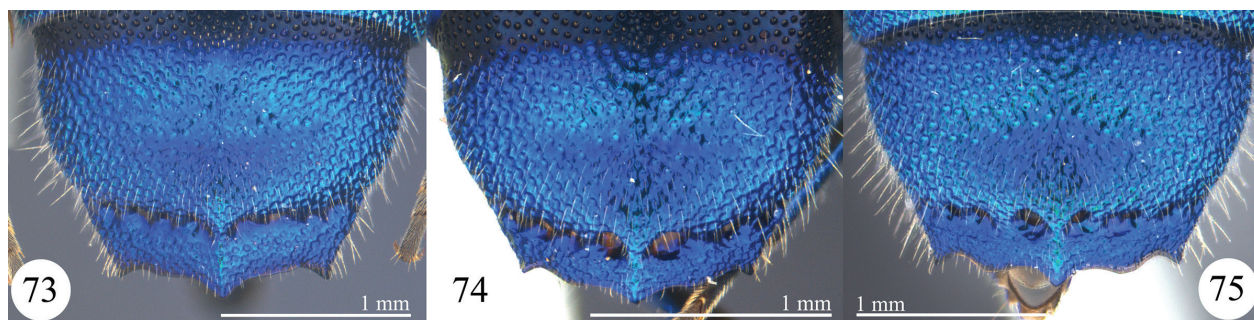
Figures 67–72. *Trichrysis triacantha* (Mocsáry), syntype (female). **67.** Habitus, lateral view; **68.** Head, frontal view; **69.** Head and mesosoma, dorsal view; **70.** Metasoma, dorsal view; **71.** T3, dorsal view; **72.** Metasoma, ventral view. (Photos courtesy of Dr. Dominique Zimmermann).

ing characteristics: tegula fully metallic blue; pronotal sublateral carina complete; TFC well developed, usually appearing double and sometimes with weak branches upward to ocellar area; S2 black spots small (Fig. 104); T3 prepit bulge medially convex; interval between median tooth and lateral tooth slightly convex. It is separated from the common species, *T. cyanea*, by TFC (single, never double or with branches upwards to ocellar area in

T. cyanea) and by S2 black spots (Fig. 104) differently shaped (*T. cyanea*, Fig. 97).

Description. *Female.* Body length 5.5–8.0 mm.

Head. Scapal basin deep, striate, with aligned small punctures across striae. TFC well developed, usually beneath raised and laterally directed downward, appearing as double TFC, sometimes even with traces of dorsal branches upwards to ocellar area. Relative length of



Figures 73–75. *Trichrysis triacantha* (Mocsáry), variations of apex of T3 in females collected at Qingyuan, Guangdong.

P:F1:F2:F3=1.0:1.5–1.8:0.8–1.0:0.6–0.8; F1 l/w=3.3; OOL=1.6–1.9 MOD; BOL=1.5–1.7 MOD; POL=1.6–1.8 MOD; MS=1.0 MOD; clypeal apex concave.

Mesosoma. Pronotal groove deep, extending to half length of pronotum; sublateral carina distinct and complete (Fig. 69). Mesoscutellum and metanotum without antero-medial depression or pit. Punctuation uneven, with shining and wrinkled or punctate interspaces; mesoscutellum usually impunctate antero-medially. Mesopleuron with large punctures; episternal sulcus not particularly deep or enlarged.

Metasoma. Punctuation uniform on metasoma (Fig. 70); punctures on T1 larger than on T2; T1 and T2 laterally with small punctures on interspaces between large punctures. T2 with median carina. T3 prepit bulge convex; when evidently bulged then pre pit row area with large impunctate and shining area; pit row with large isolate pits. Apex of T3 with three pointed teeth, with convex interval between median tooth and lateral tooth (Fig. 71). S2 black spots small (Fig. 104), fused medially.

Colouration. Body metallic blue to bluish-green. Scape and pedicel metallic bluish-green, F1 from black to partially or fully metallic bluish-green, rest of flagellum black. Tegula metallic blue, or blackish-brown with extensive metallic reflections. Legs metallic bluish-green, with fore tarsi blackish-brown with reflection, mid and hind tarsi fully or partially metallic green.

Male. Similar to female, except for: apex of T3 with smaller teeth and without pre pit area.

Variation. *Trichrysis triacantha* is one of the most variable species. Its TFC varies from straight to down-curved at two ends, usually appearing as double TFC, with or without branches pointing to ocellar area, with some intermediate forms. Tsuneki (1961) synonymised *T. bicarinata* with *C. tonkinensis* without type examining; this identification was incorrect, but the drawings of *T. bicarinata* and *T. tonkinensis* in his publications (Tsuneki 1950, 1961) confirm the synonymy with *T. triacantha*. Other variable characteristics of *T. triacantha* are: metallic colouration of F1 (from fully black to partially or fully metallic green); metallic colouration of basitarsus (partially or fully metallic green); and interval between median tooth and lateral tooth (vary from gently convex

to markedly convex) (Figs 73–75). However, these specimens do not show variation for OOL, BOL, POL and relative length of P:F1:F2:F3.

Distribution. China (Fujian, Taiwan, Guangdong, Hong Kong, Hainan, Yunnan) (Rosa et al. 2014). Widely distributed in the Oriental Region (Kimsey and Bohart 1991).

Remarks. *Trichrysis singalensis* (Mocsáry, 1889) was synonymised with *T. triacantha* by Kimsey and Bohart (1991). *T. singalensis* was described from a single (?) specimen from Sri Lanka, originally housed in MNHU, and not from a syntype series including Myanmar specimens housed in MSNG as stated by Kimsey and Bohart (1991). The holotype was not found during our research (P.R. and N-s.W.) in the institute and not even by Dr. Frank Koch, curator at MNHU, and we could not find it in other museums. The four specimens identified as *C. singalensis* in MSNG do not match the original description. They were collected after the description and belong to different species. In Mocsáry's collection in Budapest there are seven specimens labelled as *C. singalensis*, but they also belong to different species.

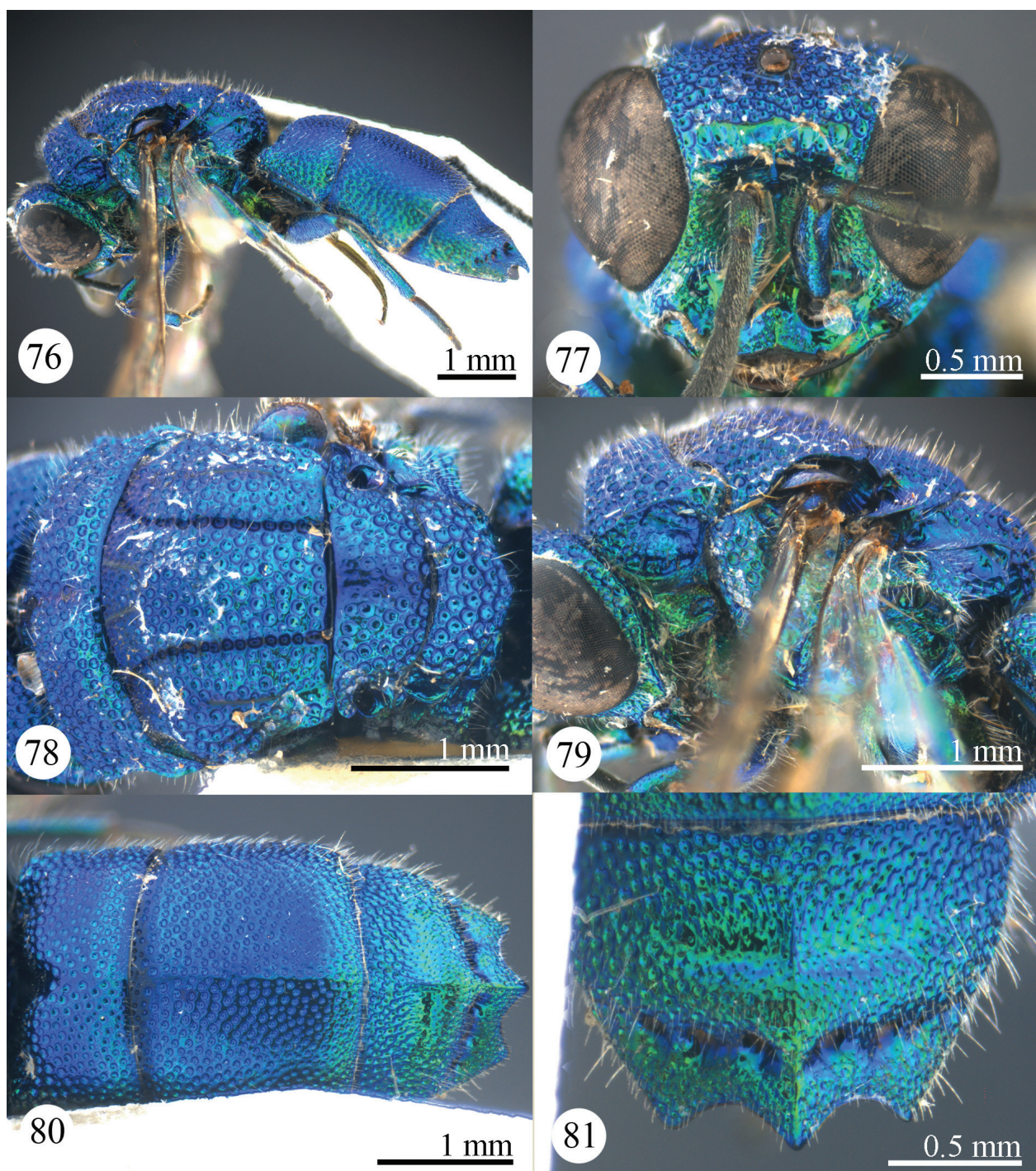
T. vestigator (Smith, 1858) was described from Borneo and could be present in Sumatra, from where *T. triacantha* (Mocsáry, 1889) was described. The two species are very likely synonymy, but the type of *T. vestigator* was not available for this study. Based on short description and key given by Bohart (1987), we could not state that *T. triacantha* is a junior synonym of *T. vestigator* at present.

Trichrysis tridensnotata Rosa, Wei & Xu, sp. n.

<http://zoobank.org/5AC9D089-A5DA-4130-BAF9-84A76B598CAE>
Figs 76–81, 105

Material examined. Holotype, ♀: CHINA, Hainan, Yinggeling National Nature Reserve (19°0'52"N, 109°32'47"E), 11.V.2005, leg. L-s. Chen (SCAU). Paratype: 1♀, same locality as holotype, 26–27.VIII.2005, leg. L-s. Chen (SCAU).

Diagnosis. *Trichrysis tridentinotata* sp. n. is close to *T. triacantha* (Mocsáry, 1889) based on tegula fully metallic blue, pronotal sublateral carina distinct and complete, TFC well developed, appearing double, and T3



Figures 76–81. *Trichrysis tridensnotata* sp. n., holotype (female). 76. Habitus, lateral view; 77. Head, frontal view; 78. Mesosoma, dorsal view; 79. Mesosoma, lateral view; 80. Metasoma, dorsal view; 81. T3, dorsal view.

prepit bulge distinctly convex. However, it can be separated from *T. triacantha* by: deep concave interval between median tooth and lateral tooth and different shape of S2 black spots (Fig. 105).

Description. *Female.* Holotype. Body length 7.3 mm.

Head. Scapal basin deep, striate medially with aligned small punctures across striae and punctuate laterally. TFC almost straight. Area beneath TFC raised with punctures elongate longitudinally, TFC appearing double (Fig. 77).

Relative length of P:F1:F2:F3 = 1.0:1.6–1.8:0.7–0.8:0.5–0.7; F1 l/w = 3.3; OOL = 1.7–2.2 MOD; BOL = 1.6–2.2 MOD; POL = 2.4 MOD; MS = 0.6–1.0 MOD; clypeal apex slightly concave.

Mesosoma. Pronotal groove deep, almost extending to posterior margin of pronotum (Fig. 78); pronotum concave laterally; sublateral carina distinct and complete. Mesoscutellum impunctate antero-medially. Episternal sulcus and scrobal sulcus with large areolate punctures.

Metasoma. T1 and T2 with punctuation geminate and evenly distributed. T2 and T3 with raised median carinae (Fig. 80). T3 prepit bulge distinctly convex; pit row with deep and isolated pits. Apex of T3 with three long and large teeth; interval between median tooth and lateral tooth markedly concave (Fig. 81). S2 black spots small (Fig. 105), fused medially.

Colouration. Head metallic blue, with greenish reflections on face. Mesosoma metallic blue, with greenish-golden reflections on mesopleuron and metapleuron. T1 and T2 metallic blue, with greenish-golden reflections laterally; T3 metallic blue, with greenish-golden reflections laterally and posteriorly. Scape and pedicel metallic bluish-green, flagellum black. Tegula entirely metallic blue. Legs metallic greenish-blue, with fore tarsi blackish-brown.

Male. Unknown.

Variation. The paratype of *Trichrysis tridensnotata* sp. n. shows some variations in relative length of flagellomeres, OOL, BOL and MS, as given in the description of head.

Distribution. China (Hainan).

Etymology. The specific name *tridensnotata* derives from the Latin adjective *tridens* (= with three teeth) and the Latin adjective *notatus* (= evident) and refers to three large teeth on apex of T3.

Trichrysis trigona (Mocsáry, 1889)

Figs 82–87, 106

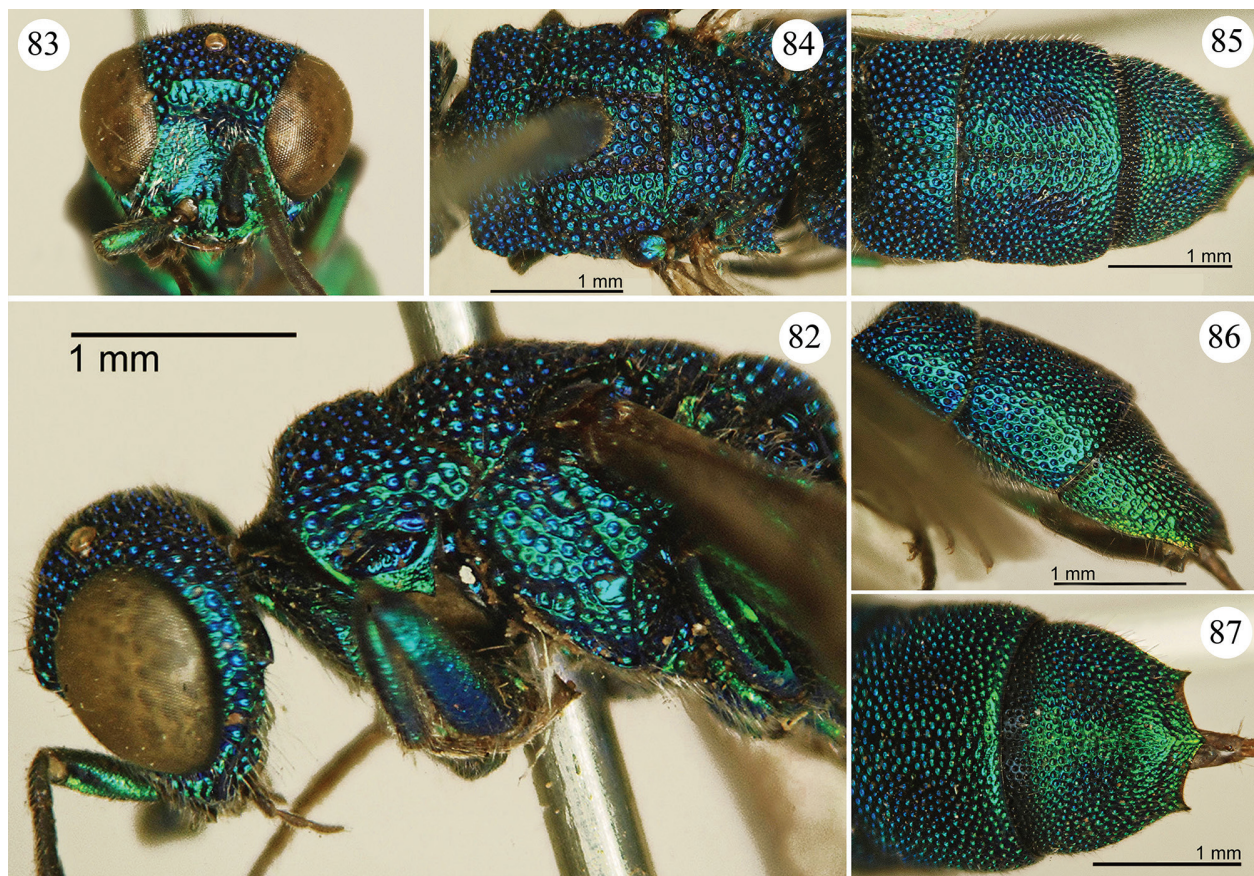
Chrysis (*Trichrysis*) *trigona* Mocsáry, 1889: 327. Holotype, ♀, Indonesia: Sulawesi: Bonthain (HNHM) (examined).

Trichrysis trigona (Mocsáry): Kimsey and Bohart 1991: 574; Rosa et al. 2014: 79.

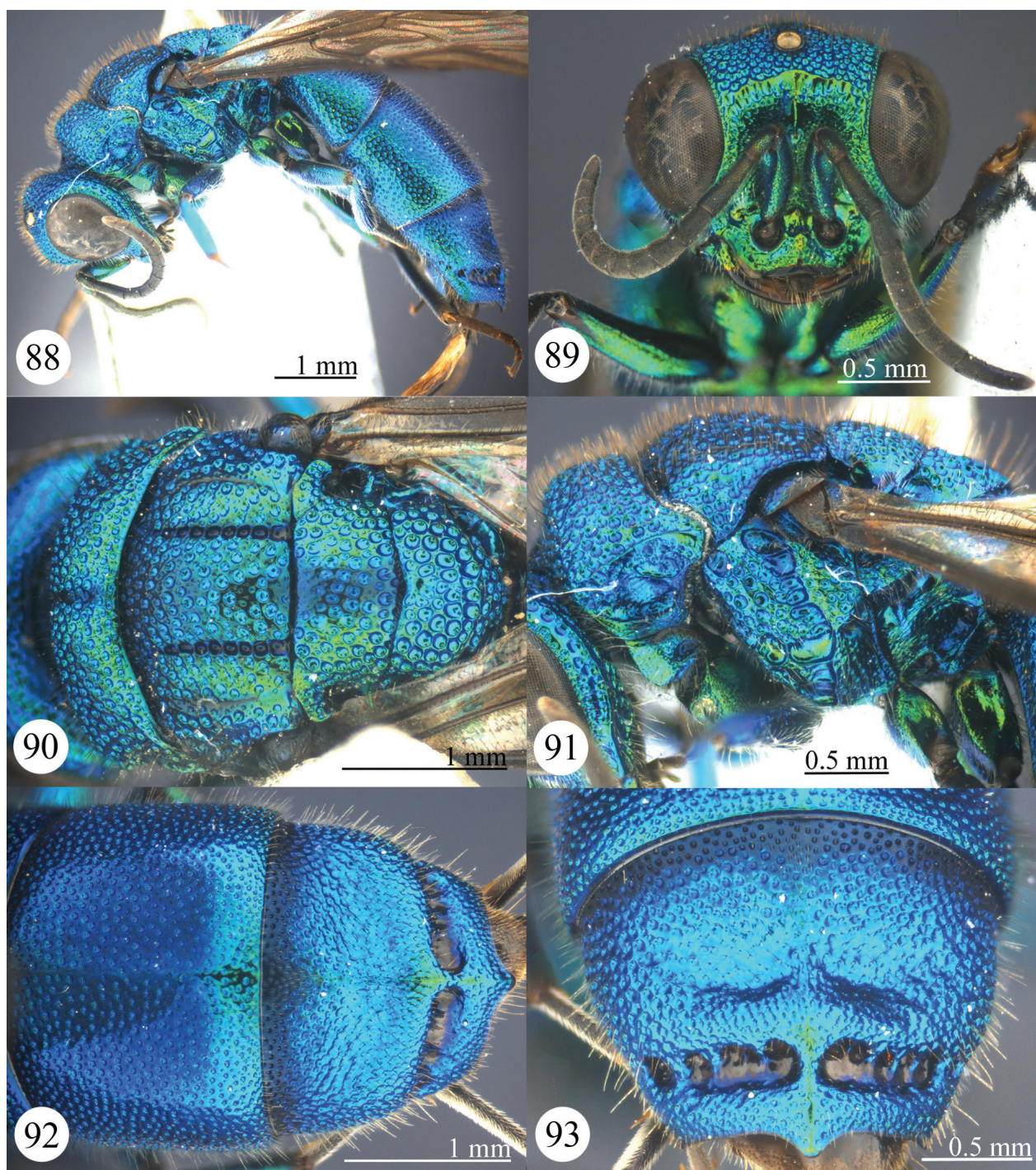
Material examined. INDONESIA: ♀, S Celebes [= Sulawesi] Bonthain C. Ribbe 1882 / 714-11 / , *trigona* Mocs det. Mocsáry typ. <handwritten in red> / Holotypus *Chrysis trigona* Mocs. ♀ RM Bohart / id nr. 135552 HNHM Hym. coll. (HNHM). PAKISTAN: 1♀, Indien Karachi [currently Pakistan] Coll. Linsenmaier / type *Chrysis* L. *azuripicta* det. Linsenmaier 1991 / no type sp. in litteris P. Rosa det. 2010 GBIF-Chrysididae / ex-synoptic collection / NML_ENT GBIF_Chr00041038 (NMLS).

Diagnosis. *Trichrysis trigona* (Mocsáry, 1889) is similar to *T. coeruleamaculata* sp. n., but it can be easily separated from the latter by: body punctuation without interspaces between large punctures or with small wrinkled interspaces; OOL=2.0 MOD; scapal basin striate medially; T1, T2 and T3 each with two small blue spots; tegula entirely metallic blue.

Description. *Female.* Body length 7.0 mm.



Figures 82–87. *Trichrysis trigona* (Mocsáry), holotype (female). 82. Head and mesosoma, lateral view; 83. Head, frontal view; 84. Mesosoma, dorsal view; 85. Metasoma, dorsal view; 86. Metasoma, lateral view; 87. T2 and T3, dorsal view.



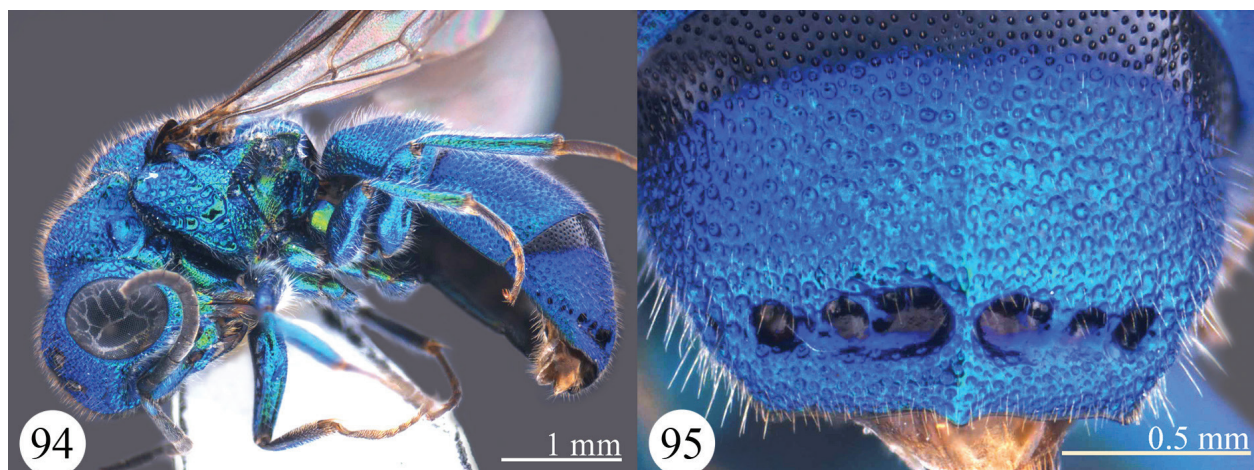
Figures 88–93. *Trichrysis yuani* sp. n., holotype (female). **88.** Habitus, lateral view; **89.** Head, frontal view; **90.** Mesosoma, dorsal view; **91.** Mesosoma, lateral view; **92.** T2 and T3, dorsal view; **93.** T3, dorsal view.

Head. Scapal basin deep, punctate laterally and striate medially (Fig. 83). TFC with endbending downwards. Area beneath TFC raised with punctures elongate longitudinally, TFC appearing double. Clypeus almost truncated. $P:F1:F2:F3 = 1.0:1.2:0.8:0.8$; $F1\ l/w = 2.5$; $OOL = 1.5\ MOD$; $BOL = 1.6\ MOD$; $POL = 2.2\ MOD$; $MS = 1.1\ MOD$.

Mesosoma. Pronotal groove weak; pronotum deeply concave laterally; sublateral carina incomplete, well de-

veloped only anteriorly. Mesoscutellum and metanotum without antero-median depression or pit. Punctuation on mesosoma continuous without interspaces between large punctures or with small and wrinkled interspaces (Fig. 84). Episternal sulcus and scrobal sulcus with large foveate punctures (Fig. 82).

Metasoma. Metasoma with dense and large punctures (Fig. 85), dorsally on T2 with large punctures geminate



Figures 94–95. *Trichrysis yuani* sp. n., paratype (male). **94.** Habitus, lateral view; **95.** T3, dorsal view.

and with wrinkled interspaces between punctures, with punctures subtransversely aligned; punctures on T3 smaller, wrinkled over pre pit area (Fig. 87). T2 without median carina. T3 prepit bulge medially convex; pit row distinct, with small, almost indistinct and separated pits (Fig. 87). Apex of T3 with three sharp teeth, with interval between median tooth and lateral tooth concave. S2 black spots triangular, elongated longitudinally and partially fused medially (Fig. 106).

Colouration. Body bluish-green, with small blue spots on vertex, mesoscutum, mesoscutellum, metanotum, with two small symmetric blue spots on T1, T2 and T3, respectively. Antenna blackish, with scape, pedicel and F1 metallic bluish-green. Tegula metallic blue. Legs metallic bluish-green, with tarsi blackish-brown without metallic reflections.

Male. Unknown.

Distribution. China (Hong Kong?), Laos (Kimsey and Bohart 1991); Indonesia; Pakistan (new record).

Trichrysis yuani Rosa, Feng & Xu, sp. n.

<http://zoobank.org/4A2A02BA-5EC7-4458-8D73-83AE3FBF42AD>
Figs 88–95, 107

Material examined. Holotype, ♀: CHINA: Hubei, Jingmen, Jingshan (31°1'1.05"N 114°7'10"E), 15.VII.2009, leg. Y. Yuan (SCAU). Paratypes: 1♂, same data as holotype (SCAU); 1♀, Hunan, Huaihua (27°33'11"N, 109°59'53"E), VIII.2004, leg. J.-h. Zhou (SCAU); 1♂, Hunan, Mt. Huping, Nianzigou (29°55'38"N 110°48'48"E), 9.VII.2009, leg. S.-h. Wang (SCAU).

Diagnosis. *Trichrysis yuani* sp. n. is similar to *T. pellucida* (du Buysson, 1887); however it can be separated from the latter by: different shape of T3; distance from anterior margin of pit row to posterior margin of median tooth about 2 MOD (Fig. 88); T3 median tooth blunt in dorsal view (Fig. 93); F1 l/w=3.0; body light blue in both sexes; P entirely metallic; body length about 7.0 mm.

Description. *Female.* Holotype. Body length 7.0 mm.

Head. Scapal basin deep, punctate laterally, striate and punctate medially. TFC single, slightly inverted V-shape. Area between TFC and scapal basin raised (Fig. 89). Relative length of P:F1:F2:F3=1.0:1.6:0.9:0.7; F1 l/w=3.0; OOL=1.9–2.4 MOD; BOL=1.5 MOD; POL=1.5–2.0 MOD; MS=1.0 MOD; clypeal apex almost truncate.

Mesosoma. Pronotal groove deep, almost extending to posterior margin of pronotum (Fig. 90); sublateral carina distinct and complete. Metanotum with shallow depression antero-medially. Punctuation on mesosoma dense, with consistent punctures relatively small (about 0.5 MOD), subequally interspaced; interspaces punctate (Fig. 90). Episternal sulcus and scrobal sulcus with large areolate punctures. Hind basitarsus l/w = 4.5.

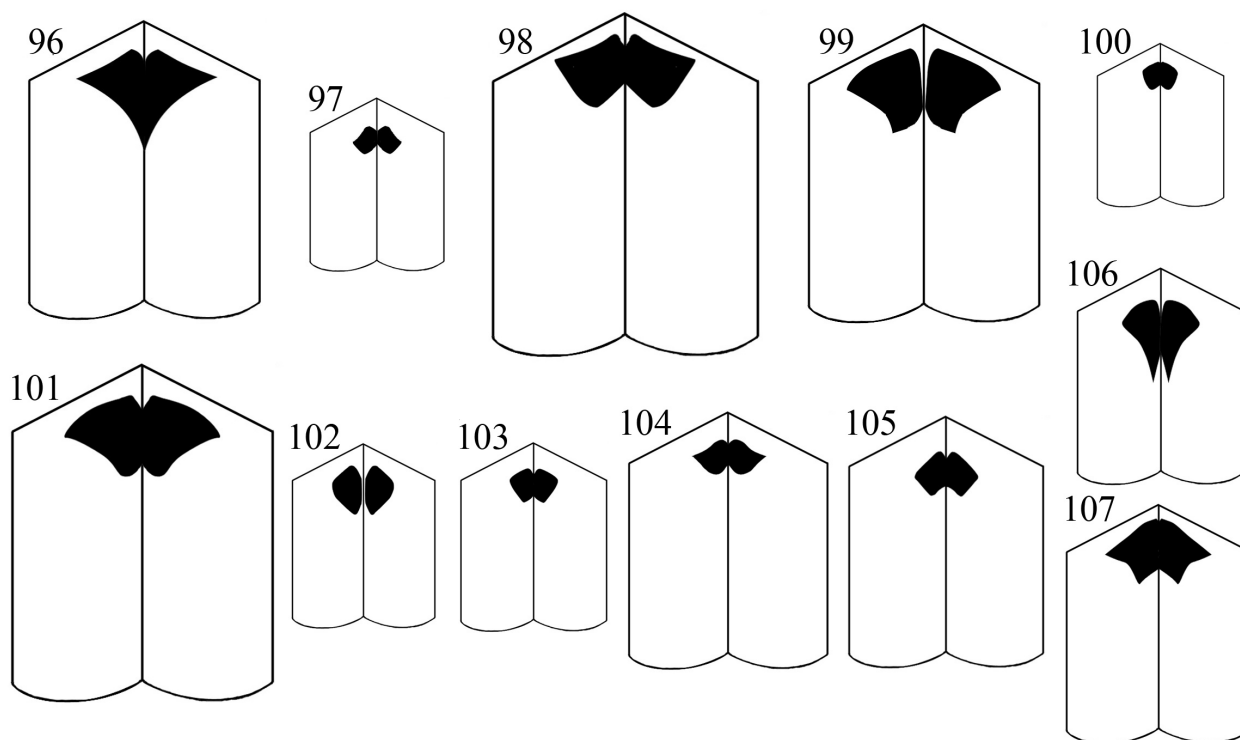
Metasoma. Punctures on T1 and T2 geminate and punctate on interspaces (Fig. 92); on T1 increasing in diameter toward lateral margins. T2 and T3 with median carina. T3 with coarse punctuation; prepit bulge convex; pit row with remarkably large and deep pits partially fused. Apex of T3 with one blunt median tooth and two blunt angulate lateral teeth; interval between median tooth and lateral tooth straight to slightly convex. S2 black spots enlarged and medially fused (Fig. 107).

Colouration. Body metallic greenish-blue, with dark blue spots on vertex, mesoscutellum and T2. Scape and pedicel greenish-blue, flagellum black. Face with greenish-golden reflections. Tegula blackish-brown, with metallic greenish-blue reflections. Legs metallic greenish-blue, with tarsi black without metallic reflections.

Male. Similar to female (Fig. 94), except for: apex of T3 subtruncate; T3 without prepit bulge; median tooth more blunt (Fig. 95).

Distribution. China (Hubei, Hunan).

Etymology. The species is named after the collector of holotype.



Figures 96–107. Black spots on S2. **96.** *Trichrysis coeruleamaculata* sp. n.; **97.** *T. cyanea* (Linnaeus); **98.** *T. imperiosa* (Smith); **99.** *T. lusca* (Fabricius); **100.** *T. luzonica* (Mocsáry); **101.** *T. pellucida* (du Buysson); **102.** *T. secernenda* (Mocsáry); **103.** *T. tonkinensis* (Mocsáry); **104.** *T. triacantha* (Mocsáry); **105.** *T. tridensnotata* sp. n.; **106.** *T. trigona* (Mocsáry); **107.** *T. yuani* sp. n.

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References

- Alfken JD (1915) Verzeichnis der Goldwespen (Chrysiden) Nordwestdeutschlands. Abhandlungen des Naturwissenschaftlichen Vereins zu Bremen 23: 291–295.
- As  s JD, Tormos J, Gayubo SF (1994) Biological observations on *Trypoxylon attenuatum* and description of its mature larva and its natural enemy *Trichrysis cyanea* (Hymenoptera: Sphecidae: Chrysididae). Journal of the Kansas entomological Society 67: 199–207.
- Azevedo CO, Madl M, Olmi M (2010) A Catalogue of the Bethyilidae, Chrysididae, Dryinidae, Embolemidae, Sclerogibbidae and Scolobythidae (Hymenoptera: Chrysidoidea) of the Malagasy Subregion. Linzer biologische Beitr  ge 42(2): 845–918.
- Balthasar V (1953 [“1951”]) Monographie des Chrysidides de Palestine et des pays limitrophes. Acta Entomologica Musei Nationalis Pragae, Supplementum, 27(2), 317 pp.
- Bingham CT (1903) The Fauna of British India, including Ceylon and Burma. Hymenoptera, Vol. II. Ants and Cuckoo-wasps. Taylor and Francis, London, 528 pp.
- Bischoff H (1910) Die Chrysididen des K  niglichen Zoologischen Museums zu Berlin. Mitteilungen aus dem Zoologischen Museum in Berlin 4: 426–493.
- Bischoff H (1913) Hymenoptera. Fam. Chrysididae. In: Wytsman P (Ed.) Genera insectorum. Fascicule 151. L. Desmet-Verteneuil, Bruxelles, 86 pp. + 5 pls.
- Bohart RM (1987) A Key to *Trichrysis* and new species from Sri Lanka and Africa (Hymenoptera: Chrysididae). Pan-Pacific Entomologist 63(4): 347–351.

- Bohart RM (1988) New species of *Chrysidea* and a key to the Madagascan species. Journal of the Entomological Society of South Africa 51(1): 129–137.
- Bohart RM, French LD (1986) Designation of chrysidid lectotypes in the Mocsáry collection at the Hungarian National Museum, Budapest (Hymenoptera: Chrysididae). Pan-Pacific Entomologist 62(4): 340–343.
- Bohart RM, Kimsey LS (1980) A generic synopsis of the Chrysididae of America North of Mexico (Hymenoptera). Journal of the Kansas Entomological Society 53(1): 137–148.
- Buysson R du (1887) Descriptions de Chrysidides nouvelles. Revue d'Entomologie 6: 167–201.
- Buysson R du (1898a) Étude des Chrysidides du Muséum de Paris. Annales de la Société Entomologique de France 66(4): 518–580.
- Buysson R du (1898b) La *Chrysis shangaiensis* Sm. Annales de la Société Entomologique de France 67(1): 80–83.
- Buysson R du (1899) Catalogue des Insectes Hyménoptères de la famille des Chrysidides du Muséum de Paris. Bulletin du Muséum National d'Histoire Naturelle Paris 5(4): 159–169.
- Buysson R du (1900) Contribution aux Chrysidides du Globe. 4 série. Revue d'Entomologie 19: 125–158.
- Buysson R du (1901) Sur la *Chrysis shangaiensis*. Bulletin de la Société Entomologique de France 1901: 29–30.
- Danks HV (1971) Biology of some stem-nesting aculeate Hymenoptera. Transactions of the Royal entomological Society 122(11): 323–399. doi: 10.1111/j.1365-2311.1971.tb00526.x
- Dufour L, Perris E (1840) Sur les Insectes Hyménoptères qui nichent dans l'intérieur des tiges seches de la Ronce. Annales de la Société entomologique de France 9: 1–53.
- Edney EB (1954) The Holonychinae (Family Chrysididae) of South Africa. Part V: *Pentachrysis* Licht. and *Hexachrysis* Licht. Occasional Papers of the National Museum of Southern Rhodesia 2(19): 624–673.
- Enslin E (1921) Zur Biologie des *Solenius rubicola* Duf. et Perr. (*larvatus* Wesm.) und seiner Parasiten. Konowia 1(1–2): 1–15.
- Fabricius JC (1804) Systema Piezatorum secundum ordines, genera, species, adjectis synonymis, locis, observationibus, descriptionibus. Brunsvigae 439 pp. + 14 [154–157, 170–177].
- García Mercet R (1911) Sobre la nidificación, la biología y los parásitos de algunos Esfégidos. I Congrès International d'Entomologie, Bruxelles 1: 457–464.
- Gathmann A, Tschamtké T (1999) Landschafts-Bewertung mit Bienen und Wespen in Nisthilfen: Artenspektrum, Interaktionen und Bestimmungsschlüssel. Veröffentlichungen für Naturschutz und Landschaftspflege in Baden-Württemberg 73: 277–305.
- Grandi G (1931) Contributi alla conoscenza biologica e morfologica degli Imenotteri melliferi e predatori. XII. Bollettino del Laboratorio di Entomologia di Bologna 4: 19–71.
- Grandi G (1936) Contributi alla conoscenza degli Imenotteri Aculeati. XVI. Bollettino del Laboratorio di Entomologia di Bologna 9: 253–346.
- Groot W (1971) Waarnemingen aan Hymenoptera-nesten. Entomologische Berichten 31: 168–175.
- Ha S, Lee SG, Kim JK (2008) First record of the genus *Elampus* (Hymenoptera: Chryridoidea: Chrysididae) from Korea, with a key and checklist of current valid species of Korean Chrysididae. Korean Journal of Systematic Zoology 24(1): 69–76. doi: 10.5635/KJSZ.2008.24.1.069
- Hammer K (1950) Über einige von Kjell Kolthoff und anderen in China gesammelten Hymenoptera. Chrysididae, Cleptidae, Mutillidae. Arkiv för Zoologi 42A: 1–12.
- Hanada Y (1989) On the variations and the distributions of a cuckoo wasp, *Chrysis (Trichrysis) formosana* auct. (Hymenoptera: Chrysididae) in the Nansei Islands, Japan. Entomological Journal of Fukui 5: 13–16.
- International Commission on Zoological Nomenclature (ICZN) (1999) International Code of Zoological Nomenclature. Fourth Edition. ITZN, London, xxx + 306 pp.
- Iwata K (1963) Miscellaneous biological notes on aculeate Hymenoptera in Kagawa in the years of 1948 and 1949. Transactions of the Shikoku Entomological Society 7: 114–118.
- Joannis J de (1896) Sur un cas nouveau de parasitisme observe chez *Chrysis shanghaiensis* Smith, Chryside parasite d'un Lépidoptère. Bulletin de la Société entomologique de France 1896: 147.
- Kimsey LS, Bohart RM (1980) A synopsis of the chrysidid genera of Neotropical America (Chryridoidea, Hymenoptera). Psyche 87: 75–92. doi: 10.1155/1980/21857
- Kimsey LS, Bohart RM (1991 [‘1990’]) The Chrysidid Wasps of the World. Oxford University Press, New York, 652 pp.
- Komeda Y, Hisamatsu M (2005) Percentage parasitism of *Praestochrysis shanghaiensis* (Hymenoptera: Chrysididae) and some new biological knowledge in Kanto District, Japan. Bulletin of Ibaraki Nature Museum 8: 23–28. [In Japanese]
- Kunz PX (1994) Die Goldwespen (Chrysididae) Baden-Württembergs. Taxonomie, Bestimmung, Verbreitung, Kartierung und Ökologie. Veröffentlichungen für Naturschutz und Landschaftspflege in Baden-Württemberg 77, 188 pp.
- Kurzenko NV, Lelej AS (2007) [Fam. Chrysididae-Chrysidid wasps]. In: Lelej AS (Ed.) [Key to the Insect of Russian Far East, Vol. 4, Part 5]. Dalnauka, Vladivostok, 998–1006. [In Russian]
- Latreille PA (1809) Genera Crustaceorum et Insectorum secundum ordinem naturalem in familias disposita, iconibus exemplisque plurimis explicata. Tomus quartus et ultimus. Amand Koenig, Parisiis et Argentorati [= Paris and Strasbourg], 399 pp. doi: 10.5962/bhl.title.34916
- Lichtenstein J (1876) Note sur le genre *Chrysis*. Petites Nouvelles Entomologiques 145: 27.
- Linnaeus C (1758) Systema Naturae per Regna tria Naturae, secundum Classes, Ordines, Genera, Species, cum characteribus, differentiis, synonymis, locis. Editio Decima, Refurmata, Tomus I. Laurenti Salvii, Holmiae, 824 pp. + IV.
- Linnaeus C (1761) Fauna Suecia sistens Animalia Sueciae Regni: Mammalia, Aves, Amphibia, Pisces, Insecta, Vermes. Distributa per Classes et Ordines, enera et Species, cum Differentiis, Specierum, Synonymis, Auctorum, Nominibus Incolarum, Locis natalium, Descriptionibus Insectorum. Editio Altera, Auctior. Laurentius Salvius, Stockholm, 578 pp. + 2 pl.
- Linsenmaier W (1959) Revision der Familie Chrysididae (Hymenoptera) mit besonderer Berücksichtigung der europäischen Spezies. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 32 (1): 1–232.
- Linsenmaier W (1968) Revision der Familie Chrysididae (Hymenoptera). Zweiter Nachtrag. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 41(1–4): 1–144.
- Linsenmaier W (1984) Das Subgenus *Trichrysis* Lichtenstein in Nord und Südamerika (Hym., Chrysididae, Genus *Chrysis* L.). Mitteilungen der Schweizerischen Entomologischen Gesellschaft 57: 195–224.
- Linsenmaier W (1994) The Chrysididae (Insecta: Hymenoptera) of the Arabian Peninsula. Fauna of Saudi Arabia 14: 145–206.

- Linsenmaier W (1997) Altes und Neues von den Chrysididen (Hymenoptera, Chrysididae). *Entomofauna* 18(19): 245–300.
- Lomholdt O (1975) The Sphecoidea (Hymenoptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica* 4: 1–452.
- Mader L (1939) Beitrag zur Kenntnis der Hymenopteren. III. *Entomologische Nachrichten* 13: 93–110.
- Madl M, Rosa P (2012) A Catalogue of the Chrysididae (Hymenoptera: Chrysidoidea) of the Ethiopian Region excluding Malagasy Subregion. *Linzer biologische Beiträge* 44(1): 5–169.
- Mocsáry A (1889) *Monographia Chrysididarum Orbis Terrarum Universi*. Hungarian Academy of Science, Budapest, 643 pp.
- Mocsáry A (1912) *Species Chrysididarum novae*. III. *Annales Musei Nationalis Hungarici* 10: 375–414.
- Mocsáry A (1913a) *Species Chrysididarum novae*. IV. *Annales Musei Nationalis Hungarici* 11: 1–45.
- Mocsáry A (1913b) Chrysididae in insula Formosa a Joanne Sauter collectae. *Annales Musei Nationalis Hungarici* 11: 612–619.
- Mocsáry A (1913c) The Chrysididae of the Philippine Islands. *Philippine Journal of Science* 8(D): 287–291.
- Mocsáry A (1914) Chrysididae plerumque exoticae novae. *Annales Musei Nationalis Hungarici* 12: 1–74.
- Morgan D (1984) Cuckoo-Wasps Hymenoptera, Chrysididae. *Handbooks for the Identification of British insects*. Royal Entomological Society of London 6(5): 1–37.
- Parker DE (1936) *Chrysis shanghaiensis* Smith, a parasite of the oriental moth *Monema flavescens*. *Journal of Agricultural Research* 52: 449–458.
- Pärn M, Soon V, Vallisoo T, Hovi K, Luig J (2014) Host specificity of the tribe Chrysidini (Hymenoptera, Chrysididae) in Estonia ascertained with trap-nesting. *European Journal of Entomology* 112(1): 91–99. doi: 10.14411/eje.2015.012
- Piel O (1933) *Monema flavescens* Wkr. and its parasites (Lepidoptera, Heterogeneidae). *Lingnan Science Journal* 12 (supplement): 173–201.
- Polazek A (1987) Chrysididae. A summary of records of chrysidid parasitoids of South East Asian Limacodidae. In: Cock MJW, Godfray HCJ, Holloway JD (Eds) *Slug and Nettle Caterpillars. The Biology, Taxonomy and Control of the Limacodidae of Economic Importance on Palms in South East Asia*. CABI, Wallingford, 270 pp. [185–186].
- Radoszkowski O (1877) Chrysidiformes, Mutillidae et Sphegidae. *Putieshestvie v Turkestan A.P. Fedtshenko* [Voyage au Turkestan d'Alexis Fedtschenko] (14) 2(5): 1–87.
- Rohwer SA (1921) Description of a cuckoo-wasp from the Hawaiian Islands. *Proceedings of the Hawaiian Entomological Society* 5: 67–69.
- Rosa P (2006) I Crisidi della Valle d'Aosta. *Monografie del Museo regionale di Scienze naturali*, 6, St.-Pierre, Aosta, 368 pp.
- Rosa P, Xu ZF (2015) Contribution to the genus *Chrysidea* Bischoff, 1913 from China, with description of a new species (Hymenoptera, Chrysididae). *Zootaxa* 4040(4): 465–468. doi: 10.11646/zootaxa.4040.4.6
- Rosa P, Lotfalizadeh H, Pourrafi L (2013) First checklist of the chrysidid wasps (Hymenoptera: Chrysididae) of Iran. *Zootaxa* 3700 (1): 1–47. doi: 10.11646/zootaxa.3700.1.1
- Rosa P, Bernasconi MV, Wyniger D (2015) The Linsenmaier Chrysididae collection housed in the Natur-Museum Luzern (Switzerland) and the main results of the related GBIF Hymenoptera Project (Insecta). *Zootaxa* 3986(5): 501–548. doi: 10.11646/zootaxa.3986.5.1
- Rosa P, Wei NS, Xu ZF (2014) An annotated checklist of the chrysidid wasps (Hymenoptera, Chrysididae) from China. *ZooKeys* 455: 1–128. doi: 10.3897/zookeys.455.6557
- Semenov-Tian-Shanskij A (1967) [New species of gold wasps (Hymenoptera, Chrysididae)]. *Trudy Zoologicheskogo Instituta Akademii Nauk SSSR* 43: 118–184. [In Russian]
- Smith F (1858) Catalogue of the hymenopterous insects collected at Sarawak, Borneo; Mount Ophir, Malacca; and at Singapore, by A. R. Wallace. *Journal of the Proceedings of the Linnean Society of London, Zoology* 2: 42–130.
- Smith F (1874) A revision of the Hymenopterous Genera *Cleptes*, *Paranopes*, *Pyria* and *Stilbum*, with descriptions of new species of those genera, and also of new species of the Genus *Chrysis* from North China and Australia. *Transactions of the Entomological Society of London* 7: 451–471.
- Strumia F (1996) *Praestochrysis* from India and South-East Asia (Hymenoptera Chrysididae). *Bollettino della Società entomologica italiana* 128(1): 57–64.
- Strumia F (1997) Alcune osservazioni sugli ospiti di Imenotteri Crisididi (Hymenoptera: Chrysididae). *Frustula entomologica* 20 (n.s.) (33): 178–183.
- Strumia F (2009) *Trichrysis baratzensis* sp. n. (Hymenoptera: Chrysididae) from Sardinia. *Zootaxa* 2318: 589–595.
- Tormos J, Asís J, Gayubo S, Mingo E (1996) Description of the mature larvae of *Chrysis gracillima* and *Omalus biacinctus* and new data on the biology of *Trichrysis cyanea* (Hymenoptera: Chrysididae). *Florida Entomologist* 79: 56–63. doi: 10.2307/3495754
- Trautmann W (1927) *Die Goldwespen Europas*. Uschman, Weimar, 194 pp.
- Tsuneki K (1947) Chrysididae from North China and Inner Mongolia. *Mushi* 17(9): 43–60.
- Tsuneki K (1950) Descriptions of new species and subspecies of the Chrysididae from East Asia (Hymenoptera). *Mushi* 21(8): 21–81.
- Tsuneki K (1953a) Chrysididae of Korea (Hymenoptera). *Kontyu* 20(1–2): 22–28.
- Tsuneki K (1953b) Chrysididae of Manchuria (Hymenoptera). *Mushi* 25(8): 53–61.
- Tsuneki K (1955) *Chrysis (Pentachrysis)* of North-Eastern Asia (Hymenoptera, Chrysididae). *Memoirs of the Faculty of Liberal Arts, Fukui University, Series II, Natural Science* 4(5): 35–46.
- Tsuneki K (1961) Chrysididae collected by the Osaka City University Biological Expedition to Southeast Asia, 1957–1958. *Nature and Life in Southeast Asia* 1: 367–382.
- Tsuneki K (1970) Ein beitrage zur goldwespen-fauna Formosas. *Etizenia* 49: 1–21.
- Uchida T (1927) Eine uebersicht der Chrysididen Japans und mit den beschreibungen der neuen Arten und Varietaeten. *Insecta Matsumurana* 1(3): 149–157.
- Uchida T (1933) Catalogue of Japanese Insects, II. Hymenoptera Chrysididae. *Entomological World*, Tokyo, 8 pp.
- Yamada Y (1980) The importance of spatio-temporal coincidence in host-parasite interaction between the Oriental moth, *Monema flavescens* and a chrysidid wasp, *Chrysis shanghaiensis*. *International Congress of Entomology Proceedings* 16: 142.
- Yamada Y (1990) Role of parasitoid with a low fecundity, *Praestochrysis shangaiensis* (Hymenoptera: Chrysididae) in the population dynamics of its host. *Researches on Population Ecology* 32: 365–379. doi: 10.1007/BF02512570
- Zimsen E (1964) The type material of I.C. Fabricius. *Munksgaard, Copenhagen*, 656 pp.

Key to the species of *Megarhyssa* (Hymenoptera, Ichneumonidae, Rhyssinae) in America, north of Mexico

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Abstract

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A dichotomous and an interactive key to the species of *Megarhyssa* (Hymenoptera: Ichneumonidae) in America, north of Mexico are presented. A diagnosis accompanied by images is provided for male and female wasps of each of the four species, *Megarhyssa atrata*, *Megarhyssa greenei*, *Megarhyssa macrurus* and *Megarhyssa nortoni*.

Key Words

parasitoid

identification

giant ichneumon fly

Introduction

The subfamily Rhyssinae Morley, of the ‘pimpliformes’ Ichneumonidae (Order: Hymenoptera), is found worldwide and comprises 234 described species in eight genera (Yu et al. 2012). Though hypothesized to have originated in the northern hemisphere (Wahl and Gauld 1998), the diversity of this subfamily is heavily biased to the tropics with nearly half of the species belonging to the circumtropical genus, *Epirhyssa* Cresson, 1865 (Yu et al. 2012). Rhyssinae are generally large in size and some of the most impressive specimens occur in the cosmopolitan genus *Megarhyssa* Ashmead (Hymenoptera: Ichneumonidae: Rhyssinae). The majority of the 37 described species in this genus occur in the Oriental region and the Eastern Palearctic. A handful of species occur in each of the following regions: Western Palearctic, Nearctic and Australasian; with one record for both the Neotropical (Chiapas) and Afrotropical regions (Yu et al. 2012).

Though only four species of *Megarhyssa* occur in the Nearctic (Yu et al. 2012), they are a common sight in the forests of the United States and Canada. Members of this genus are ectoparasitoid idiobionts of wood-boring siricid larvae (Townes 1969) and one species, *M. nortoni* (Cresson), is an effective biocontrol agent employed by the National *Sirex* Coordination Committee to control the invasive woodwasp, *Sirex noctilio* Fabricius (Hymenoptera: Siricidae). Characteristics such as their bright coloration and large size place these spectacular insects among the ‘charismatic megafauna’ of the arthropod world, often capturing the attention of hobbyists and nature enthusiasts. Given the frequency with which non-specialists encounter and work with species of *Megarhyssa*, image-rich dichotomous and interactive keys will increase the accuracy of identifications.

The four species of *Megarhyssa* found in the United States and Canada are broadly distributed across the region (Townes and Townes 1960; Carlson 1979). The only species native to more southern regions is *Megarhyssa*

sa macrurus (Linnaeus) which is also found in Mexico (Townes and Townes 1960). In addition, *Megarhyssa nortoni* now occurs in Australia, New Zealand and South Africa where it was introduced as a biological control agent (Taylor 1976; Bartlett et al. 1978; Taylor 1978; Haugen and Underdown 1990; Tribe and Cillie 2004; Hurley et al. 2007). Siricid wood wasps native to north America are the common hosts of each of the four species (Beaulne 1939; Carlson 1979; Champlain 1922; Heatwole and Davis 1965; Hopkins 1893; Nénon 1995; Stillwell 1967; Townes 1944; Townes and Townes 1960; Treherne 1916) with *M. nortoni* also parasitizing the invasive wood wasp, *Sirex noctilio* (Carlson 1979; Nuttall 1980; Valentine and Walker 1991; Vincent and King 1995).

A key to the genera of Nearctic Rhyssinae, illustrated with high quality color images, is available online at <http://www.amentinst.org/GIN/Rhyssinae>. Here, we present a key to the four Nearctic species, designed for use by non-specialists. We have adopted some characters

from previous keys (Merill 1915; Townes and Townes 1960) in addition to creating our own when necessary. This key will be linked to the website of the American Entomological Institute where it will complement its generic key. It will also be advertised on the popular website www.bugguide.net to promote its use by the general public.

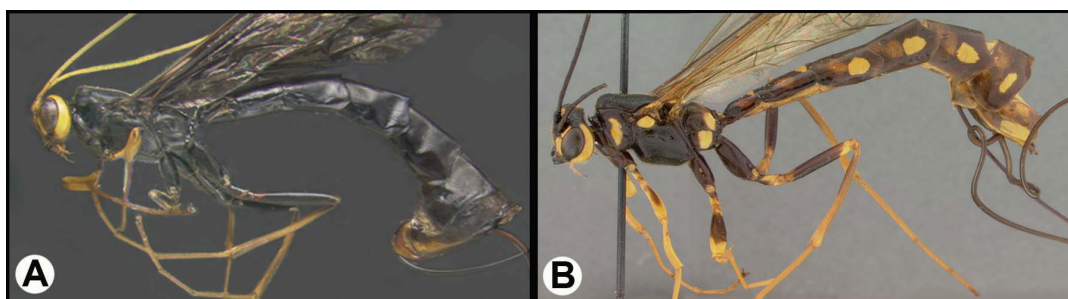
Materials and methods

Type specimens for each species were checked for the diagnostic morphological characters assigned by Merrill (1915) and Townes and Townes (1960). A broad range of specimens from the hundreds of *Megarhyssa* housed in the Kentucky and American Entomological Institute collections were examined. Characters included in the keys were chosen based on the ease with which they could be assessed by a non-specialist.

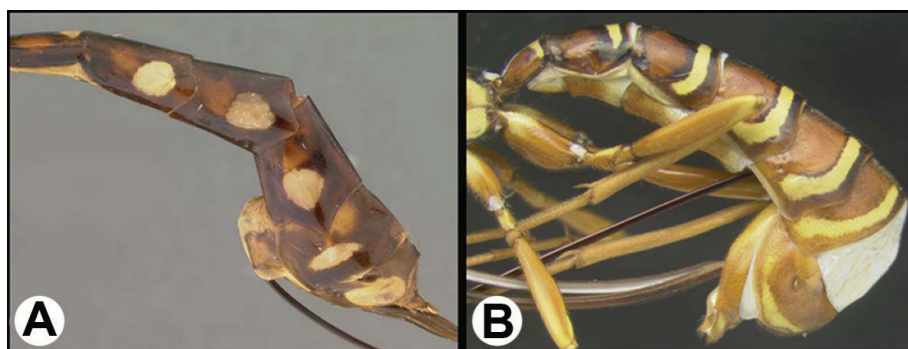
Key to species

Females.

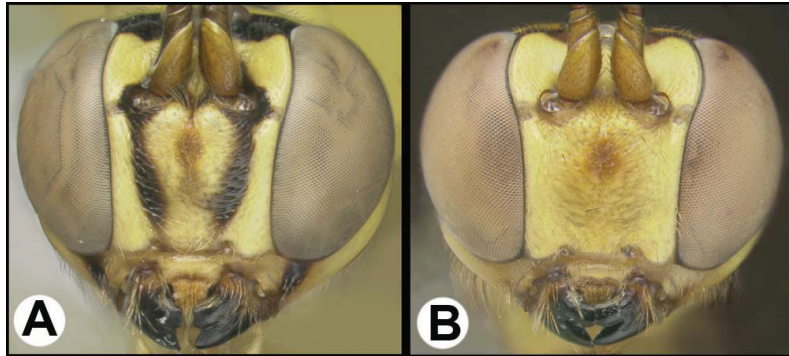
- 1 A. Metasoma melanic (blackish-brown) and lacking yellow markings; ovipositor sheath about 3.7 times as long as fore wing.....*M. atrata* (Fabricius)
- B. Metasoma ranging from brown to reddish-brown with conspicuous bright yellow markings; ovipositor sheath 1.8 to 3 times as long as fore wing..... 2



- 2 A. Well-defined, yellow, roundish spot on each of tergites 4-6..... *M. nortoni* (Cresson)
- B. Angled yellow bands on each of tergites 4-6..... 3

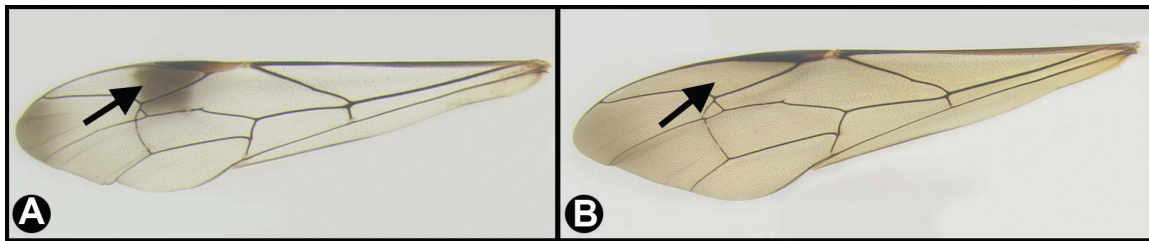


- 3 A. Vertical black stripe on face below each antennal socket; ovipositor sheath about 3 times as long as fore wing *M. macrurus* (Linnaeus)
- B. Vertical stripes on face absent; ovipositor sheath about 1.8 times as long as fore wing *M. greenei* Viereck

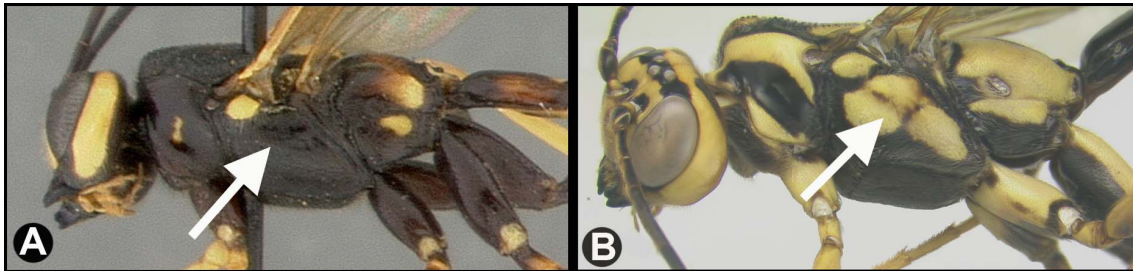


Males.

- 1 A. Fore wing marked with brown patch at base of cell 2R1 *M. macrurus* (Linnaeus)
- B. Fore wing lacking brown patch at base of cell 2R1 2



- 2 A. Mesopleuron blackish brown with yellow spot below wing insertion, no additional yellow markings *M. nortoni* (Cresson)
- B. Mesopleuron ranging from blackish brown to reddish-brown, yellow spot below wing insertion and additional yellow markings 3



- 3 A. Mesosoma color reddish-brown and yellow *M. greenei* Viereck
- B. Mesosoma color blackish-brown and yellow *M. atrata* (Fabricius)



Taxonomy

Modified from Merrill 1915; Townes and Townes 1960.

Megarhyssa Ashmead, 1900

Characters diagnostic of *Megarhyssa* include the presence of a petiolate triangular areolet on the fore wing, a longitudinal ridge on the trochantellus of the middle leg and lateral tubercles on the apical margin of the clypeus. In addition, tergites 3–5 of female *Megarhyssa* are smooth to punctate and sternites 2–6 possess a pair of tubercles close to the anterior sternal margin. Male *Megarhyssa* have a strong setiferous groove which is close to and paralleling the apical 0.7 of the ventral interior margin; and tergites 3–6 are strongly concave apically and possess a median apical or subapical longitudinal submembranous area. These male specific characters are not well developed in small specimens and they may key to the genus *Rhyssella* (Townes & Townes, 1960).

Megarhyssa atrata (Fabricius)

Figs 1–2

Ichneumon atratus Fabricius, 1781. Species Insectorum, v. 1, p. 436.

Ichneumon tenebrator Thunberg, 1822; 1824. Acad. Imp. des Sci. St. Petersburg, Mem.8: 266; 9: 322. Unnecessarily proposed n. name for *atratus* Fabricius.

Rhyssa laevigata Brullé, 1846. In Lepeletier, Hist. Nat. Ins. Hym., v. 4, p. 78.

Megarhyssa atrata lineata Porter, 1957. Ent. News 68: 206. Synonymized by Carlson (1979)

Geographic range. Eastern Nearctic to about longitude 100 °W (Townes and Townes 1960).

Hosts. *Tremex columba* (Hopkins 1893; Treherne 1916; Beaulne 1939; Townes 1944; Nénon 1995).

Distinguishing characters. Female: Head and antenna mostly yellow, may or may not have a dark spot above the clypeus. Mesosoma and metasoma black. Mesosoma

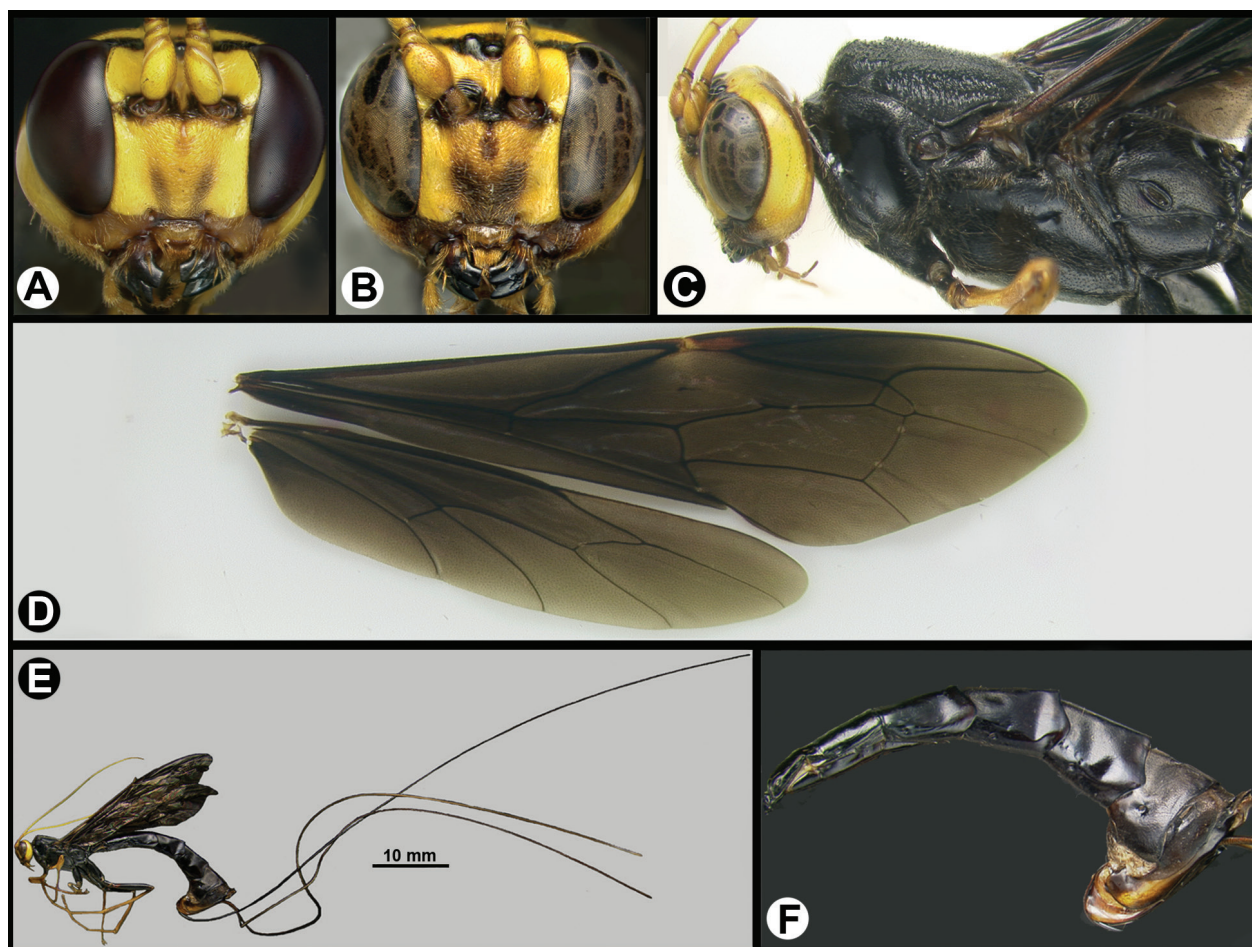


Figure 1. *Megarhyssa atrata* female. A. Anterior head; B. Anterior head showing color variation; C. Lateral head and mesosoma; D. Wings; E. Lateral habitus; F. Lateral metasoma.

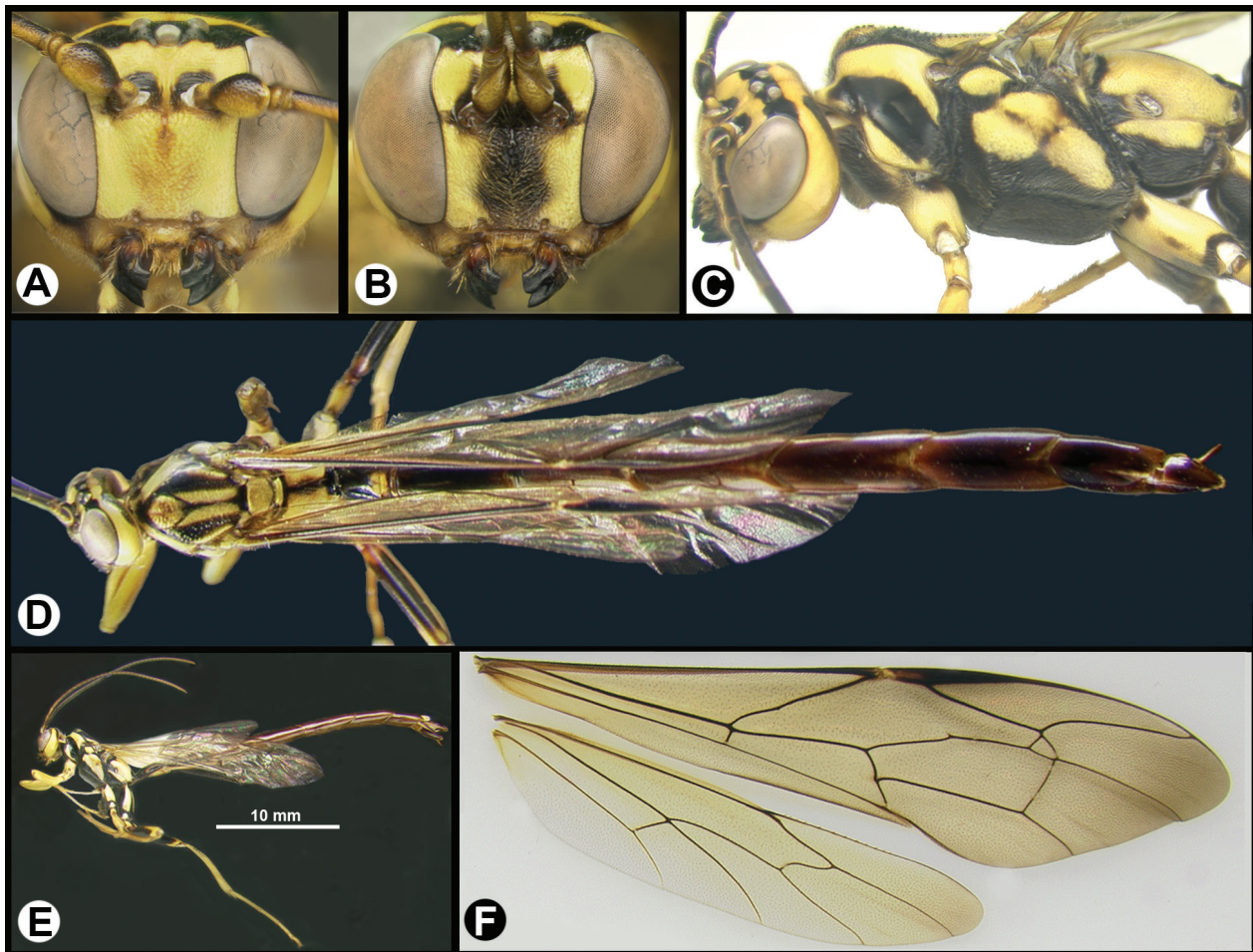


Figure 2. *Megarhyssa atrata* male. **A.** Anterior head; **B.** Anterior head showing color variation; **C.** Lateral head and mesosoma; **D.** Dorsal habitus; **E.** Lateral habitus; **F.** Wings.

sometimes with a small yellow spot on posterodorsal corner of pronotum, rarely with yellow markings. Fore wing 15 to 30 mm long; wings infusate or entirely black. Ovipositor sheath about 3.7 times as long as forewing.

Females may be distinguished from the other species occurring in the USA and Canada by their body color.

Male. Head yellow, may or may not have a dark spot above the clypeus. Mesosoma yellow and blackish brown; metasoma very dark brown to black with a yellow mark on the hind margin of the first tergite; wings hyaline, fore wing 16 to 22 mm long.

Males may be distinguished from *M. macrurus* by the evenly darkened fore wing and the lack of a brown patch at the base of cell 2R1; from *M. nortoni* by the additional yellow markings on the mesopleuron; and from *M. greenei* by the color of the mesosoma.

Megarhyssa greenei Viereck, 1911

Figs 3–4

Megarhyssa greenei Viereck, 1910. In Smith, N. J. State Mus., Ann. Rpt. for 1909, p. 627. Nomen nudum.

Megarhyssa greenei Viereck, 1911. U. S. Natl. Mus., Proc. 40: 191.

Megarhyssa greenei floridana Townes, 1960. U. S. Natl. Mus. Bul. 216 (pt. 2): 424. Synonymized by Carlson (1979).

Geographic range. Most specimens are found in the eastern Nearctic to about longitude 96 °W, with some found as far west as Wyoming (Townes and Townes 1960).

Hosts. *Tremex columba* (Townes 1944; Townes and Townes 1960; Heatwole and Davis 1965; Stillwell 1967).

Diagnosis. Female: Head mostly yellow; mesosoma reddish-brown and yellow. Metasoma reddish-brown, each tergite with an angled yellow band; bands on the third and following tergites interrupted on the midline. Fore wing 12 to 27 mm long. Wings hyaline and the fore wing usually with a large brown patch at the base of cell 2R1. Ovipositor sheath about 1.8 times as long as fore wing.

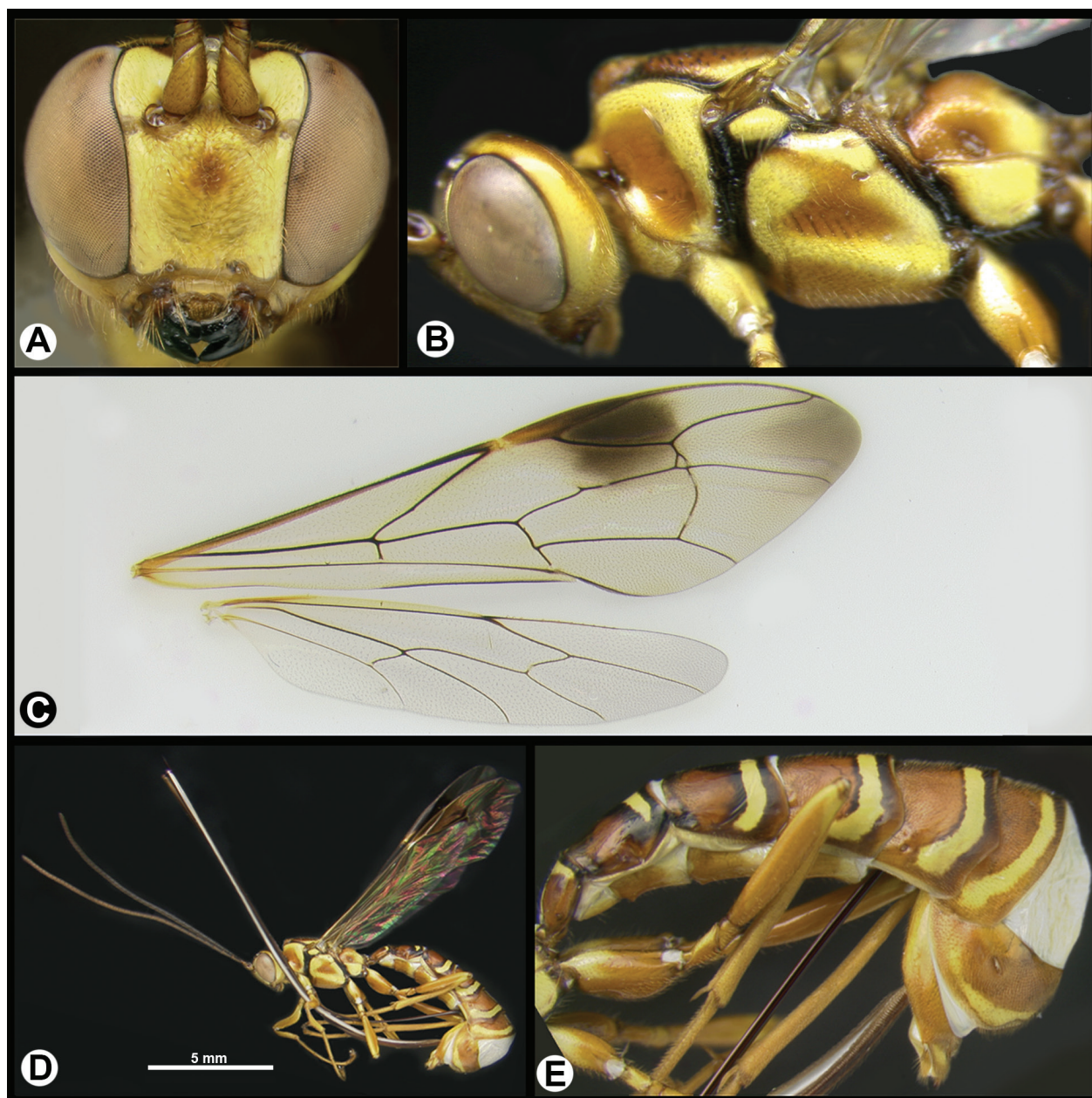


Figure 3. *Megarhyssa greenei* female. A. Anterior head; B. Lateral head and mesosoma; C. Wings; D. Lateral habitus; E. Lateral metasoma.

Females can be distinguished from *M. atrata* by their reddish-brown and yellow body color; from *M. nortoni* by the angled yellow bands on their metasoma; and from *M. macrurus* by the lack of vertical stripes on the face.

Male: Head mostly yellow; mesosoma reddish-brown and yellow; metasoma reddish-brown with yellow and

black markings on first two or three tergites. Wings hyaline; fore wing 10 to 16 mm long.

Males can be distinguished from *M. atrata* by their mesosoma color; from *M. nortoni* and *M. macrurus* by the lack of vertical stripes on the face.

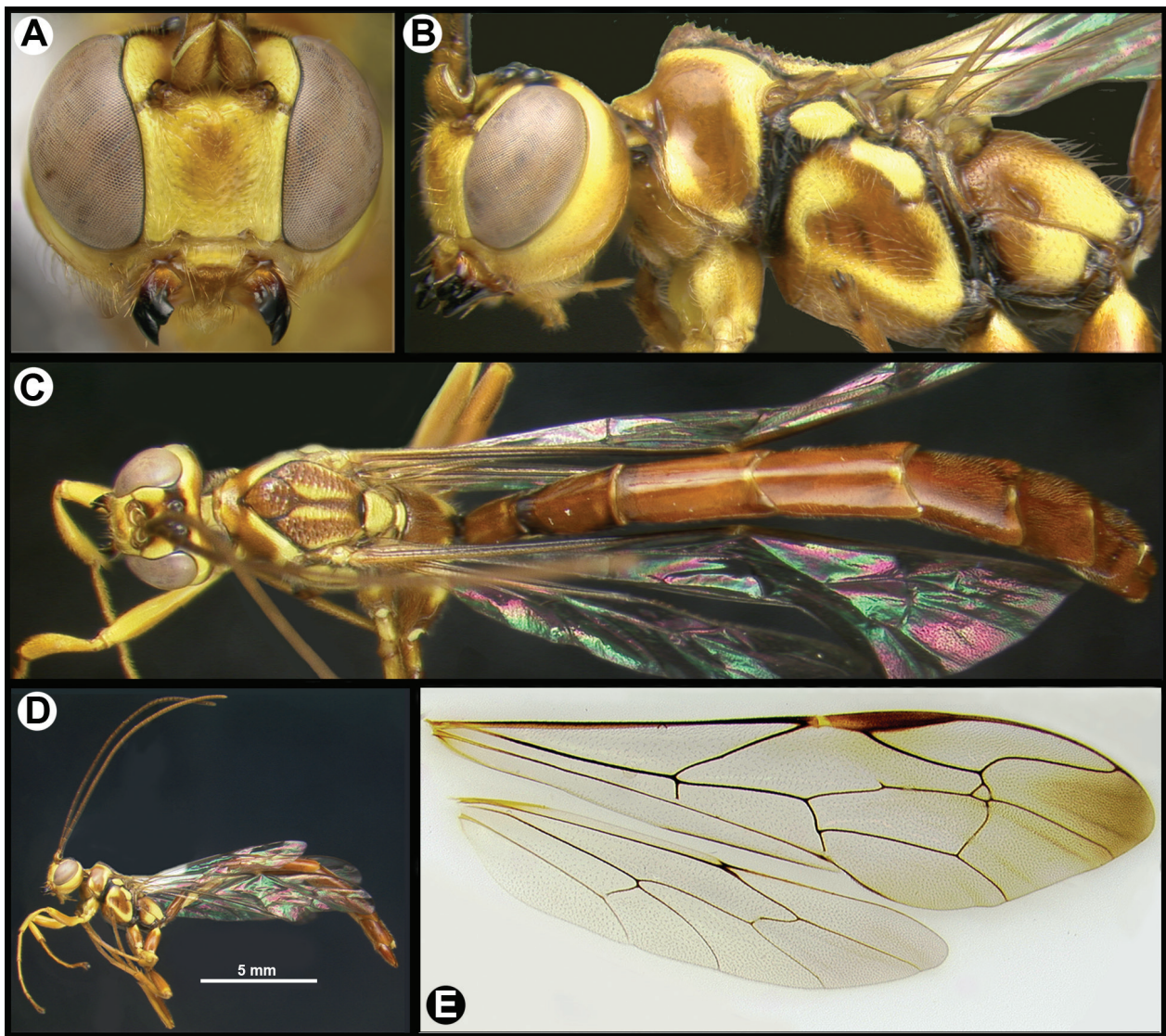


Figure 4. *Megarhyssa greenei* male. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Dorsal habitus; **D.** Lateral habitus; **E.** Wings.

Megarhyssa macrurus (Linnaeus, 1771)

Figs 5–6

There are three subspecies:

Megarhyssa macrurus icterosticta Michener

Megarhyssa lunator icterosticta Michener, 1939. Pan-Pacific Ent. 15: 130.

Megarhyssa macrurus lunator (Fabricius)

Ichneumon lunator Fabricius, 1781. Species Insectorum, v. 1, p. 430.

Thalessa? histrio Kriechbaumer, 1890. Wien, Mus. der Naturgesch., Ann. 5: 487. Preocc. in *Megarhyssa* by *Ichneumon histrio* Christ, 1791.

Megarhyssa macrurus macrurus (Linnaeus)

Ichneumon macrurus Linnaeus, 1771. Mantissa Plantarum, v. 2, p. 540.

Ichneumon georgicus Megerle, 1803. Appendix ad Cat. Ins., Quae Mense Novembris 1802 Vienne Austriae Auctionis Lege Vendita Fuere, p. 16.

Megarhyssa lunatrix Schulz, 1906. Spolia Hym., p. 115. Emendation.

Megarhyssa lunator phaeoptila Michener, 1939. Pan-Pacific Ent. 15: 129.

Note. The specific epithet *macrura* is commonly applied to this species, however the name *macrurus* was interpreted by Townes (1944) and Townes and Townes (1960) as a noun and therefore is not required to match the gender of the genus name.

Geographic range. *M. macrurus icterosticta* is found in Arizona, Colorado, New Mexico, and Utah. *M. macrurus lunator* ranges across the eastern Nearctic to the

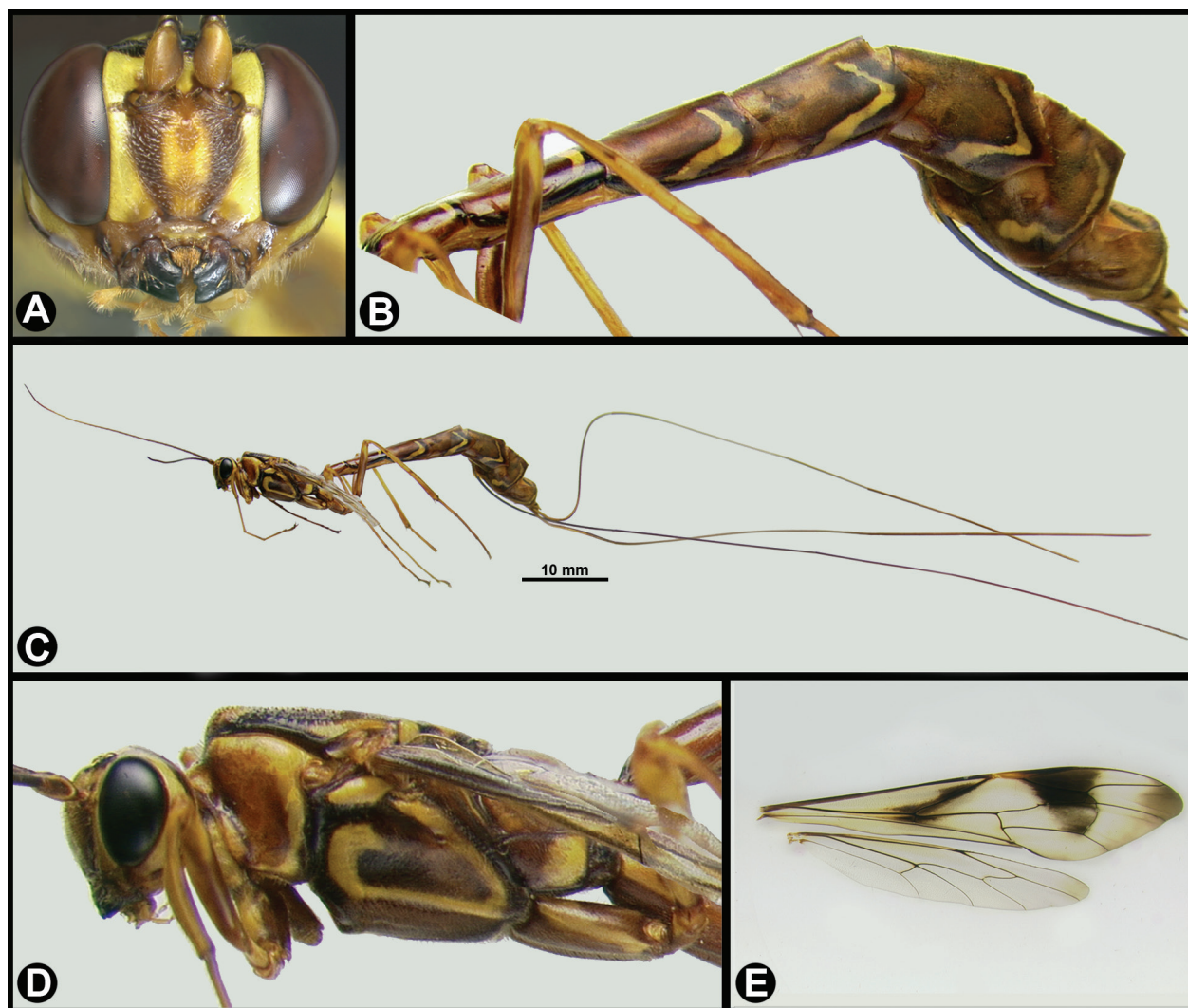


Figure 5. *Megarhyssa macrurus* female. **A.** Anterior head; **B.** Lateral metasoma; **C.** Lateral habitus; **D.** Lateral head and mesosoma; **E.** Wings.

eastern slopes of the Rocky Mountains. *M. macrurus macrurus* extends from Florida to south-western Texas, and has been collected in Mexico (Chihuahua).

Hosts. *Tremex columba* (Carlson, 1979).

Diagnosis. Female. Head yellow and dark brown, with two vertical stripes on face, one below each antennal socket. Mesosoma and metasoma ranging from dark brown to reddish-brown and yellow. Each tergite with an angled yellow band interrupted on the third to sixth tergites. Wings hyaline with brown patches; fore wing 18 to 29 mm long. Ovipositor sheath about 3.0 times as long as fore wing.

Females can be distinguished from *M. atrata* by their body color; from *M. nortoni* by the angled yellow bands

on the tergites; and from *M. greeni* by the vertical stripes on the face.

It should be noted that Carlson (1979) did not separate *M. macrurus lunator* from *M. macrurus macrurus*.

Male. Head yellow and dark brown, with two vertical stripes on face, one below each antennal socket. Mesosoma yellow and blackish brown, metasoma brown, first and second tergites with a short yellow band on hind margin. Wings hyaline, fore wing 7 to 21 mm long with a brown patch at the base of cell 2R1.

Males can be distinguished from the other species occurring in the USA and Canada by the brown patch at the base of cell 2R1 of the fore wing and the presence of two vertical stripes on the face.

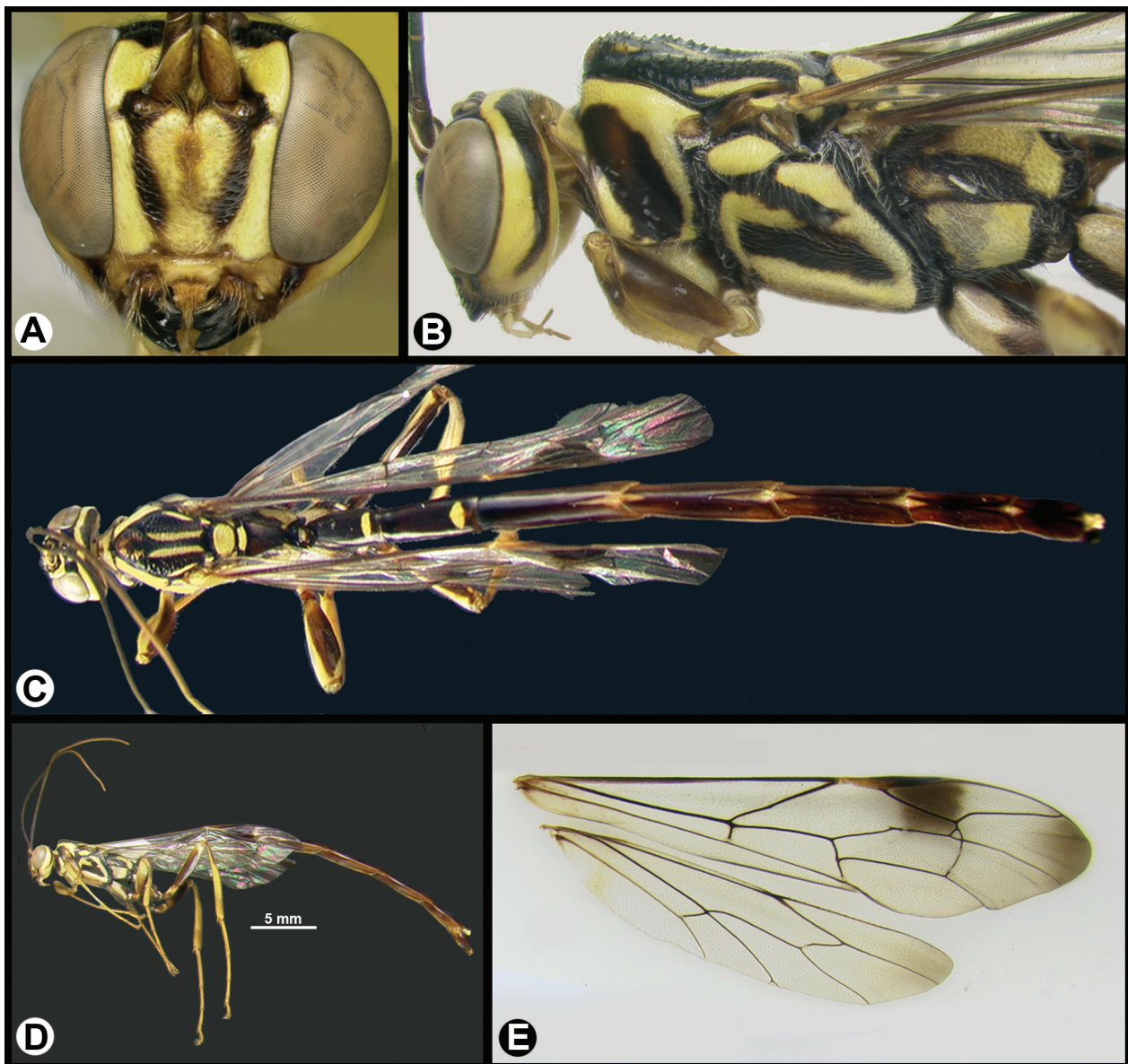


Figure 6. *Megarhyssa macrurus* male. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Dorsal habitus; **D.** Lateral habitus; **E.** Wings.

Megarhyssa nortoni (Cresson, 1864)

Figs 7–8

There are two subspecies:

Megarhyssa nortoni nortoni (Cresson).

Rhyssa nortoni Cresson, 1864. Ent. Soc. Phila., Proc. 3: 317.

Megarhyssa nortonii Dalla Torre, 1901. Cat. Hym., v. 3, p. 481. Emendation.

Megarhyssa nortoni quebecensis (Provancher).

Thalessa quebecensis Provancher, 1873. Nat. Canad. 5: 447.

Geographic range. *M. nortoni nortoni* is distributed along the Pacific Coast from south-western Canada to California, and extends eastward to central Colorado. *M.*

nortoni quebecensis is found in the north-eastern U.S. and adjacent parts of Canada. In the late 1960s and early 1970s this species was collected across the United States and Canada, encompassing the ranges of both subspecies, for introduction as a biocontrol agent in Australia (Taylor 1976) and New Zealand (Bartlett et al. 1978). The populations established in Australia were then introduced to South Africa (Tribe and Cillie 2004).

Hosts. *Sirex noctilio* (Carlson 1979; Nuttall 1980; Valentine and Walker 1991; Vincent and King 1995); *Sirex* sp. (Carlson 1979); *Urocerus albicornis* (Champlain 1921; Townes 1944); *Xeris morrisoni* (Townes 1944).

Diagnosis. Female. Head black to blackish brown and yellow; mesosoma black or blackish brown, with yellow spots; metasoma brown and usually a little paler than me-

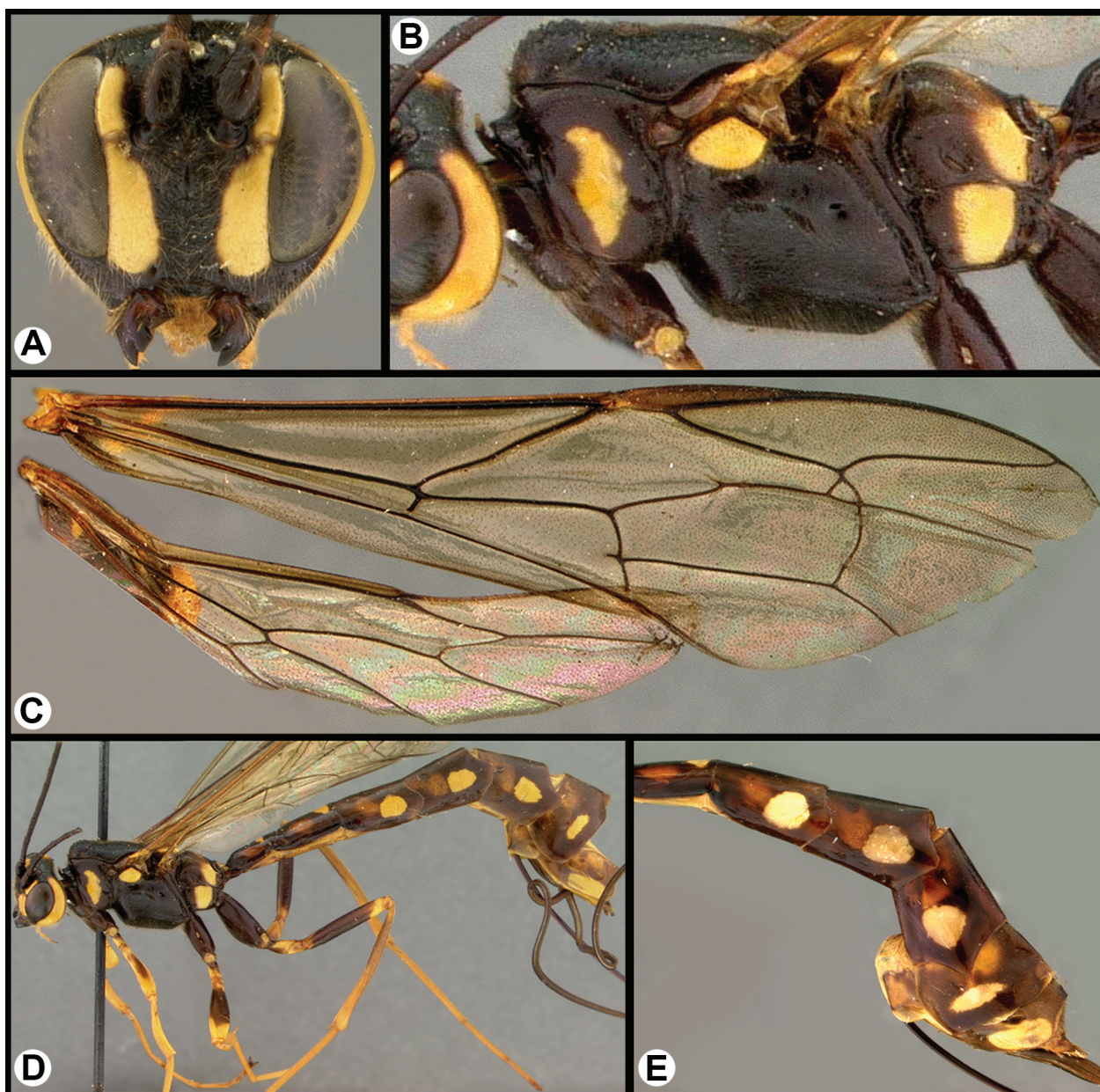


Figure 7. *Megarhyssa nortoni* female. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Wings; **D.** Lateral habitus; **E.** Lateral metasoma.

sosoma. Subtriangular median subapical spot on first and second tergites, large round yellow spot on side of tergites 3-5, and vertical yellow blotch on side of sixth and seventh tergites. Fore wing 13 to 29 mm long. Ovipositor sheath about 2.7 times as long as fore wing.

Females can be distinguished from *M. atrata* by the body color; and from *M. macrurus* and *M. greenei* by the yellow spots on the tergites.

It should be noted that Carlson (1979) did not separate *M. nortoni nortoni* from *M. nortoni quebecensis*.

Male. Head black to blackish brown and yellow; mesosoma black to blackish brown, with yellow spots; metasoma brown, the tergites usually darker medially; the first two tergites with a median subapical yellow spot. Fore wing 9.5 to 20 mm long.

Males can be distinguished from *M. macrurus* by the lack of a brown patch at the base of cell 2R1 of the fore wing and from *M. atrata* and *M. greenei* by the single vertical black band on the face and the color of the mesopleuron.

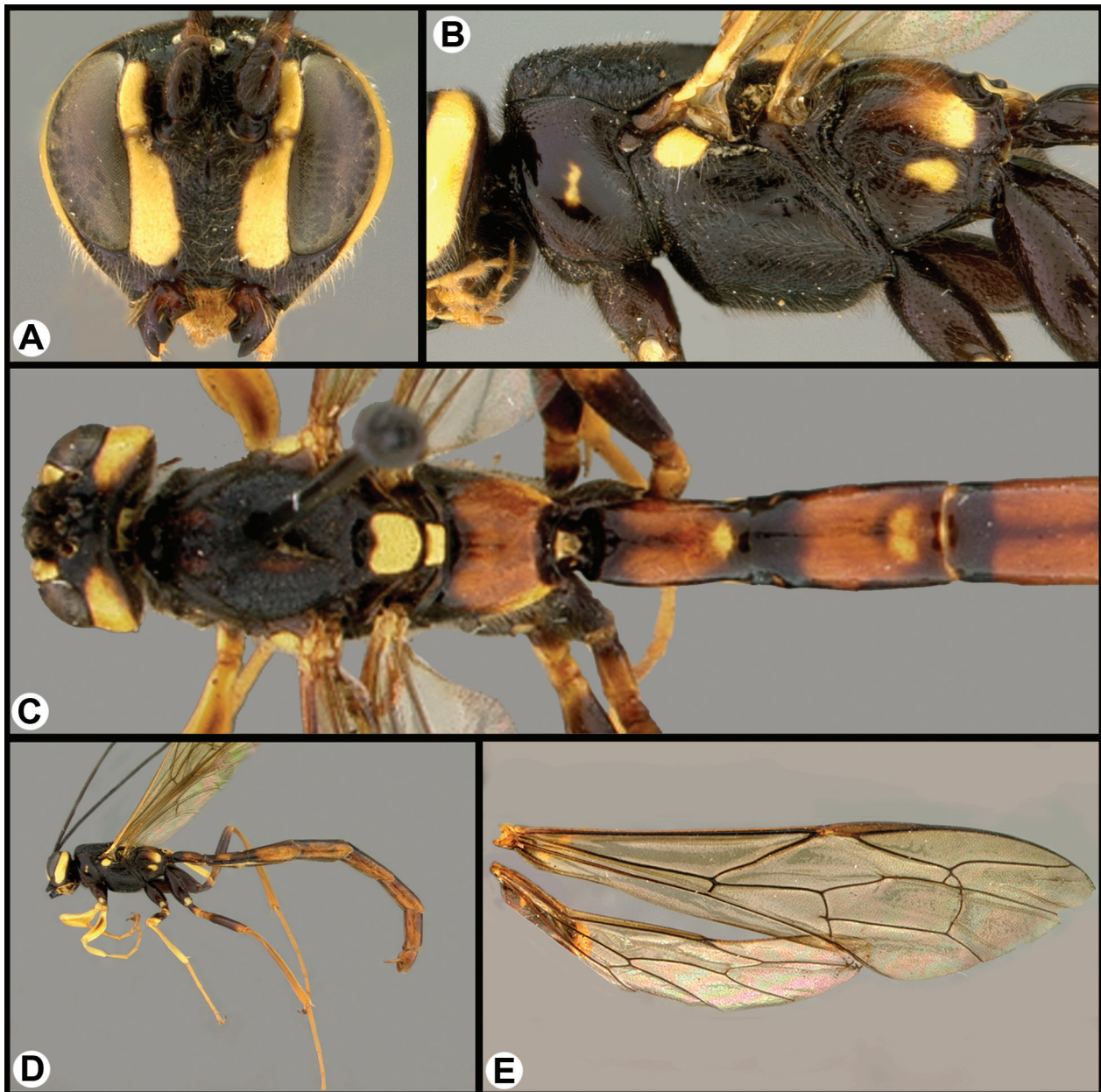


Figure 8. *Megarhyssa nortoni* male. **A.** Anterior head; **B.** Lateral head and mesosoma; **C.** Dorsal habitus; **D.** Lateral habitus; **E.** Wings.

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The authors gratefully acknowledge Drs. Robert Kula, Dominique Zimmerman, Mike Fitton and Jeanne Robinson for loaning specimens and Drs. Gavin Broad, Jason Weintraub and Christine LeBeau for imaging specimens. Taxonomic information was taken from Carlson (1979), Merrill (1915) and Townes and Townes (1960). The authors also thank the Museum für Naturkunde Berlin for their support in the publication of the manuscript. The authors would also like to extend their appreciation to Drs. Ilari Saaksjarvi, Alexey Reshchikov and Ralph Peters for editorial comments. This is publication No. 16-08-012 of the Kentucky Agricultural Experiment Station and is published with the approval of the Director. This work is sup-

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References

- Ashmead WH (1900) Order Hymenoptera. In: Smith JB. Insects of New Jersey, with notes on those of economic importance. MacCrellish and Quigley, Trenton, 755.
- Bartlett BR, Clausen CP, DeBach P, Goeden RD, Legner EF, McMurttry JA, Oatman ER (1978) Introduced parasites and predators of arthropod pests and weeds: A world review. Agricultural Research Service. United States Department of Agriculture. Agriculture Handbook, 480.

- Beaulne JI (1939) Parasites and predators reared at Quebec. *Canadian Entomologist* 71(5): 120. doi: 10.4039/ent71120-5
- Carlson RW (1979) Family Ichneumonidae. Stephanidae. In: Krombein KV, Hurd Jr. PD, Smith DR, Burks BD. *Catalog of Hymenoptera in America north of Mexico*. Smithsonian Institution Press, Washington, 315–741.
- Champlain AB (1921) The curious mating habits of *Megarhyssa atrata* (Fab.). (Hymen.: Ichneumonoidea). *Entomological News* 32: 241.
- Haugen DA, Underdown MG (1990) *Sirex noctilio* control program in response to the 1987 green triangle outbreak. *Australian Forestry* 53(1): 33–40. doi: 10.1080/00049158.1990.10676058
- Heatwole H, Davis DM (1965) Ecology of three sympatric species of parasitic insects of the genus *Megarhyssa* (Hymenoptera: Ichneumonidae). *Ecology* 46(1–2): 140–150. doi: 10.2307/1935265
- Hopkins AD (1893) Catalogue of West Virginia forest and shade tree insects. *West Virginia Agricultural Experiment Station Bulletin* 32: 171–251.
- Hurley BP, Slippers B, Winfield MJ (2007) A comparison of control results for the alien invasive woodwasp, *Sirex noctilio*, in the Southern Hemisphere. *Agricultural and Forest Entomology* 9(3): 159–171. doi: 10.1111/j.1461-9563.2007.00340.x
- Khalaim AI, Ruiz-Cancino E (2013) A new species of *Megarhyssa* Ashmead (Hymenoptera: Ichneumonidae: Rhyssinae) from tropical Mexico with a key to Mexican species. *Zootaxa* 3619(2): 195–200. doi: 10.11646/zootaxa.3619.2.7
- Merrill JH (1915) On some genera of the pimpline Ichneumonidae. *Transactions of the American Entomological Society* 41: 109–154. doi: 10.5962/bhl.title.63578
- Nénon JP (1995) Bioecology of *Megarhyssa atrata* (Hymenoptera: Ichneumonidae), an ectoparasitoid of *Tremex columba* (Hymenoptera: Siricidae) in Quebec. *Phytoprotection* 76(3): 115–122. doi: 10.7202/706090ar
- Nuttall MJ (1980) Insect parasites of *Sirex* (Hymenoptera: Ichneumonidae, Ibalidae, and Orussidae). *Forest and Timber Insects of New Zealand* 47: 1–11.
- Stillwell MA (1967) The pigeon tremex, *Tremex columba* (Hymenoptera: Siricidae), in New Brunswick. *Canadian Entomologist* 99: 685–689. doi: 10.4039/Ent99685-7
- Taylor KL (1976) The introduction and establishment of insect parasitoids to control *Sirex noctilio* in Australia. *Entomophaga* 21(4): 429–440. doi: 10.1007/BF02371642
- Taylor KL (1978) Evaluation of the insect parasitoids of *Sirex noctilio* (Hymenoptera: Siricidae) in Tasmania. *Oecologia* 32(1): 1–10. doi: 10.1007/BF00344686
- Townes HK (1944) A Catalogue and Reclassification of the Nearctic Ichneumonidae (Hymenoptera). Part I. The subfamilies Ichneumoninae, Tryphoninae, Cryptinae, Phaeogeninae and Lissonotinae. *Memoirs of the American Entomological Society* 11: 1–477.
- Townes HK (1969) The genera of Ichneumonidae, Part I. *Memoirs of the American Entomological Institute* 11: 300. doi: 10.1007/bf02027741
- Townes HK, Townes M (1951) Family Ichneumonidae. In: Muesebeck CFW, Krombein KV, Townes HK (Eds) *Hymenoptera of America north of Mexico – Synoptic catalog*. USDA. Agriculture Monograph 2: 184–409.
- Townes HK, Townes M (1960) Ichneumon-flies of American north of Mexico: 2 Subfamily Ephialtinae, Xoridinae, Acaenitinae. *United States National Museum Bulletin* 216(2): 1–676. doi: 10.5479/si.03629236.216.1-2
- Treherne RC (1916) A preliminary list of parasitic insects known to occur in Canada. *Reports of the Entomological Society of Ontario* 46: 178–193.
- Tribe GD, Cillie JJ (2004) The spread of *Sirex noctilio* Fabricius (Hymenoptera: Siricidae) in South African pine plantations and the introduction and establishment of its biological control agents. *African Entomology* 12(1): 9–17.
- Valentine EW, Walker AK (1991) Annotated catalogue of New Zealand Hymenoptera. D.S.I.R. Plant Protection.
- Vincent JFV, King MJ (1995) The mechanism of drilling by wood wasp ovipositors. *Biomimetics* 3(4): 187–201.
- Wahl DB, Gauld ID (1998) The cladistics and higher classification of the Pimpliformes (Hymenoptera: Ichneumonidae). *Systematic Entomology* 23: 265–298. doi: 10.1046/j.1365-3113.1998.00057.x
- Yu DSK, van Achterberg C, Horstmann K (2012) Taxapad 2012, Ichneumonoidea 2011. Database on flash-drive. www.taxapad.com, Ottawa, Ontario, Canada.

Supplementary material 1

Delta Editor Character Matrix

Authors: Victoria G. Pook, Michael J. Sharkey, David B. Wahl
Data type: specimens data

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Supplementary material 2

Interactive Key

Authors: Victoria G. Pook, Michael J. Sharkey, David B. Wahl
Data type: species key

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The Pselaphinae (Coleoptera, Staphylinidae) of New Caledonia and Loyalty Islands. III. *Kieneriella*, a new genus of the tribe Brachyglutini

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<http://zoobank.org/419C1640-610F-4CAA-819A-E67FEC924274>

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Abstract

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A new genus of the tribe Brachyglutini (Pselaphinae: Goniaceritae), *Kieneriella* **gen. n.**, is described based on a new species *K. novaecaledoniae* **sp. n.** from New Caledonia. The strongly elongate maxillary palpi of *Kieneriella* is an unusual character state found in other genera of the tribe. The new taxon is compared with allied relatives, and its major diagnostic features are illustrated.

Key Words

Taxonomy
rove beetles
Pselaphinae
new species
Oceania
biodiversity

Introduction

The tribe Brachyglutini Raffray of the pselaphine supertribe Goniaceritae Reitter (Newton and Thayer 1995) currently holds 1510 extant species classified in four tribes and 116 genera worldwide (Chandler 2001; Newton unpublished database). This tribe is represented by 28 genera in Australia (Chandler 2001), eight genera in New Zealand (Nomura and Leschen 2006), and six genera in Oceania (Park 1952). In New Caledonia, Brachyglutini are so far represented by four genera with ten species (Hlaváč et al. 2006), but this number of species is likely to increase as a result of studies of a large numbers of undetermined specimens from this region (Hlaváč pers. obs.).

Recently when visiting the Muséum d'histoire naturelle, Geneva, the senior author found a peculiar pselaphine with greatly elongate maxillary palpi from the New Caledonia. Further examination of this material

revealed that it represents a new genus and species of Brachyglutini, which is described in the present paper. This work is the third of a series of papers (1–2 see Hlaváč et al. 2006; Hlaváč 2009) focusing on the pselaphine fauna of New Caledonia.

Material and methods

Material studied in this paper is housed in the Muséum d'histoire naturelle de Genève, Switzerland (MHNG).

Disarticulated and dissected parts were preserved in Euparal on plastic slides that were placed on the same pin with the specimen. The habitus image was taken using a Canon 7D camera in conjunction with a Canon MP-E 65mm f/2.8 1-5X Macro Lens and a Canon MT-24EX Macro Twin Lite Flash. Images of the morphological details were made using a Canon G9 camera mounted on

an Olympus CX31 microscope. Zerene Stacker (version 1.04) was used for image stacking. All images were modified and grouped in Adobe Photoshop CS5 Extended. The collecting data of the material are quoted verbatim.

The following abbreviations are applied: AL—length of the abdomen along the midline; AW—maximum width of the abdomen; EL—length of the elytra along the suture; EW—maximum width of the elytra; HL—length of the head from the anterior clypeal margin to the occipital constriction; HW—width of the head across eyes; PL—length of the pronotum along the midline; PW—maximal width of the pronotum. The length of the body is a combination of HL + PL + EL + AL. Terminology for morphological structures follows Chandler (2001) with the exception that the term ‘ventrite’ replaces ‘sternite’, except prosternum.

Taxonomy

Kieneriella Yin & Hlaváč, gen. n.

<http://zoobank.org/F79344A7-2F25-4DBF-8782-23F7E9AB6DE5>

Figs 1–3

Type species. *Kieneriella novaecaledoniae* sp. n., here designated.

Diagnosis. Head with large nude vertexal foveae and small frontal fovea; antennal club loosely formed by two apical antennomeres; median gular ridge prominent and broad. Pronotum globular, with setose median and lateral antebasal foveae, lacking transverse antebasal sulcus connecting these foveae. Each elytron with two large basal foveae, lacking discal stria. Tergite IV (first visible tergite) with two basolateral foveae in transverse basal sulcus; sternite IV (second visible sternite) with deep basolateral sulci.

Description. Length 2.72 mm. Head with large, nude vertexal foveae (Fig. 1B, *vf*); lacking frontal rostrum, with small frontal fovea (Fig. 1B, *ff*); antennal tubercles moderately prominent; lateral margins lacking postantennal notches; with eleven antennomeres, antennal club weakly formed by two apical antennomeres (Fig. 1A); ocular-mandibular carinae (Fig. 3B, *omc*) present; gular plate (Fig. 1C, *gp*) large, with well-defined gular suture (Fig. 1C, *gs*) demarcating ventrally ‘neck region’ from anterior part of head, median gular ridge (Fig. 1C, *mgr*) prominent and large, edges of gular ridge divergent, merging medially anterior to fused gular tentorial pits (Fig. 1C, *gtp*); maxillary palpus (Fig. 3C) greatly elongate, with short palpomere I, II elongate, more than twice as long as of III, palpomere III briefly pedunculate at base, semi-triangular, IV about twice as long as III, slightly curved through entire length, with long palpal cone.

Pronotum globular (Fig. 1B), disc strongly convex, finely punctate; with setose median and lateral antebasal foveae (Fig. 1B, *maf*, *laf*), lacking antebasal sulcus connecting foveae; paranotal sulci slightly curved, extending from base to half of pronotal length.

Each elytron with two large basal foveae (Fig. 3F, *bef*), with indistinct subbasal fovea (Fig. 3F, *sef*); sutural striae (Fig. 3F, *ss*) entire and deep, lacking discal striae, subhumeral foveae, and marginal striae.

Prosternum with large, setose procoxal foveae widely separated. Mesoventrite (Fig. 2A) lacking median fovea, with lateral mesoventral and lateral mesocoxal foveae (Fig. 2A, *lmsf*, *lmc*); metaventrite with lateral foveae (Fig. 2A, *lmtf*) moving medially and close, metaventral process broadly emarginate at middle, with two distinct lateral projections.

Abdomen (Fig. 2B–D) with tergite IV (first visible tergite) about as long as V; tergite IV with basal sulcus (Fig. 2C, *bs*) covered by elytra in natural position (Fig. 1A), with two basolateral foveae (Fig. 2C, *blf*); tergites IV–VII each with adjacent paratergites. Sternite IV (second visible sternite) with deep basolateral sulci (Fig. 2D, *bls*), with mediobasal and basolateral foveae in sulci (Fig. 2D, *mbf*, *blf*).

Legs with tarsomeres II and III subequal in length.

Male with spinose protibia (Fig. 3E). Aedeagus (Fig. 3G–3H) with almost symmetric median lobe except dorsally oriented apical hook, and pair of broad, flattened, and nearly symmetric parameres (Fig. 3I, detached from median lobe). Female with simple protibiae.

Comparative notes. The short dorsal margin of the mesotrochanters (Fig. 3D), barely visible short abdominal sternite III, and separated metacoxae (Fig. 2D) place *Kieneriella* in the subtribe Brachyglutina (Goniaceritae: Brachyglutini), near the *Rybaxis* group of genera whose median gular ridge is well-defined, prominent, and large (Chandler 2001: 292). At present, four genera and ten species of Goniaceritae are known from New Caledonia: *Anasopsis* Raffray (3 spp.), *Baraxina* Raffray (1 sp.), *Eupines* King (5 spp.), and *Physoplectus* Reitter (1 sp.) (Hlaváč et al. 2006). *Kieneriella* is morphologically similar to the only New Caledonian member of the *Rybaxis* group, *Baraxina*, by the same foveal pattern of the head and pronotum, more or less elongate maxillary palpi, and similar length of the abdominal segments. *Kieneriella* can be readily separated from *Baraxina* by the maxillary palpi with much more elongate and slender palpomeres II and IV, and basally pedunculate and semi-triangular palpomeres III, presence of two basal elytral foveae, deep sutural striae of the elytra, and fused gular tentorial pits. *Baraxina* also have relatively elongate palpomeres II and IV, but they are more robust and less extended than in *Kieneriella*. Also, in *Baraxina*, the palpomeres III are roundly triangular, three basal foveae are present on each elytron, the sutural striae on the elytra are indistinct, and the gular tentorial pits are well-separated.

The strongly extended maxillary palpi is an unusual character state for Brachyglutini. A similar condition can be found only in a limited number of genera, e.g. *Triomicrus* Sharp, and an undescribed genus near *Triomicrus* from Sri Lanka (preserved in MHNG). *Kieneriella* can be separated from *Triomicrus* by the unmodified male

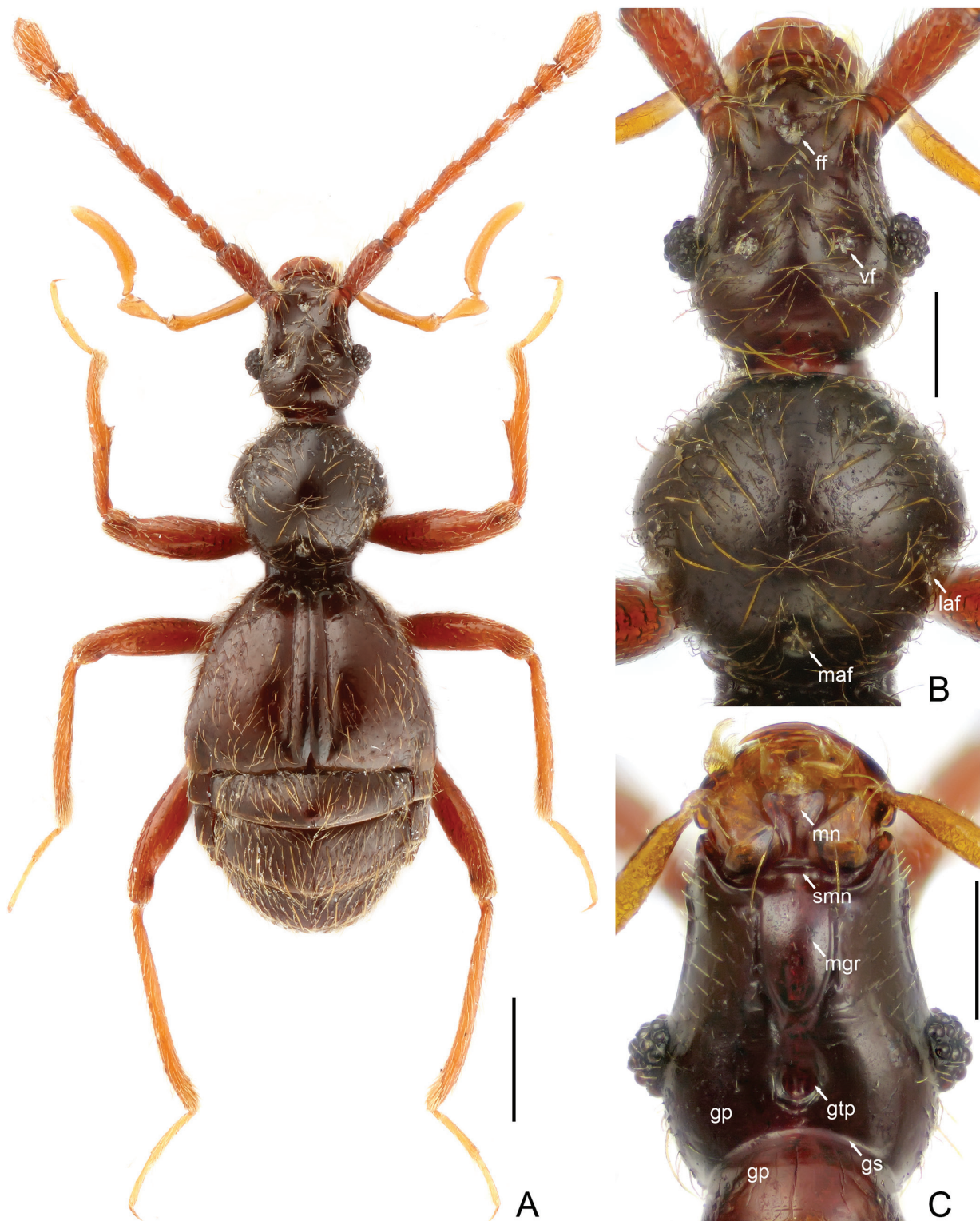


Figure 1. Diagnostic features of *Kieneriella novaecaledoniae*, male. **A.** Dorsal habitus; **B.** Head dorsum and pronotum; **C.** Head venter. Abbreviations: laf—lateral antebasal foveae; ff—frontal fovea; gp—gular plate; gtp—gular tentorial pits; gs—gular suture; maf—median antebasal fovea; mgr—median gular ridge; mn—mentum; smn—submentum; vf—vertexal foveae. Scales: **A** = 0.5 mm; **B**, **C** = 0.2 mm.

antennomeres XI and sternite VII, much more constricted pronotal and elytral bases, lack of discal striae on the elytra, relatively shorter tergite IV, and structures of the aedeagus.

Etymology. The generic name is dedicated to the Swiss entomologist Severino Kiener (1955–1998), who collected the holotype during his 1986 trip to New Caledonia (Marggi 2003). The gender of *Kieneriella* is feminine.

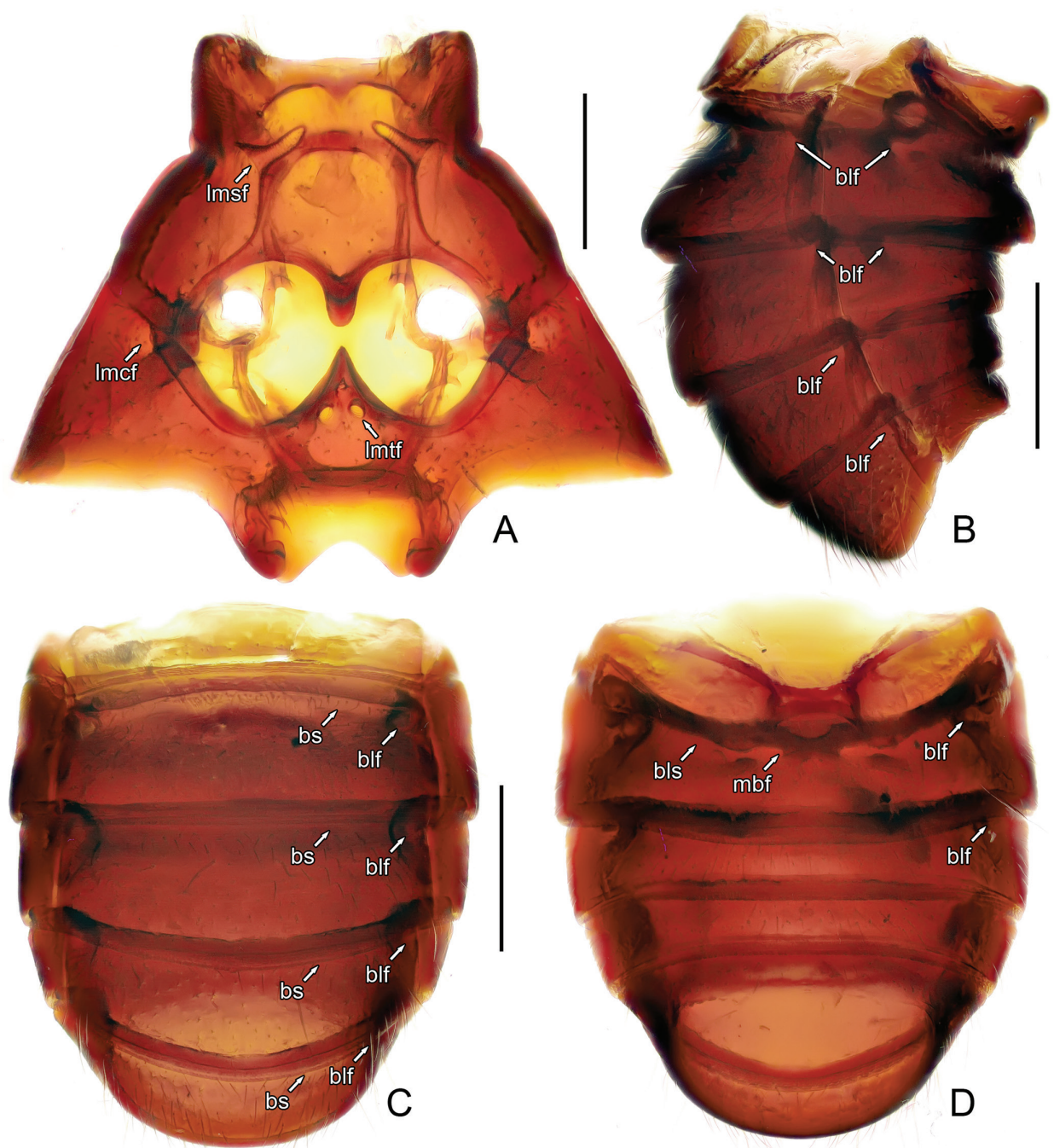


Figure 2. Diagnostic features of *Kieneriella novaecaledoniae*, male. **A.** Meso- and metaventrite; **B.** Abdomen, in lateral view; **C.** Same, in dorsal view; **D.** Same, in ventral view. Abbreviations: blf—basolateral foveae; bls—basolateral sulci; bs—basal sulcus; lmcf—lateral mesocoxal foveae; lmsf—lateral mesoventral foveae; lmtf—lateral metaventral foveae; mbf—mediobasal foveae. Scales: **A** = 0.2 mm; **B–D** = 0.3 mm.

***Kieneriella novaecaledoniae* Yin & Hlaváč, sp. n.**

<http://zoobank.org/CA431E15-399E-40F8-9D0F-93A78085981A>

Figs 1–3

Type material. Holotype ♂ (head and pronotum lost after photography and measurement, other body parts completely disarticulated and preserved in Euparal slides): ‘Nouvelle Calédonie, Touaourou côte sud, 16–18.xi.1986, leg. S. Kiener (hand written) / HOLOTYPE

(red) ♂, *Kieneriella novaecaledoniae* sp. n., det. Yin & Hlaváč, 2016 (hand written) / MHNG ENTO 00008971 (accession number, printed)’ (MHNG). According to Kiener’s 1986 unpublished locality list preserved in MHNG, this specimen was collected from ‘Regenwald Bodenstreu (= Rainforest floor litter)’ (Cuccodoro pers. comm.).

Diagnosis. Same as that of the genus, plus the protibia with an acute denticle at the middle of the mesal margin,

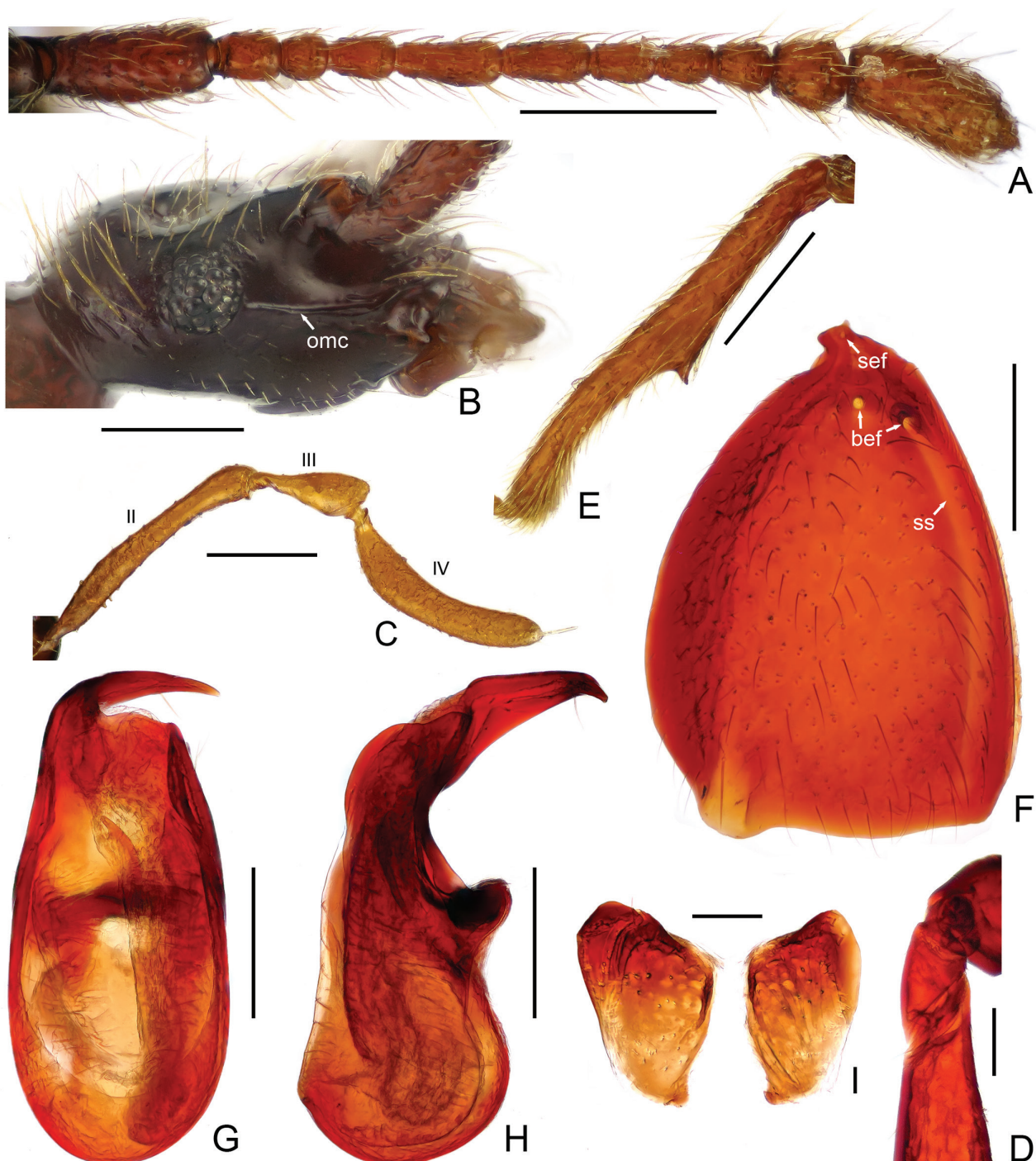


Figure 3. Diagnostic features of *Kieneriella novaecaledoniae*, male. **A.** Antenna; **B.** Head, in lateral view; **C.** Maxillary palpus; **D.** Mesotrochanter; **E.** Protibia; **F.** Left elytron; **G.** Aedeagus, in dorsal view; **H.** Same, in lateral view; **I.** Aedeagal parameres, in ventral view. Abbreviations: bef—basal elytral foveae; omc—ocular-mandibular carinae; sef—subhumeral fovea; ss—sutural striae. Scales: **A, F** = 0.3 mm; **B, C, E, G, H** = 0.2 mm; **D, I** = 0.1 mm.

aedeagus with the median lobe being strongly curved toward left at the apex, and flattened parameres.

Description. Male (Fig. 1A). Length 2.72 mm. Head (Fig. 1B) distinctly longer than wide, HL 0.60 mm, HW 0.51 mm; dorsal surface finely punctate, sparsely covered with relatively long suberect setae; vertex moderately raised at middle, with distinct nude vertexal foveae (Fig.

1B, vf) situated at level of middle of eyes; frons distinctly extended, with small frontal fovea (Fig. 1B, ff) between moderately prominent antennal tubercles; clypeus short, with round anterior margin; eyes prominent, each composed of about 25 facets; ocular-mandibular carinae (Fig. 3B, omc) extending from anterior margins of eyes to clypeal apex; lateral areas of ventral part of head sparsely

covered with short setae; gular area (Fig. 1C) with two small tentorial pits in shared oval opening, edges of gular ridge extending from anterior margin of tentorial pits opening toward mouthparts, with single macroseta at end of each edge. Maxillary palpus (Fig. 3C) greatly elongate, length of palpomeres II–IV: 0.48 mm, 0.20 mm, 0.41 mm, respectively; palpomere I small, II briefly narrowed at base and slightly broadened at apex, III briefly pedunculate at base, with broadened apical half, IV with narrowed base, evenly curved laterally throughout entire length, with long palpal cone. Antenna (Fig. 3A) with enlarged scape and antennomere XI, antennal club weakly formed by two apical antennomeres. Pronotum transversely globular, PL 0.60 mm, PW 0.65 mm, disc finely punctate and sparsely setose. Elytra (Fig. 3F) with broad posterior margin and strongly constricted base, much wider than long, EL 0.77 mm, EW 1.0 mm; lacking metathoracic wings. Thorax (Fig. 2A) short and transverse; metaventral process emarginate at middle, with two distinct obtuse projections. Legs simple, except protibia (Fig. 3E) with one acute spine at middle of mesal margin. Abdomen (Fig. 2B–D) with long pubescence on dorsal surface, slightly wider than long, AL 0.75 mm, AW 0.79 mm; tergites IV–VI of similar length, VII slightly shorter; sternite IV with pair of submedian projections. Length of aedeagus (Fig. 3G–H) 0.66 mm, median lobe almost symmetric, dextrally oriented apical hook sharp, acute, with one preapical macroseta; pair of parameres (Fig. 3I, detached from median lobe) broad and flattened, nearly symmetric; endophallus composed of single thin, elongate sclerite.

Female. Unknown.

Distribution. New Caledonia: southern Grande Terre.

Etymology. The specific epithet is derived from the type locality of the new species, i.e., New Caledonia.

Kieneriella species

Material examined. 1 ♀: 'New Caledonia, Mt. Koghi, 500–600m, 14.XI.1997. I. Löbl, prim. forest, litter / MHNG ENTO 00008972 (accession number, printed)' (MHNG).

Comments. This specimen is very similar to *K. novae-caledoniae* sp. n. but without an associated male it is not possible to determine whether they are conspecific or not. This female confirms that the spinose protibiae is a male sexual character of the genus, the protibiae of the females are simple and unmodified.

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Alfred Newton (Field Museum, Chicago, USA) provided exact number of the species of Brachyglutini from his unpublished staphylinid database. Giulio Cuccodoro (MHNG) provided a large loan of unstudied pselaphine material to the senior author including the new taxon described in this paper. Christopher Carlton (Louisiana State Arthropod Museum, USA) and Giulio Cuccodoro read a previous version of the manuscript and provided helpful comments. The senior author was supported by a grant of the National Natural Science Foundation of China (No. 31501874), and a grant of the Science and Technology Commission of Shanghai Municipality (No. 15YF1408700), the junior author was supported by grant CIGA No. 20154312 of the Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences. The open access fee was covered by the Museum für Naturkunde Berlin.

References

- Chandler DS (2001) Biology, morphology, and systematics of the ant-like litter beetles of Australia (Coleoptera: Staphylinidae: Pselaphinae). *Memoirs on Entomology International* 15: 1–560.
- Hlaváč P (2009) The Pselaphinae (Coleoptera: Staphylinidae) of New Caledonia and Loyalty Islands. II. Revision of the tribe Tyrini Reitter, 1882. *Zootaxa* 2010: 46–56.
- Hlaváč P, Monteith GB, Dunay G (2006) Pselaphinae (Coleoptera: Staphylinidae) of New Caledonia: I. *Taomica*, new genus of Pselaphini, with a catalogue of Pselaphinae of New Caledonia. *Memoirs of the Queensland Museum* 2: 79–86.
- Marggi W (2003) In memoriam Severino Kiener. *Mitteilungen der Entomologischen Gesellschaft Basel* 53: 37–40.
- Newton AF, Thayer MK (1995) Protopselaphinae new subfamily for *Protopselaphus* new genus from Malaysia, with a phylogenetic analysis and review of the Omaliine Group of Staphylinidae including Pselaphidae (Coleoptera). In: Pakakuk J, Slipinski SA (Eds) *Biology, Phylogeny, and Classification of Coleoptera: Papers celebrating the 80th Birthday of Roy A. Crowson* (Vol. 1). Muzeum i Instytut Zoologii PAN, Warszawa, 219–320.
- Nomura S, Leschen AB (2006) Faunistic review on the Pselaphinae species known from New Zealand (Insecta, Coleoptera, Staphylinidae). *Proceedings of the 7th and 8th Symposia on Collection Building and Natural History Studies in Asia and the Pacific Rim*. In: Tomida Y, Kubodera T, Akiyama S, Kitayama T (Eds) *National Science Museums Monographs*, 34. Tokyo, 239–272.

A review of the genus *Xotidium* Löbl, 1992 (Coleoptera, Staphylinidae, Scaphidiinae), with descriptions of five new species

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Abstract

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In the present study, we have reviewed all species of the genus *Xotidium* Löbl, 1992, as well as five new species from Borneo, Malaysia, and Sulawesi, Indonesia, namely, *Xotidium flagellum* sp. n., *X. heissi* sp. n., *X. meridionale* sp. n., *X. smetanai* sp. n., *X. tarantulatatum* sp. n. A key to all *Xotidium* species is provided. The female genitalic characters of *Xotidium* are illustrated and described for the first time.

Key Words

Shining fungus beetle

Baeocera group

female genitalia

Borneo

Sulawesi

key to species

Introduction

The genus *Xotidium* Löbl, 1992, currently comprises seven species from the subtropical and tropical regions of Mauritius, Sri Lanka, the Himalayas, the Lesser Sunda Islands, the Philippines, and Eastern Australia. Members of this genus have narrow body with approximate mesocoxae and metacoxae. They appear to be related to the members of *Scaphoxium* Löbl, 1979 and *Toxidium* LeConte, 1860, belonging to the *Toxidium* group because of the shared approximate mesocoxae and metacoxae. However, this genus was included in the *Baeocera* group by Leschen and Löbl (2005) based on seven synapomorphies. *Xotidium* can be readily distinguished from *Scaphoxium* and *Toxidium* by the presence of multidentate mandibles, two-segmented labial palpi, pronotum with anterior bead, and the presence of secondary lines of mesoventrite. They may be collected from fungi growing

up rotten woods and accumulated litter on the forest floor, based on collection data and personal observation. They are also usually found in the higher altitudes of forested areas. However, their feeding habits and natural history still remain unknown. *Xotidium* is distributed exclusively in the subtropical and tropical parts of Palaeotropical region, excluding Neotropical region, parts of Indonesia Islands to Australia, and the continental Africa. Some unidentified samples collected from Borneo, Malaysia, which have been preserved at Muséum d'histoire naturelle, Genève, Switzerland, and new samples, which were collected in Sulawesi, Indonesia by the first author, are described below as new species, and new information about their distribution is provided. In addition, female genitalia have been observed to be useful in the scaphidiines for defining a group of species or specific species (Ogawa and Sakai 2011; Ogawa and Löbl 2013). However, such characterization needs further investigation.

In the present study, we have reviewed all the members of *Xotidium* and describe five new species collected from Borneo, Malaysia, and Sulawesi, Indonesia, and present the first reported observations of the female genitalia in *Xotidium*. Moreover, we provide a key to all *Xotidium* species, including these new species.

Material and methods

The examined samples were collected by the first author and procured from the collections deposited at the Natural History Museum, London, United Kingdom (NHM) and the Muséum d'histoire naturelle, Genève, Switzerland (MHNG). We have referred to a study by Ogawa and Löbl (2013) and the references quoted therein for methods and terminology. The photographs of the habitus in dorsal and lateral views were captured using a single-lens reflex camera (Canon® Eos Kiss X7) with a macro photo lens (Canon® MP-E 65mm Macro lens) attached to a stand (LPL® CSC-10), and then the focus-stack images were created using COMBINE ZM. A stereomicroscope and biological microscope with a single-lens reflex camera (described above) were used for illustrations. Measurements of the body length and width and of the antennae were taken using an ocular micrometer under the stereomicroscope, but antennomere I was not measured. Some of the illustrations of the lateral habitus are mirror-reversed because of the symmetrical ventral structure. The label data are given verbatim.

The abbreviations used are as follows: **EL**, length of elytra from base of pronotum to apex of elytra; **EW**, maximum width of elytra; **HW**, maximum width of head including eye; **ID**, interocular distance; **PL**, maximum length of pronotum; **PW**, maximum width of pronotum; **EUMJ**, Ehime University Museum, Matsuyama, Japan; **NHM**, Natural History Museum, London, United Kingdom; **MHNG**, Muséum d'histoire naturelle, Genève, Switzerland; **MZBI**, Museum Zoologicum Bogoriense, Bogor, Indonesia.

Taxonomy

Xotidium Löbl, 1992

Xotidium Löbl, 1992: 573; type species: *Xotidium unifornae* Löbl, 1992.

Diagnosis. Body narrow, usually 1.8 times as long as wide. Maxillary palpomere IV aciculate with some macrosetae (Fig. 2d, h). Labial palpus two segmented, apical segment very slender (Fig. 2c, g). Mentum setose (Fig. 2b). Antenna filiform; antennomere III slender, straight; antennomeres each VII–XI covered with microsetae. Mandible multidentate apically; mola with brush (Fig. 2e, i). Galea broad, without subapical short

bristles. Anterior margin of pronotum with a bead. Posterior angle of pronotum not pointed (obtuse), lateral margin not sinuate, sub-basal stria absent. Eyes weakly emarginate. Prothoracic corbiculum present. Secondary lines of mesoventrite present. Anterior portion of proventrite greatly reduced. Elytra usually with entire basal stria joined with lateral and sutural stria, sometimes sutural stria interrupted. Mesepimeron reduced, small or concealed (Fig. 1). Visible abdominal ventrite I without metacoxal bead. Profemoral ctenidium absent. Meso- and metatibiae with single long spur. Meso- and metacoxae adjacent.

Remarks. The shape of the labral apex in this genus is possibly species specific (Fig. 2a, f).

Xotidium bolmarum Löbl, 2015

Figs 3a, 6a, 7g, 9a

Xotidium bolmarum Löbl, 2015: 119.

Type material examined. Paratypes, 1♂4♀, INDONESIA, LOMBOK IS., SENARO, N slope of Rinjani, 2–5. Feb. 1994, Bolm lgt. 1100m. (MHNG).

Supplemental description of female genitalia. Ovipositor simple: gonostylus with a long apical seta, almost as long as wide: distal gonocoxites elongated (Fig. 9a). Spermatheca connected in medial portion of vagina (Fig. 9a).

Measurements (n = 4). Length (PL+EL): 1.40–1.48 mm, PW: 0.77–0.79 mm, EW: 0.83–0.87 mm, HW: 0.31–0.35 mm, ID: 0.10–0.13 mm, PL/PW: 0.71–0.78, EL/EW: 1.00–1.05. Approximate ratio of each antennal segment in length (width) (n = 1): II 1.1 (0.5) : III 1.0 (0.2) : IV 1.1 (0.2) : V 1.3 (0.2) : VI 1.4 (0.2) : VII 1.4 (0.3) : VIII 1.4 (0.2) : IX 1.7 (0.3) : X 1.3 (0.4) : XI 1.7 (0.5).

Distribution (see Löbl 2015). Indonesia: Lombok.

Xotidium mauritianum (Vinson, 1943)

Figs 4b, 6b, 9g

Toxidium mauritianum Vinson, 1943: 201. Transferred: Leschen and Löbl 2005.

Material examined. 2♂1♀, Mauritius, Le Pouce, 18. XI. 1943, J. Vinson. (MHNG).

Supplemental description of female genitalia. Ovipositor simple: gonostylus short, longer than wide, with a long apical seta: distal gonocoxites elongated and slightly robust (Fig. 9g). Spermathecae undetected.

Measurements (n = 3). Length (PL+EL): 1.34–1.51 mm, PW: 0.72–0.79 mm, EW: 0.75–0.85 mm, HW: 0.32–0.34 mm, ID: 0.11–0.13 mm, PL/PW: 0.71–0.74, EL/EW: 1.08–1.11. Approximate ratio of each antennal segment in length (width) (n = 1): II 1.5 (0.5) : III 1.0 (0.3) : IV 1.0 (0.3) : V 1.0 (0.3) : VI 1.1 (0.3) : VII 1.5 (0.4) : VIII 1.1 (0.3) : IX 1.5 (0.5) : X 1.5 (0.6) : XI 1.8 (0.7).

Distribution (referred to Vinson 1943). Mauritius.

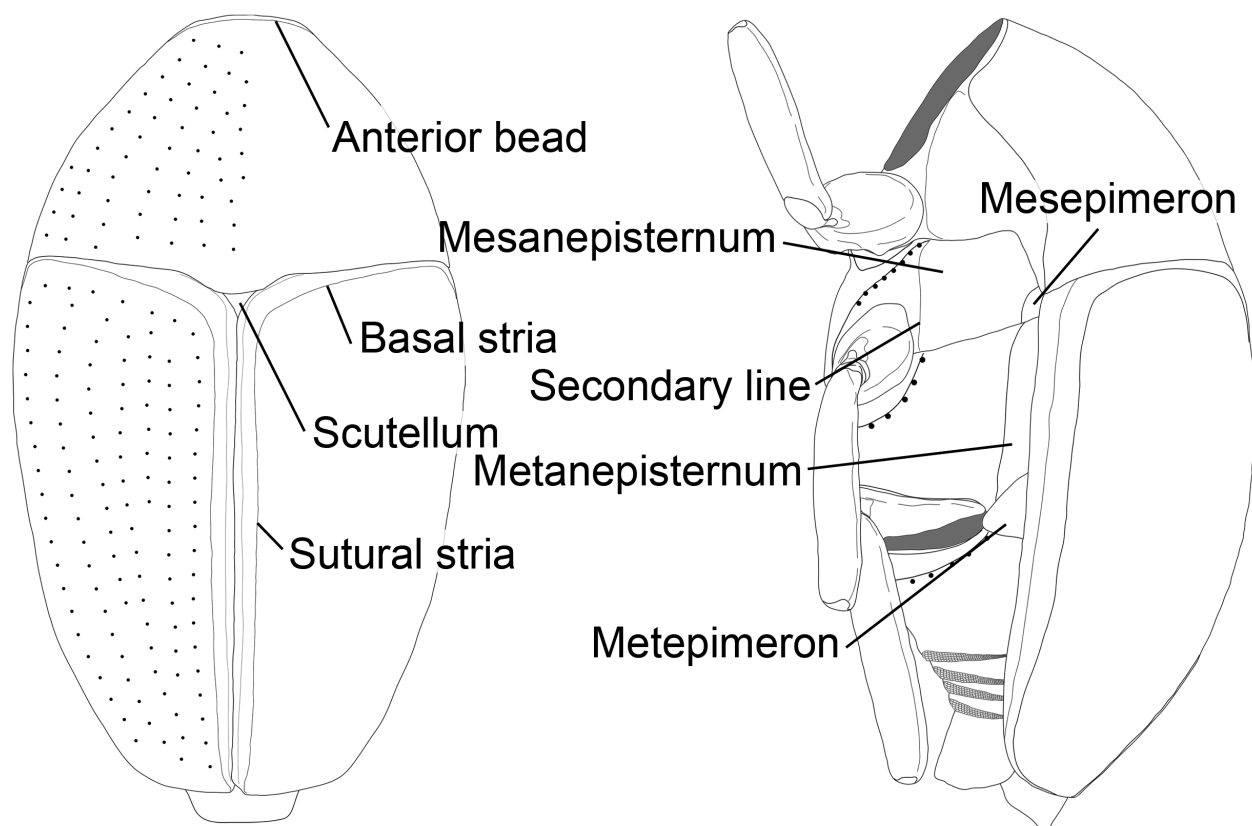


Figure 1. Terminology. Model: *Xotidium uniforme* Löbl.

Xotidium montanum (Löbl, 1971)

Figs 3c, d, 6c, 7e, 9b

Toxidium montanum Löbl, 1971: 1000. Transferred: Löbl 1992.

Type material examined. Holotype, 1♂, CEYLAN Central, Nuwera Eliya, 1950m, 29. I. 1970, Mussard Besuchet Löbl, MHNG ENTO 00005403 (MHNG).

Paratypes, 4♂, same data as holotype; 2♂1♀, same data as holotype, but 15. II. 1970. (MHNG).

Additional material examined. 1♀, SRI LANKA, 29. iv.–1. v., Idalgashinna, 1400m, 25km SW Badulla, Z. Kejval leg. 1994 (MHNG)

Supplemental description of female genitalia. Ovipositor simple: gonostylus with a long apical seta, distinctly longer than wide; distal gonocoxites elongated (Fig. 9b). Spermatheca connected in medial portion of vagina (Fig. 9b).

Measurements (n = 6). Length (PL+EL): 1.38–1.48 mm, PW: 0.73–0.83 mm, EW: 0.79–0.87 mm, HW: 0.32–0.36 mm, ID: 0.13–0.14 mm, PL/PW: 0.64–0.75, EL/EW: 1.00–1.10. Approximate ratio of each antennal segment in length (width) (n = 1): II 1.4 (0.5) : III 1.0 (0.3) : IV 1.1 (0.3) : V 1.3 (0.3) : VI 1.3 (0.3) : VII 1.6 (0.5) : VIII 1.3 (0.4) : IX 1.9 (0.6) : X 1.8 (0.6) : XI 1.9 (0.8).

Distribution (see Löbl 1971). Sri Lanka.

Remarks. This species is variable in the color of elytra as shown in Fig. 3c, d.

Xotidium notatum (Löbl, 1977)

Figs 4c, d, 6d, 7c, 9f

Toxidium notatum Löbl, 1977: 65. Transferred: Löbl 1992.

Type material examined. Holotype, 1♂, Acacia Plat. N. S. W., J. Armstrong, W. Steel coll., B. M. 1969-552 (NHM).

Paratype, 1♂, N. S. Wales, Acacia Plat, J. Armstrong (MHNG).

Additional material examined. 3♂, Queensland, Umg, Brisbane, Wachtel. V. 1981; 1♂1♀, Monsildale Via Kilcay, S. E. Qld., 22. IV. 1963, Monteith; 1♀, N. S. W. Sydney, Oxford falls, litter + bails, Au: 33, 29. X. 1982, Endrödy-Younga (MHNG).

Supplemental description of female genitalia. Ovipositor simple: gonostylus with a long apical seta, almost as long as wide: distal gonocoxites elongated (Fig. 9f). Spermatheca connected in medial portion of vagina.

Measurements (n = 5). Length (PL+EL): 1.19–1.38 mm, PW: 0.62–0.68 mm, EW: 0.66–0.74 mm, HW: 0.32–0.36 mm, ID: 0.09–0.13 mm, PL/PW: 0.67–0.74,

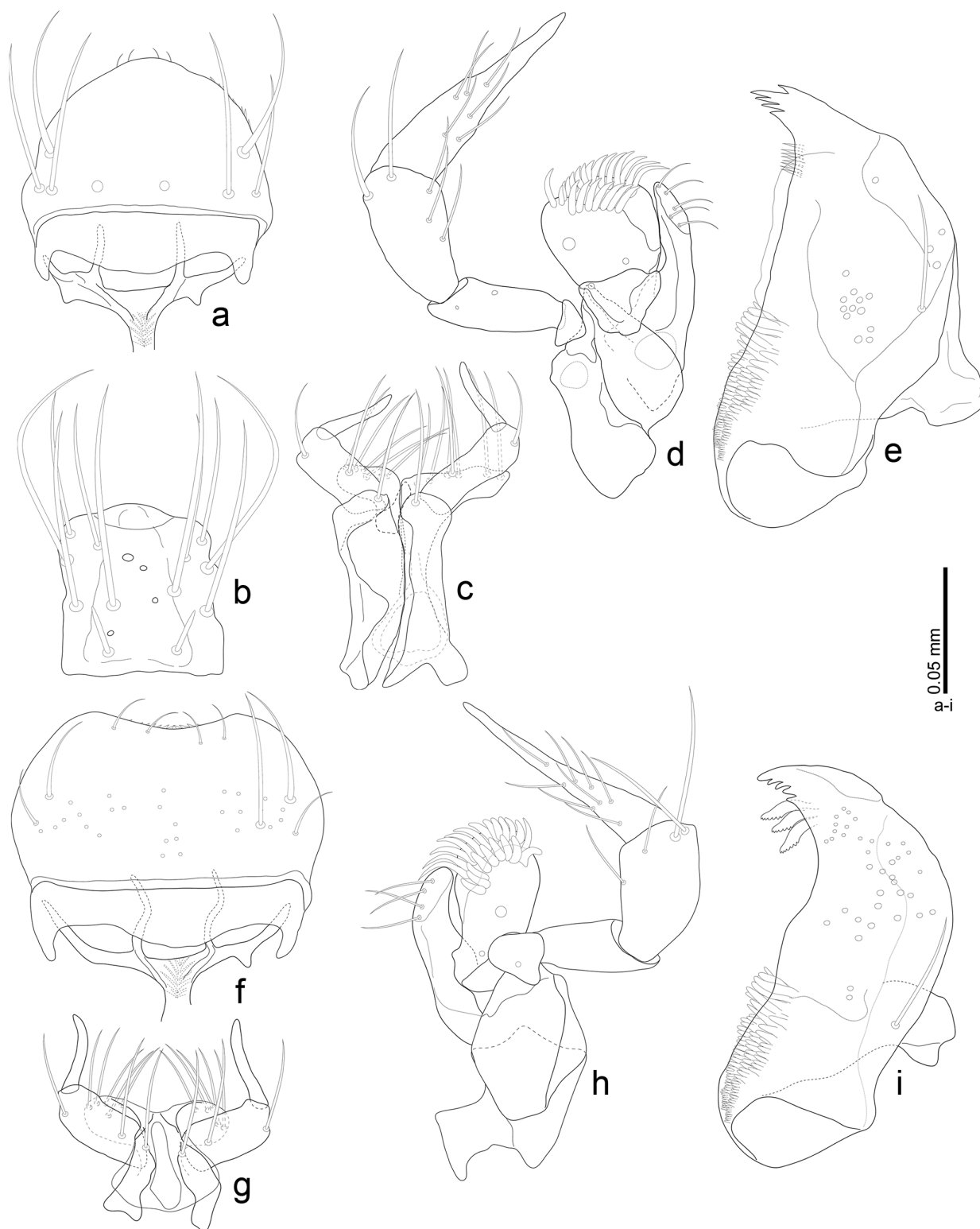


Figure 2. Mouth parts. **a, f** Labrum; **d, h** maxillae; **e, i** mandible; **c, g** labium; **b** mentum. **a–e** *Xotidium smetanai* sp. n.; **f–i** *X. tarantulum* sp. n. **a, f, i, e** Dorsal view; **b, c, d, g, h** ventral view.

EL/EW: 1.08–1.24. Approximate ratio of each antennal segment in length (width) ($n = 1$): II 1.2 (0.5) : III 1.0 (0.3) : IV 1.0 (0.3) : V 1.2 (0.3) : VI 1.3 (0.3) : VII 1.5 (0.4) : VIII 1.4 (0.3) : IX 1.6 (0.5) : X 1.5 (0.5) : XI 2.0 (0.6).

Distribution (see Löbl 1977). Australia: New South Wales and Queensland.

Remarks. The male genitalia have a long sclerite (Fig. 7c), given as short in Löbl (1977). Moreover, the body color is variable (Fig. 4c, d).

***Xotidium pygmaeum* (Löbl, 1971)**

Figs 4a, 6e, 7a, 9d

Toxidium pygmaeum Löbl, 1971: 998. Transferred: Löbl 1992.**Type material examined.** Holotype, 1♂, CEYLAN Central, Kandy, 700 m, 16. II. 1970, Mussard Besuchet Löbl, MHNG ENTO 00005402 (MHNG).

Paratypes, 9♂2♀, same data as holotype, but 14. II. 1970 (MHNG); 1♂, same data as holotype (MHNG).

Supplemental description of female genitalia. Ovipositor simple: gonostylus with a long apical seta, distinctly longer than wide; distal gonocoxites elongated (Fig. 9d). Spermathecae undetected.**Measurements** (n = 5). Length (PL+EL): 1.11–1.19 mm, PW: 0.66–0.68 mm, EW: 0.68–0.74 mm, HW: 0.26–0.30 mm, ID: 0.09–0.11 mm, PL/PW: 0.66–0.69, EL/EW: 0.97–1.03. Approximate ratio of each antennal segment in length (width) (n = 1): II 1.3 (0.7) : III 1.0 (0.4) : IV 1.1 (0.3) : V 1.2 (0.4) : VI 1.3 (0.4) : VII 1.5 (0.5) : VIII 1.3 (0.4) : IX 1.7 (0.6) : X 1.3 (0.6) : XI 1.7 (0.7).**Distribution** (see Löbl 1971). Sri Lanka.***Xotidium tubuliferum* Löbl, 2011**

Fig. 7f

Xotidium tubuliferum Löbl, 2011: 720.**Material examined.** 1♂, Tarragona, Leyte I. Philippine islds VIII: II: 1945 / Col. & pres. by C. L. Remington /in rotting burned log. [pronotum and head missing] (MHNG).**Distribution** (referred to Löbl 2011). Philippines: Leyte.***Xotidium uniforme* Löbl, 1992**

Figs 1, 3b, 6f, 7d, 9c

Xotidium uniforme Löbl, 1992: 575.**Type material examined.** Holotype, 1♂, E. NEPAL: KOSI, Val. Induwa Kola, 2100 m, 17. IV. 1984, Löbl – Smetana (MHNG).

Paratypes, 1♀, INDE Kumaon (UP), Rangarh nr. 6b, ewu. 2000m, I. Löbl, 9. X. 1979; 2♂, INDE: HTM. PM. PR., 10km, NW Sarahan, 1700m, 7. X. 1988, S. Vit; 3♂1♀, 414, Sankhua Sabha Distr., Arun Valley, Chichila, 1900–2000m, Quercus forest, bushes near village, 18–20. VI. 1988, J. Martens & W. Schawaller (MHNG).

Supplemental description of female genitalia. Ovipositor simple: gonostylus with a very long apical seta, slightly longer than wide; distal gonocoxites elongated (Fig. 9c). Spermatheca connected in medial portion of vagina (Fig. 9c).**Measurements** (n = 5). Length (PL+EL): 1.58–1.63 mm, PW: 0.85–0.88mm, EW: 0.92–0.96 mm, HW: 0.36–0.38 mm, ID: 0.10–0.14 mm, PL/PW: 0.71–0.75, EL/EW: 1.02–1.08. Approximate ratio of each antennal segment in length (width) (n = 1): II 1.4 (0.6) : III 1.0 (0.2) : IV 1.2 (0.3) : V 1.3 (0.2) : VI 1.3 (0.3) : VII 1.6 (0.4) : VIII 1.4 (0.3) : IX 1.8 (0.4) : X 1.5 (0.5) : XI 1.6 (0.5).**Distribution** (see Löbl 1992). India: Himachal Pradesh, Uttarakhand (Kumaon); Nepal.**New taxa*****Xotidium flagellum* Ogawa & Löbl, sp. n.**<http://zoobank.org/0E041090-CDCA-4A1A-A71C-57997CBD7B7A>

Figs 5b, 6h, 8d

Type material. Holotype, 1♂, Borneo Sabah, Mt. Kinabalu N. P. summit tr. Pondok Lowii, 2300–2400 m, 28. IV. 1987, A. Smetana, MHNG ENTO 00008953 (MHNG).**Etymology.** The species epithet refers to the presence of a flagellum in the internal sac.**Description (male).** Dorsal and ventral surface almost reddish-brown (Fig. 5b). Antennae almost yellowish-brown, antennomeres VI–XI blackish. Legs reddish-brown to brown; tarsi paler than tibiae and femora. Head, pronotum, and elytra sparsely and finely pubescent.

Head with eye width almost the same as interocular distance. Punctuation sparse and fine.

Pronotum wider than long. Punctuation sparse and fine, as on head. Scutellum with exposed apex.

Elytra as long as wide, widest at basal fourth, lateral margins sharply narrowed apically, minutely serrate at inner part of posterior margin. Punctuation fine and sparse as on pronotum. Sutural striae extending outwards along basal margin to form basal striae, reaching humeral area and joined with lateral striae.

Hypomeron and lateral portion of mesoventrite smooth. Lateral portion of metaventrite finely and sparsely punctate. Metanepisternum about four times as long as wide, without longitudinal line. Mesepimeron almost as long as wide. Metacoxa about six times as wide as metacoxal process. Ventrite I sparsely and finely punctate.

Protarsomere V about three times as long as each I–IV. Mesotarsomere I about three times as long as each II–IV; V about 2.5 times as long as each II–IV. Metatarsomere I about twice as long as each II and III; each II and III about 1.5 times as long as IV; V about twice as long as IV.

Protarsomeres I–III possibly with tenent setae, but invisible at ×80 magnification, not enlarged. Aedeagus about 0.52 mm long; parameres symmetrical, with moderately widened apical section much longer than third of total parameral length; internal sac with a sinuate and curved flagellum, widened basally and apically (Fig. 8d).

Female. Unknown.

Measurements (n = 1). Length (PL+EL): 1.23 mm, PW: 0.65 mm, EW: 0.69 mm, HW: 0.30 mm, ID: 0.13



Figure 3. Habitus of previously described species. **a** *Xotidium bolmarum* Löbl; **b** *X. uniforme* Löbl; **c, d** *X. montanum* (Löbl). **a, d** Paratype; **c, b**, holotype. Scale: 1 mm.

mm, PL/PW: 0.62, EL/EW: 1.19. Approximate ratio of each antennal segment in length (width) ($n = 1$): II 1.4 (0.7) : III 1.0 (0.3) : IV 1.1 (0.2) : V 1.3 (0.3) : VI 1.5 (0.3) : VII 1.7 (0.4) : VIII 1.6 (0.3) : IX 1.9 (0.5) : X 1.7 (0.5) : XI 1.9 (0.6).

Distribution. East Malaysia: Sabah.

Remarks. This species is very similar to *X. pygmaeum* (Löbl) in the smaller body, but may be easily distinguished by the very long flagellar sclerite of male genitalia.

***Xotidium heissi* Ogawa & Löbl, sp. n.**

<http://zoobank.org/E978428E-9E12-4BF2-A819-AB3BBCE140A0>
Figs 5a, 6i, 8a

Type material. Holotype, 1♂, Brunei/Temburong, Kuala Belalong FSC, 60–300 m, 16–20. IV. 1993, mixed Dipterc. for., E. Heiss, MHNG ENTO 00008955 (MHNG).

Paratype, 1♂, SABAH: Porig Hot, Springs, 500 m, 6. V. 1987, Burckhardt – Löbl, MHNG ENTO 00008956 (MHNG).

Etymology. This species epithet is named in honour of the collector of the holotype, E. Heiss from Innsbruck, Austria.



Figure 4. Habitus of previously described species. **a** *Xotidium pygmaeum* (Löbl); **b** *X. mauritianum* (Vinson); **c, d** *X. notatum* (Löbl). **a** (left), **c** Holotype; **a** (right), paratype. Scale: 1 mm.

Description (male). Dorsal and ventral surface almost reddish-brown (Fig. 5a). Antennae almost yellowish-brown, but antennomeres VI–XI blackish. Legs reddish-brown to brown; tarsi paler than tibiae and femora. Head, pronotum, and elytra sparsely and finely pubescent.

Head with eye width almost the same as interocular distance. Punctuation sparse and fine.

Pronotum wider than long. Punctuation sparse and fine, as on head. Scutellum almost as long as wide, with exposed apex.

Elytra almost as long as wide, widest at basal fourth, lateral margins sharply narrowed apically, minutely serrate at inner part of posterior margin. Punctuation fine and sparse as on pronotum. Sutural striae extending outwards along basal margin to form basal striae, reaching humeral area and joined with lateral striae.

Hypomeron and lateral portion of mesoventrite smooth. Lateral portion of metaventricle finely and sparsely punctate. Metanepisternum about four times as long as wide,

without longitudinal line. Metepimeron almost as long as wide. Metacoxa about six times as wide as metacoxal process. Ventricle I sparsely and finely punctate.

Protarsomere V about 2.5 times as long as each I–IV. Mesotarsomere I about 2.5 times as long as each II–IV; V about twice as long as IV. Metatarsomere I about three times as long as each II–IV; V about 1.5 times as long as each II–IV.

Protarsomeres I–III possibly with tenent setae, but invisible at $\times 80$ magnification, not enlarged. Aedeagus 0.54 mm long; parameres symmetrical, with strongly widened apical section longer than third of total parameral length; internal sac with a sinuate flagellar sclerite, basally widened and bent (Fig. 8a).

Female. Unknown.

Measurements ($n = 2$). Length (PL+EL): 1.33–1.38 mm, PW: 0.73 mm, EW: 0.75–0.78 mm, HW: 0.33–0.35 mm, ID: 0.13 mm, PL/PW: 0.69–0.72, EL/EW: 1.10. Approximate ratio of each antennal segment in length

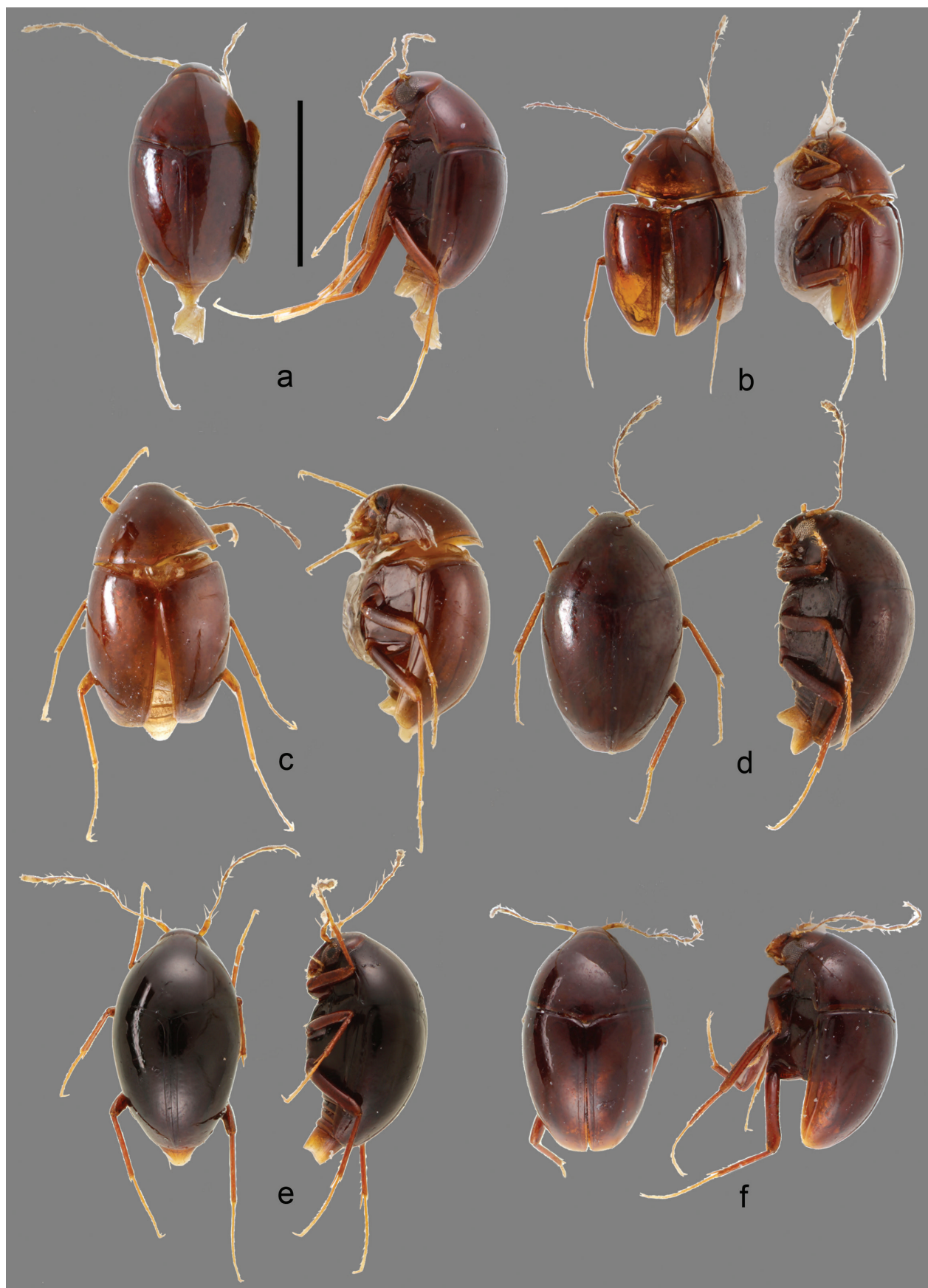


Figure 5. Habitus of new species. **a** *Xotidium heissi* sp. n.; **b** *X. flagellum* sp. n.; **c** *X. smetanai* sp. n.; **d** *X. meridionale* sp. n.; **e**, **f** *X. tarantulatum* sp. n. Scale: 1 mm.

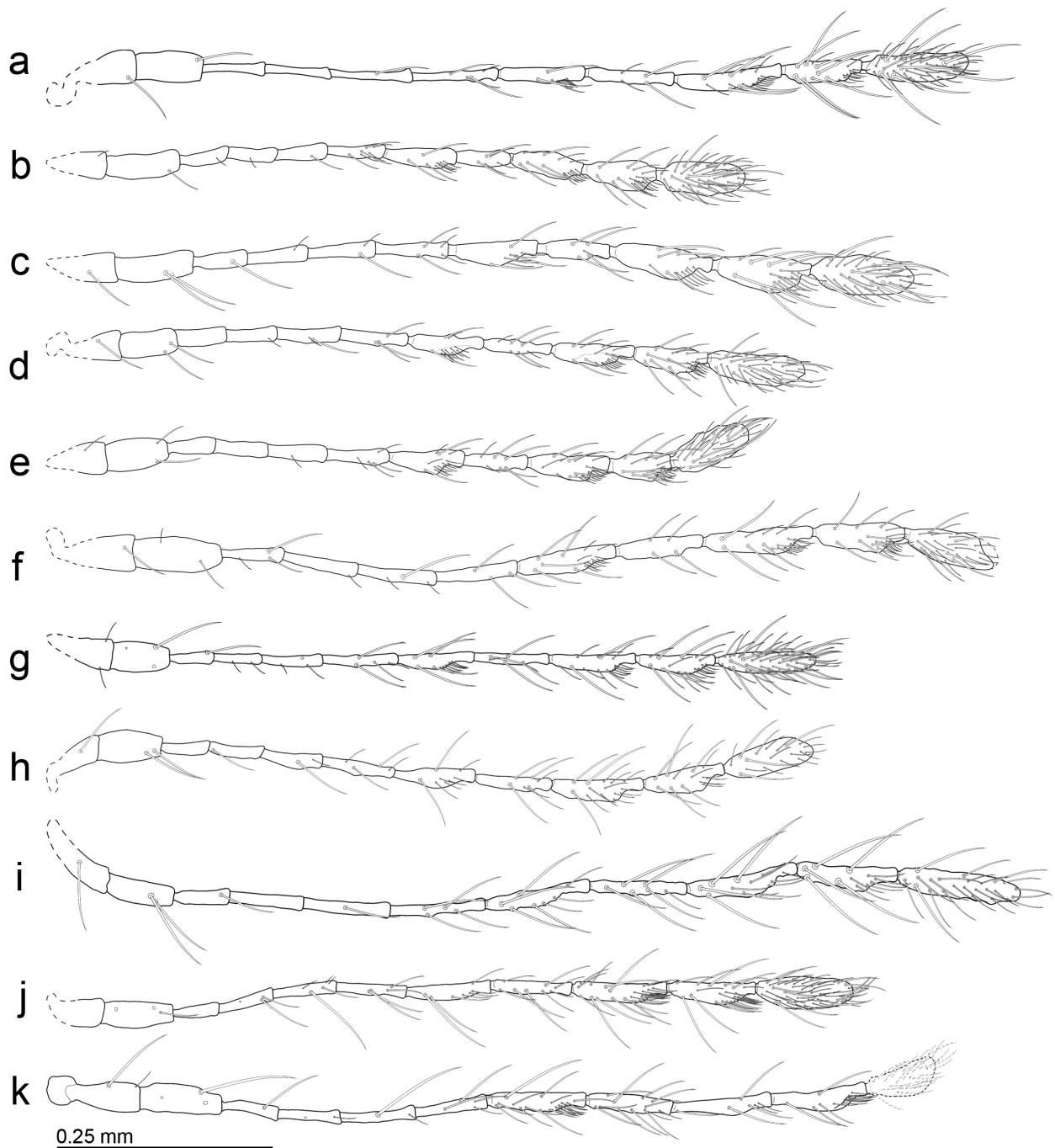


Figure 6. Antennae. **a** *Xotidium bolmarum* Löbl; **b** *X. mauritanum* (Vinson); **c** *X. montanum* (Löbl); **d** *X. notatum* (Löbl); **e** *X. pygmaeum* (Löbl); **f** *X. uniforme* Löbl; **g** *X. tarantulatatum* sp. n.; **h** *X. flagellum* sp. n.; **i** *X. heissi* sp. n.; **j** *X. meridionale* sp. n.; **k** *X. smetanai* sp. n.

(width) (n = 1): II 1.2 (0.4) : III 1.0 (0.3) : IV 1.4 (0.3) : V 1.6 (0.3) : VI 1.8 (0.2) : VII 2.0 (0.3) : VIII 1.8 (0.3) : IX 2.1 (0.5) : X 1.9 (0.5) : XI 2.3 (0.5).

Distribution. Brunei; East Malaysia: Sabah.

Remarks. This species is very similar to *X. bolmarum* Löbl in the reddish body and the body size, but may be easily distinguished by the strongly widened apical portion of parameres and the sinuate sclerite of male genitalia.

***Xotidium meridionale* Ogawa & Löbl, sp. n.**

<http://zoobank.org/BDF620F4-6A62-475D-A6BD-EBDF46959D59>

Figs 5d, 6j, 8e, f

Type material. Holotype, 1♂, Mt. Lompobatang, Malino, S. Sulawesi, alt. ca. 1700m, 5°23'44.20"N, 119°55'22.27"E, 20. I. 2011, R. Ogawa leg. (MZBI).

Etymology. The species epithet is from the Latin *meridionale* meaning southern, referring to Lompobatang located at the southernmost Sulawesi.

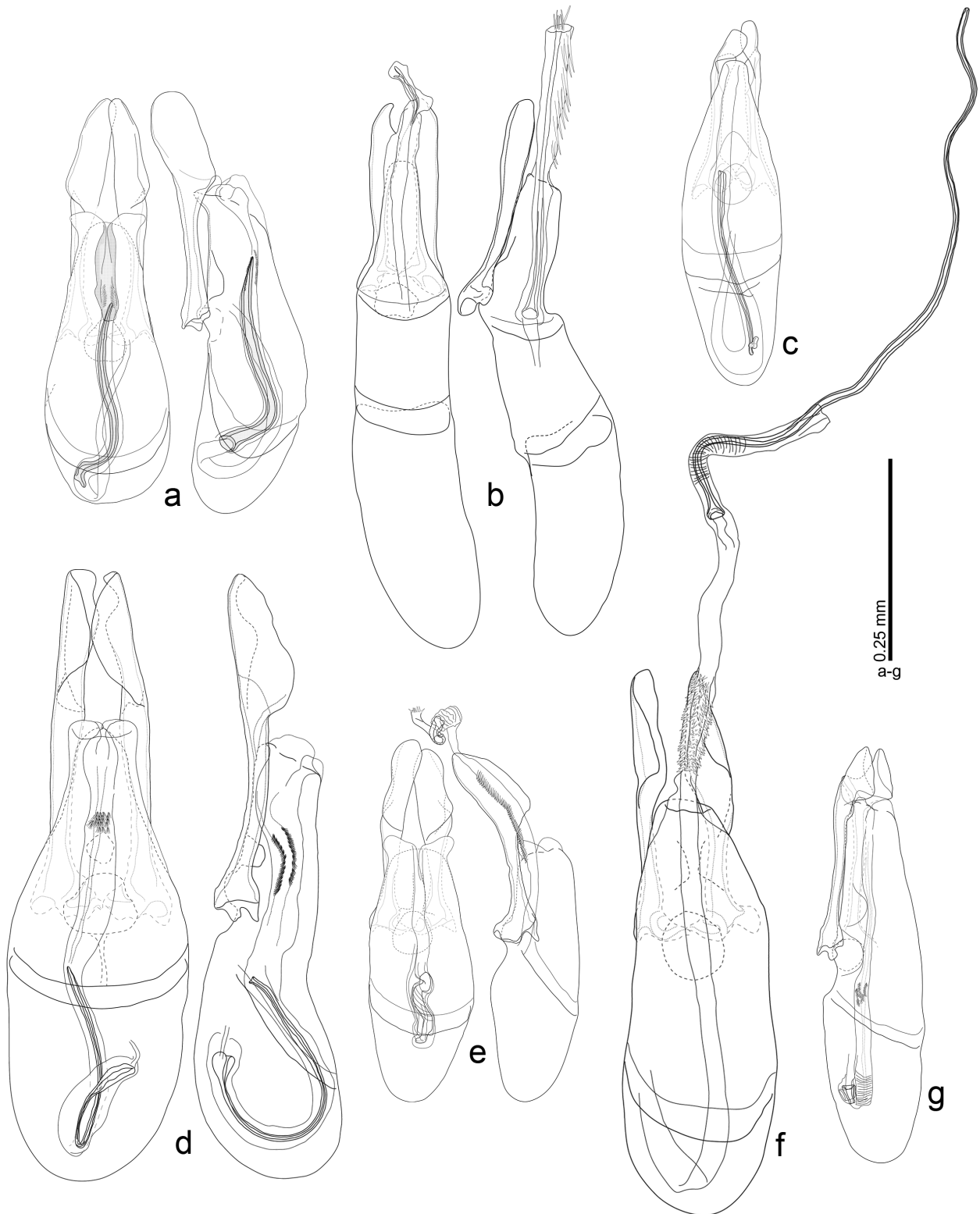


Figure 7. Male genitalia of previously described species from dorsal and lateral views. **a** *Xotidium montanum* (Löbl); **b** *X. mauritianum* (Vinson); **c** *X. notatum* (Löbl); **d** *X. uniforme* Löbl; **e** *X. pygmaeum* (Löbl); **f** *X. tubuliferum* Löbl; **g** *X. bolmarum* Löbl.

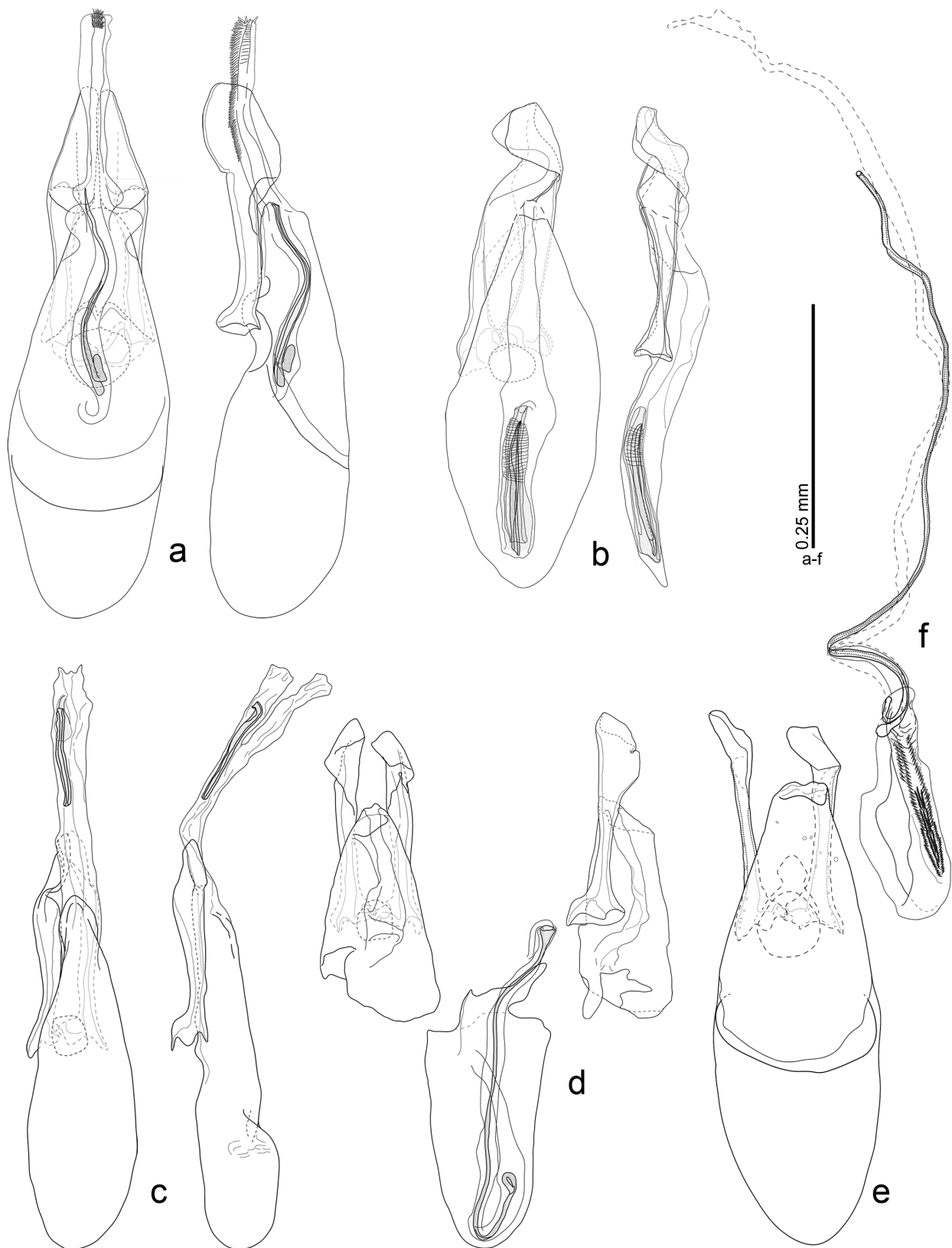


Figure 8. Male genitalia of new species from dorsal and lateral views. **a** *Xotidium heissi* sp. n.; **b** *X. smetanai* sp. n.; **c** *X. tarantulum* sp. n.; **d** *X. flagellum* sp. n.; **e**, **f** *X. meridionale* sp. n.

Description (male). Dorsal and ventral surface almost dark reddish-brown to brown (Fig. 5d). Antennae almost yellowish-brown, but antennomeres III–XI blackish. Femora from apical sixth to base darker than tibiae; tibiae reddish-brown to brown; tarsi paler than tibiae. Head, pronotum, and elytra sparsely and finely pubescent.

Head with eye width almost the same as interocular distance. Punctuation sparse and fine.

Pronotum wider than long. Punctuation sparse and fine, as on head. Scutellum with slightly exposed apex.

Elytra longer than wide, widest at basal sixth, lateral margins sharply narrowed apically, minutely serrate at inner part of posterior margin. Punctuation fine and sparse as on pronotum. Sutural striae interrupted at basal third.

Hypomeron and lateral portion of mesoventrite smooth. Lateral portion of metaventricle finely and sparsely punctate. Metanepisternum about four times as long as wide, without longitudinal line. Mesepimeron concealed. Metacoxa about six times as wide as metacoxal process. Ventricle I sparsely and finely punctate.

Protarsomere V about three times as long as each I–IV. Mesotarsomere I about twice as long as each II and III; V about twice as long as IV. Metatarsomere I about 2.5 times as long as each II and III; V about three times as long as IV.

Protarsomeres I–III possibly with tenent setae, but invisible at $\times 80$ magnification, not enlarged. Aedeagus 0.54 mm long; parameres symmetrical, with moderately widened apical section shorter than third of total parameral length; internal sac with a sinuate and very long flagellum (longer than aedeagus), basally widened and bent (Fig. 8f).

Female. Unknown.

Measurements ($n = 1$). Length (PL+EL): 1.43 mm, PW: 0.81 mm, EW: 0.87 mm, HW: 0.34 mm, ID: 0.11 mm, PL/PW: 0.72, EL/EW: 0.98. Approximate ratio of each antennal segment in length (width) ($n = 1$): II 1.5 (0.6) : III 1.0 (0.3) : IV 1.2 (0.3) : V 1.3 (0.3) : VI 1.5 (0.3) : VII 1.8 (0.4) : VIII 1.7 (0.3) : IX 2.0 (0.5) : X 1.9 (0.5) : XI 2.1 (0.7).

Distribution. Indonesia: southern Sulawesi.

Remarks. This species is similar to *X. smetanai* sp. n. in lacking sutural striae and *X. tubuliferum* Löbl in the long sclerite as flagellum of male genitalia, but it is easily distinguished from them by the body color and the widened apical section of parameres.

Xotidium smetanai Ogawa & Löbl, sp. n.

<http://zoobank.org/2D544E21-7439-4786-BDF9-ABEF1DE6915D>
Figs 2a–e, 5c, 6k, 8b

Type material. Holotype, 1♂, Borneo Sabah, Mt. Kinabalu Nat. Pk. HQ Silau-Silau, Tr. 1550 m, 2. IV. 1988, [B171], A. Smetana, MHNG ENTO 00008954 (MHNG).

Etymology. This species epithet is in honour of the collector of its holotype, A. Smetana, Ottawa Canada.

Description. Dorsal and ventral surface almost brown (Fig. 5c). Antennae almost yellowish-brown, antenno-

meres V–XI blackish. Propygidium and pygidium paler than other ventrite. Legs brown to yellowish-brown; tarsi paler than tibiae and femora. Head, pronotum, and elytra sparsely and finely pubescent.

Head with eye width almost the same as interocular distance. Punctuation sparse and fine.

Pronotum wider than long. Punctuation sparse and fine, as on head. Scutellum with slightly exposed apex.

Elytra longer than wide, widest at basal sixth, lateral margins sharply narrowed apically, minutely serrate at inner part of posterior margin. Punctuation fine and sparse as on pronotum. Sutural striae interrupted at basal third.

Hypomeron and lateral portion of mesoventrite smooth. Lateral portion of metaventricle finely and sparsely punctate. Metanepisternum about four times as long as wide, without longitudinal line. Mesepimeron almost as long as wide. Metacoxa about six times as wide as metacoxal process. Ventricle I sparsely and finely punctate.

Protarsomere V 2.5 times as long as each I–IV. Mesotarsomere I about twice as long as II; II 1.2 times as long as each III and IV; V 1.5 times as long as each III and IV. Metatarsomere I about three times as long as each II and III; each II and III 1.1 times as long as IV; V about twice as long as IV.

Protarsomeres I–III possibly with tenent setae, but invisible at $\times 80$ magnification, not enlarged. Aedeagus about 0.5 mm long; parameres symmetrical, with moderately widened apical section slightly longer than third of total parameral length; internal sac with straight, evenly wide flagellar sclerite (Fig. 8b).

Female. Unknown.

Measurements ($n = 1$). Length (PL+EL): 1.53 mm, PW: 0.85 mm, EW: 0.88 mm, HW: 0.35 mm, ID: 0.15 mm, PL/PW: 0.62, EL/EW: 1.14. Approximate ratio of each antennal segment in length (width) ($n = 1$): II 1.5 (0.5) : III 1.0 (0.2) : IV 1.1 (0.3) : V 1.3 (0.2) : VI 1.3 (0.2) : VII 1.7 (0.3) : VIII 1.5 (0.3) : IX 1.8 (0.3) : X 1.7 (0.4) [XI deformed].

Distribution. East Malaysia: Sabah.

Remarks. This species is similar to *X. mauritanum* (Vinson) and *X. meridionale* sp. n. in the reduced sutural striae, but may be easily distinguished from them by the simple sclerite of the male genitalia.

Xotidium tarantulatum Ogawa & Löbl, sp. n.

<http://zoobank.org/5704E1D0-9D28-47ED-957B-6D5EB820D440>
Figs 2 f–i, 5c, f, 6g, 8d, 9c

Type material. Holotype, 1♂, Mt Tilongkabila (Gunung Tilongkabila), N. Sulawesi, alt. ca. 1300m, 0°35'18.14"N, 123°13'22.71"E, 10. VI. 2012, R. Ogawa leg. (MZBI).

Paratypes, 1♂1♀, same data as holotype (EUMJ); 2♂, Mt Tilongkabila (Gunung Tilongkabila), N. Sulawesi, alt. ca. 1300–1500m, 0°35'18.14"N, 123°13'22.71"E – 0°35'18.37"N, 123°13'22.61"E, 10. VI. 2012, R. Ogawa leg. (EUMJ); 1♂, same data as holotype, but 800–1300m, 0°34'28.52"N, 123°11'30.61"E – 0°35'18.14"N, 123°13'22.71"E, 9. VI. 2012 (EUMJ); 1♂, same data

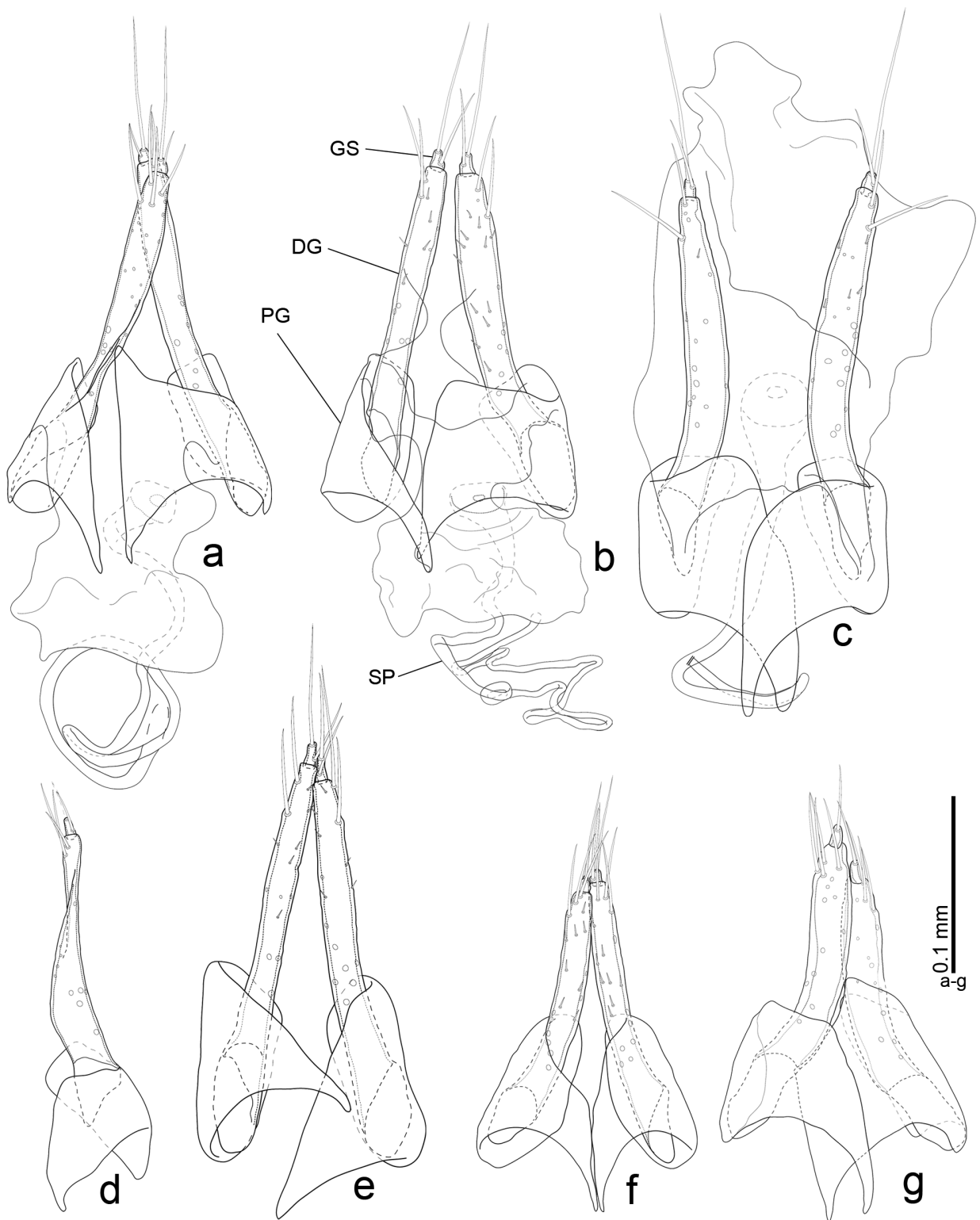


Figure 9. Female genitalia. **a** *Xotidium bolmarum* Löbl; **b** *X. montanum* (Löbl); **c** *X. uniforme* Löbl; **d** *X. pygmaeum* (Löbl); **e** *X. tarantulatatum* sp. n.; **f** *X. notatum* (Löbl); **g** *X. mauritianum* (Vinson). GS Gonostylus; DG Distal gonocoxite; PG Proximal gonocoxite; SP Spermatheca.

above, but preserved at MHNG; 1♂1♀, Mt. Pontolo, N. Sulawesi, alt. ca. 1400–1800m, 0°54'59.77"N, 122°04'13.10E – 0°54'25.07"N, 122°04'20.73"E, 25. VII. 2012, R. Ogawa leg. (EUMJ); 1♂, under bark of rot-

ten log, Plot C, ca 400m, Lowland forest, INDONESIA SULAWESI UTARA, Dumoga-Bone N.P., February, 1985, R. Ent. Soc. Lond., PROJECT WALLACE, B.M. 1985-10 (NHM).

Etymology. The species epithet is derived from Mapa-la Tarantula, the climbing club of Gorontalo State University.

Description. Dorsal and ventral surface almost black to dark reddish-brown (Fig. 5e, f), except for abdomen dark reddish-brown. Antennae almost yellowish-brown, antennomeres VI–XI blackish. Propygidium and pygidium paler than other ventrite I–III. Legs reddish-brown; tarsi paler than tibiae and femora. Head, pronotum, and elytra sparsely and finely pubescent.

Head with eye width almost the same as interocular distance. Punctuation sparse and fine.

Pronotum slightly wider than long, with an anterior bead. Punctuation sparse and fine, as on head. Scutellum almost as long as wide, with exposed apex.

Elytra almost as long as wide, widest at basal sixth, lateral margins sharply narrowed apically, minutely serrate at inner part of posterior margin. Punctuation fine and sparse as on pronotum. Sutural striae extending outwards along basal margin to form basal striae, reaching humeral area and joined with lateral striae.

Hypomeron and lateral portion of mesoventrite smooth. Lateral portion of metaventrite finely and sparsely punctate. Metanepisternum about four times as long as wide, without longitudinal line. Mesepimeron almost as long as wide. Metacoxa about six times as wide as metacoxal process. Ventrite I sparsely and finely punctate, with microsculpture.

Protarsomere I twice as long as each II–IV; V 2.5 times as long as each II–IV. Mesotarsomere I 2.5 times as long as II; II 1.2 times as long as each III and IV; V 2.5 times as long as each III and IV. Metatarsomere I about three times as long as each II and III; each II and III 1.1 times as long as IV; V about twice as long as IV.

Male. Protarsomeres I–III possibly with tenent setae, but invisible at $\times 80$ magnification, not enlarged. Aedeagus about 0.44 mm long; parameres symmetrical, with weakly widened apical section as long as fourth of total parameral length; internal sac with a sclerite as flagellum, straight, evenly wide, sometimes bent at base.

Female. Protarsomeres I–III not enlarged. Ovipositor simple: gonostylus with a long apical seta, distinctly longer than wide; distal gonocoxites apparently elongated (Fig. 9e). Spermathecae undetected.

Measurements ($n = 9$). Length (PL+EL): 1.32–1.43 mm, PW: 0.75–0.79 mm, EW: 0.79–0.89 mm, HW: 0.32–0.36 mm, ID: 0.09–0.13 mm, PL/PW: 0.69–0.76, EL/EW: 0.89–1.02. Approximate ratio of each antennal segment in length (width) ($n = 1$): II 1.3 (0.7) : III 1.0 (0.3) : IV 1.1 (0.2) : V 1.4 (0.3) : VI 1.6 (0.3) : VII 1.7 (0.4) : VIII 1.6 (0.2) : IX 1.9 (0.4) : X 1.7 (0.4) : XI 2.2 (0.5).

Distribution. Indonesia: northern Sulawesi.

Remarks. This species is similar to *X. bolmarum* Löbl from Lombok in its color and body size, but may be easily distinguished by the straight and more elongate sclerite in the internal sac.

Key to the species of *Xotidium* (modified from Löbl 2015)

- 1 Elytra without basal striae, sutural striae shortened 2
 - Elytra with basal striae, joined to sutural striae 4
- 2 Body blackish. Scutellum concealed. Antennomere VIII almost as long as III. Parameres evenly widened. Internal sac without sclerites, slightly sclerotized *X. mauritianum* (Vinson)
 - Body brownish. Scutellum slightly exposed. Antennomere VIII more than 1.5 times as long as III. Parameres notably widened at apical portion. Internal sac with a sclerite 3
- 3 Widened apical section of parameres much shorter than a third of total parameral length. Internal sac of aedeagus with a very long flagellum *X. meridionale* sp. n.
 - Widened apical section of parameres much longer than a third of total parameral length. Internal sac of aedeagus with a straight sclerite *X. smetanai* sp. n.
- 4 Elytra with distinctive bicolour pattern 5
 - Elytra uniformly reddish-brown to black 6
- 5 Elytra dark, each with light transverse fascia situated in basal half of elytron and light apical part. Pronotum entirely dark *X. montanum* (Löbl)
 - Elytra light, each darkened along basal and apical margins, usually also darkened along sutural margin. Pronotum light, usually with dark transverse fascia *X. notatum* (Löbl)
- 6 Body length (PL+EL) 1.10–1.25 mm 7
 - Body length (PL+EL) 1.35–1.65 mm 8
- 7 Antennomere X distinctly more than 1.5 times as long as III. Mesotarsomeres II and III each about three times as long as I. Metatarsomeres II and III each about twice as long as I. Internal sac of aedeagus with evenly thick and sinuate sclerite *X. pygmaeum* (Löbl)
 - Antennomere X about 1.5 times as long as III. Mesotarsomeres II and III each about twice as long as I. Metatarsomeres II and III each three times as long as I. Internal sac of aedeagus with flagellum curved, sinuate, basally and apically thickened *X. flagellum* sp. n.
- 8 Widened apical section of parameres about as long as half of total parameral length. Internal sac of aedeagus with very long, weakly sclerotized and simple tube *X. tubuliferum* Löbl

- Widened apical section of parameres shorter than half of total parameral length..... 9
- 9 Widened apical section of parameres much longer than third of total parameral length..... 10
- Widened apical section of parameres much shorter than third of total parameral length..... 11
- 10 Body length (PL+EL) 1.58–1.63 mm. Antennomere XI less than twice as long as III. Internal sac of aedeagus with an U-shaped flagellum, basally thickened.....*X. uniforme* Löbl
- Body length (PL+EL) 1.33–1.38 mm. Antennomere XI more than twice as long as III. Internal sac of aedeagus with a sinuate flagellar sclerite, basally thickened and bent.....*X. heissi* sp. n.
- 11 Antennomere XI more than twice as long as III. Internal sac of aedeagus with straight, evenly thickened flagellum*X. tarantulatam* sp. n.
- Antennomere XI less than twice as long as III. Internal sac of aedeagus with short basal sclerites followed by long membranous tube.....*X. bolmarum* Löbl

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References

- Leschen RAB, Löbl I (2005) Phylogeny and classification of Scaphisomatini (Staphylinidae: Scaphidiinae) with notes on mycophagy, termitophily and functional morphology. Coleopterists Society Monographs 3: 1–63. doi: 10.1649/0010-065X(2005)059[0001:PACOSS]2.0.CO;2
- Löbl I (1971) Scaphidiidae von Ceylon (Coleoptera). Revue Suisse de Zoologie 78(4): 937–1006. doi: 10.5962/bhl.part.97084
- Löbl I (1977) Beitrag zur Kenntnis der Scaphidiidae (Coleoptera) Australiens. Revue Suisse de Zoologie 84(1): 3–69. doi: 10.5962/bhl.part.91370
- Löbl I (1992) The Scaphidiidae (Coleoptera) of the Nepal Himalaya. Revue Suisse de Zoologie 99: 471–627. doi: 10.5962/bhl.part.79841
- Löbl I (2011) On the Scaphisomatini (Coleoptera: Staphylinidae: Scaphidiinae) of the Philippines, II. Revue Suisse de Zoologie 118(4): 695–721.
- Löbl I (2015) On the Scaphidiinae (Coleoptera: Staphylinidae) of the Lesser Sunda Islands. Revue Suisse de Zoologie 122(1): 75–120.
- Ogawa R, Sakai M (2011) A review of the genus *Cyparium* Erichson (Coleoptera, Staphylinidae, Scaphidiinae) of Japan. Japanese Journal of Systematic Entomology 17(1): 129–136.
- Ogawa R, Löbl I (2013) A revision of the genus *Baeocera* in Japan, with a new genus of the tribe Scaphisomatini (Coleoptera, Staphylinidae, Scaphidiinae). Zootaxa 3652(3): 301–326. doi: 10.11646/zootaxa.3652.3.1
- Vinson J (1943) The Scaphidiidae of Mauritius. The Mauritius Institute Bulletin 2(3): 177–209.

