

Three new species of mygalomorph and filistatid spiders from Iran (Araneae, Cyrtaucheniidae, Nemesiidae and Filistatidae)

Yuri M. Marusik^{1,2}, Alireza Zamani³, Omid Mirshamsi^{4,5}

1 Institute for Biological Problems of the North RAS, Portovaya Str. 18, Magadan 685000, Russia **2** Zoological Museum, University of Turku, FI-20014 Turku, Finland **3** Department of Animal Biology, School of Biology and Center of Excellence in Phylogeny of Living Organisms, College of Science, University of Tehran, Tehran, Iran **4** Department of Biology, Faculty of Sciences, Ferdowsi University of Mashhad, Mashhad, Iran **5** Institute of Applied Zoology, Faculty of Sciences, Ferdowsi University of Mashhad, Mashhad, Iran

Corresponding author: Alireza Zamani (zamani.alireza5@gmail.com)

Academic editor: Shuqiang Li | Received 5 October 2014 | Accepted 12 November 2014 | Published 12 December 2014

<http://zoobank.org/728333FF-3494-4914-A998-4DDE6CF19E3D>

Citation: Marusik YM, Zamani A, Mirshamsi O (2014) Three new species of mygalomorph and filistatid spiders from Iran (Araneae, Cyrtaucheniidae, Nemesiidae and Filistatidae). ZooKeys 463: 1–10. doi: 10.3897/zookeys.463.8692

Abstract

Three new spider species are described from Iran: *Anemesia koponeni* sp. n. (♂, Cyrtaucheniidae); *Raveniola mazandarunica* sp. n. (♂, Nemesiidae) and *Sahastata sinuspersica* sp. n. (♀, Filistatidae). Cyrtaucheniidae and *Sahastata* Benoit, 1968 are reported from Iran for the first time.

Keywords

Anemesia, *Raveniola*, *Sahastata*, type species, new record

Introduction

Spiders of Iran remain poorly studied in faunistic and especially taxonomic respects. Although about 540 species are known from the country (Zamani et al. 2014a), this number is smaller than that from the neighboring and much smaller Azerbaijan (714 species, Otto 2014). There are many small faunistic publications dealing usually with common spiders (e.g. Mirshamsi 2005, Ghahari and Marusik 2009, Ghahari and Tabari 2012, Kashefi et al. 2013), but taxonomic and large scale faunistic surveys are

almost lacking (Mozaffarian and Marusik 2001, Logunov et al. 2001, Ono and Martens 2005, Ghavami 2006, Moradmamand and Jäger 2011, Zamani et al. 2014b).

While studying spiders of Iran, we found three undescribed species belonging to Mygalomorphae and Filistatidae, two of which represent the first Iranian records of the family Cyrtaucheniidae and the genus *Sahastata* Benoit, 1968 (Filistatidae).

Material and methods

Photographs were taken in dishes of different sizes with paraffin at the bottom. Specimens were photographed using an Olympus Camedia E-520 camera attached to an Olympus SZX16 stereomicroscope at the Zoological Museum, University of Turku. Digital images were prepared using “CombineZP” image stacking software. Illustrations of endogynes were made after maceration in 20% potassium hydroxide aqueous solution and exposition for few minutes in alcohol/water solution of Chlorazol Black. Lengths of leg segments were measured on the dorsal side. All measurements are given in mm. Treated materials will be deposited in Senckenberg Museum, Frankfurt am Main (SMF).

List of abbreviations is as follows: **AME**, anterior median eyes; **ALE**, anterior lateral eyes; **PME**, posterior median eyes; **PLE**, posterior lateral eyes; **PMS**, posterior median spinnerets; **PLS**, posterior lateral spinnerets. For describing the spination patterns, the following abbreviations or their combinations are used: **a**, apical; **d**, dorsal; **m**, median; **p**, prolateral; **r**, retrolateral; **v**, ventral.

Taxonomic survey

Cyrtaucheniidae Simon, 1892

Genus *Anemesia* Pocock, 1895

Comments. *Anemesia* is a small genus of Cyrtaucheniidae with four species known from Afghanistan, Tajikistan, Turkmenistan and Uzbekistan (Platnick 2014). Species of this genus have been treated in six papers only (Pocock 1895, Spassky 1937, Andreeva 1968, 1976, Charitonov 1969, Zonstein 2001).

Anemesia koponeni sp. n.

<http://zoobank.org/EEDAEB57-B0E0-4CA9-A18F-6FEDF1DF9669>

Figs 1–8

Material. Holotype ♂ (SMF) – IRAN: *Khorāsān-e Jonoubi* Province, Qāen County, Kārīzan (33°53'N, 59°49'E), May 1, 2012 (O. Mirshamsi).

Etymology. Named after our colleague and friend Seppo Koponen (Turku, Finland), a famous Finnish arachnologist on occasion of his 70th birthday; noun.

Diagnosis. The new species has a rather short embolus like in *A. birulai* (Spassky, 1937) (cf. Spassky 1937, fig. 2). Other congeners occurring in Central Asia have distinctly longer emboli, for example *A. karatauvi* (Andreeva, 1968) and *A. incana* Zonstein, 2001 (Figs 9–10). *A. koponeni* sp. n. differs from the former species by larger body size (15 vs. 10 mm), much darker general coloration (chestnut-brown vs. light yellowish-brown), as well as by longer and spinose palpal tibia (shorter and aspinose in *A. birulai*). Finally it differs, from the similar *A. tubifex* (Pocock, 1889) by its narrower eye field with the AME closer to each other (cf. Pocock 1889, fig. 2d).

Description. Total length 15.2 including chelicerae. Color in alcohol: carapace, palps and most part of legs reddish-brown; eye tubercle brownish-black; clypeus, chelicerae, femora I–II dorsally dark reddish-brown; sternum, labium, maxillae, palps and legs ventrally yellowish-brown; abdomen dorsally with an indistinct pattern consisting of a short median stripe and a few pairs of interrupted transverse fasciae; metatarsi III–IV, tarsi I–IV, ventral abdominal surface and spinnerets light yellowish-brown. Carapace 6.0 long, 5.2 wide. Eye sizes and interspaces: AME 0.17, ALE 0.25, PLE 0.20, PME 0.12, AME–AME 0.20. Cheliceral rastellum weak. Maxillae with about 15 small cuspsules each. Sternum 3.15 long, 2.50 wide.

Spination. Palp: femur 3d, 2pd; patella 1p; tibia 2v; tarsus 10d. Leg I: femur 4d, 3pd, 3rd; patella 2p; tibia 3p, 3r, 6–8v; metatarsus 1d, 1p, 1r, 5v. Leg II: femur 4d, 3pd, 3rd; patella 2p; tibia 3p, 2r, 9v; metatarsus 2d, 3p, 1r, 7v. Leg III: femur 3d, 3pd, 3rd; patella 2p, 1r; tibia 1d, 3p, 3r, 6v; metatarsus 3p, 4r, 7v; tarsus 2v. Leg IV: femur 3d, 3pd, 3rd; tibia 1d, 1p, 3r, 6v; metatarsus 1d, 2p, 5r, 7v; tarsus 2v. Patella IV and tarsi I–II aspinose.

Scopula: distal on metatarsi I–II, present on tarsi I–III, absent on tarsus IV. Paired claws: inner and outer margins with 6–7 teeth each. Spinnerets: PMS 0.53 long; PLS 2.25 long; apical segment triangle.

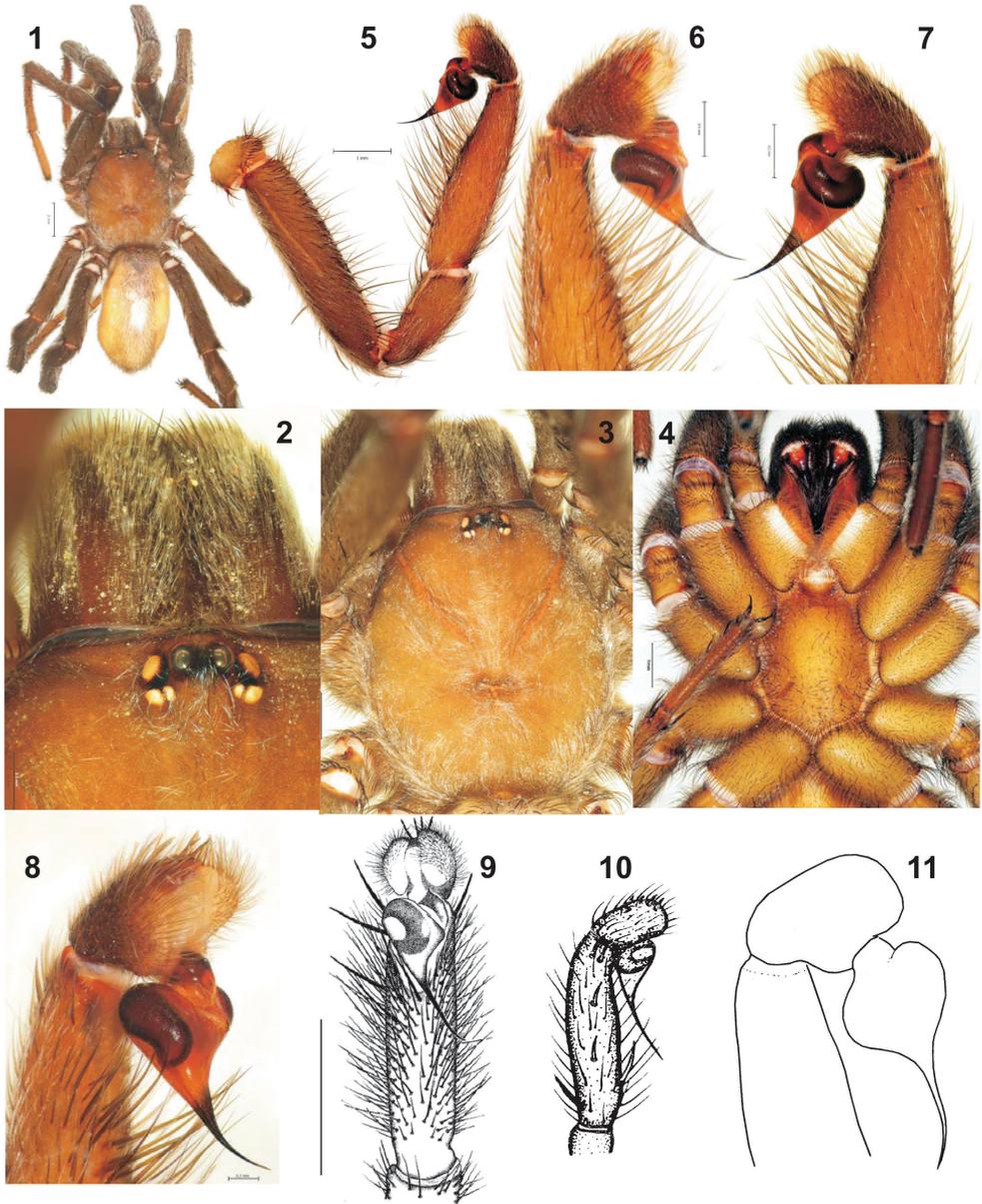
Palp as in Figs 5–8, thin, femur slightly longer than tibia, and as long as patella; bulb as long as patella, bulb (with embolus) 2.3 longer than widest diameter of bulb; embolus without distinct base, its length subequal to length of bulb.

Distribution. The species is known only from the type locality. It is the southwesternmost record of the genus.

Nemesiidae Simon, 1889

Genus *Raveniola* Zonstein, 1987

Comments. *Raveniola* is a relatively large genus of nemesiid spiders with 22 described species. The genus is distributed from Turkey to China (cf. Platnick 2014). Two species of this genus are known from Iran: *R. niedermeyeri* (Brignoli, 1972) and *R. vonwicki* Zonstein, 2000. Both species are well studied by Zonstein (2000) and Zonstein and Marusik (2010).



Figures 1–11. Habitus and male palp of four *Anemesia* species: *A. koponeni* sp. n. (1–8), *A. incana* (9, after Zonstein 2001), *A. karatawi* (10, after Andreeva 1976) and *A. birulai* (11, after Spassky 1937, modified). 1 male habitus, dorsal 2 eye group and chelicerae, dorsal 3–4 prosoma, dorsal and ventral 5 whole palp, retrolateral 6–8 tip of palp, prolateral, retrolateral and prolateral-apical 9 palp, ventral 10–11 palp, prolateral.

***Raveniola mazandarunica* sp. n.**

<http://zoobank.org/A43C76C0-5750-4B2C-9616-F747BA48DA06>

Figs 12–18

Material. Holotype ♂ (SMF), IRAN, *Māzandarān* Province, Abbās Abād, Salmān Shahr, around Dāniāl Cave (36°39'N, 51°10'E), April 2014 (P. Beyhaghi).

Etymology. The specific epithet is derived from the type locality; adjective.

Diagnosis. So far, only two *Raveniola* species are known to occur in Northern Iran: *R. niedermeyeri* and *R. vonwicki*. The new species can be distinguished from *R. niedermeyeri* by its twisted embolus (gradually bent in *R. niedermeyeri*, Fig. 21). *Raveniola mazandarunica* sp. n. differs from the similar *R. vonwicki* by the shape of its embolic tip and by having a tibial prolateral apical spine (arrowed on Fig. 15), lacking in sibling species. All three Iranian species differ in the number of their prolateral apical tibial spines: none in *R. vonwicki*, two in *R. niedermeyeri*, and one in *R. mazandarunica* sp. n.

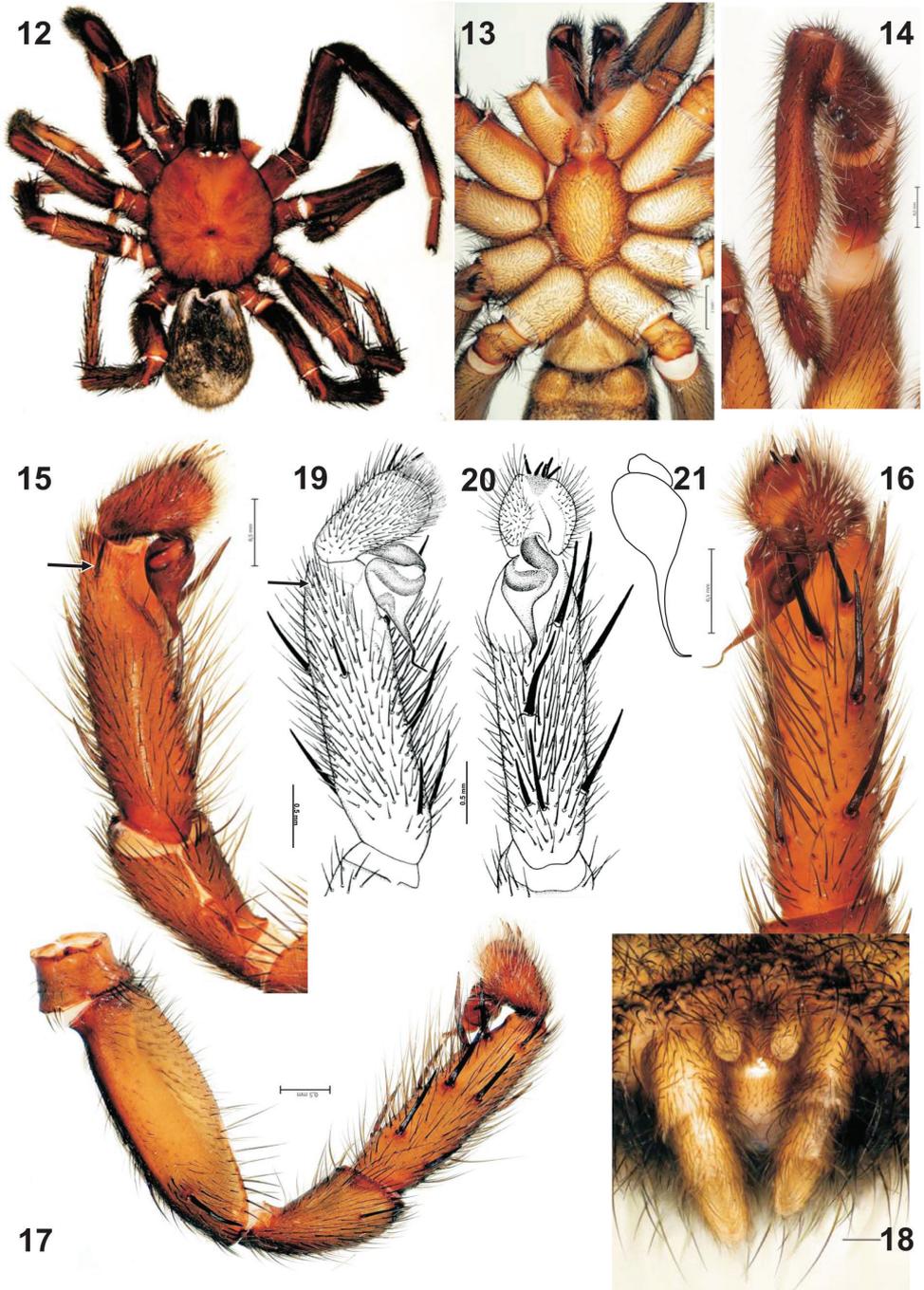
Description. Total length 11.3 with chelicerae and 9.7 without chelicerae. Carapace 5.25 long, 4.9 wide; sternum 2.55 long, 1.85 wide; eyefield 1.13 wide, 0.55 long. Habitus and pattern as in Figs 12–13. Eye sizes and interspaces: AME 0.15, ALE 0.3, PLE 0.2, PME 0.17, AME–AME 0.12. Maxillae with about 10 cusps each. Palp: 2.75 + 1.55 + 2.25 + 0.9, bulb (including embolus) 0.83 long. Leg I: 4.0 + 2.3 + 3.35 + 3.25 + 1.8. Leg II: 3.85 + 2.0 + 2.75 + 2.75 + 1.8. Leg III: 3.37 + 1.7 + 3.25 + 3.3 + 1.75. Leg IV: 4.2 + 2.0 + 3.35 + 4.75 + 2.0. Metatarsus I modified, with thinner proximal half and thicker distal half (Fig. 14). Spination of palp: femur 2d, 1pa; patella 0; tibia 2d, 1ra, 3p, 3vp, 2vr, 1vm; cymbium 4. Leg I: femur d4, p21; tibia p2, v6. Leg II: femur d4, p3; patella p1; tibia p3, v7; metatarsus p1, v6. Leg III: femur d4, p3, r2; patella p1, r1; tibia d2, p3, r3, v7; metatarsus d2, p3, r3, v8. Leg IV: femur d4, p3, r2; patella p2, r1; tibia d2, p4, r4, v7; metatarsus d5, p4, r4, v10. Scopula: present on metatarsi I–II and tarsi I–II; absent on tarsi III–IV. Paired claws: inner and outer margins with 7–11 teeth each. Spinnerets: PMS 0.3 long; PLS 1.2 long, apical segment triangle.

Palp as in Figs 15–17, femur slightly longer than tibia and about 1.5 thicker; patella longer than cymbium and wider than tibia; tibia prolaterally with one apical spine; bulb 2.7 shorter than tibia, embolus bent 3 times.

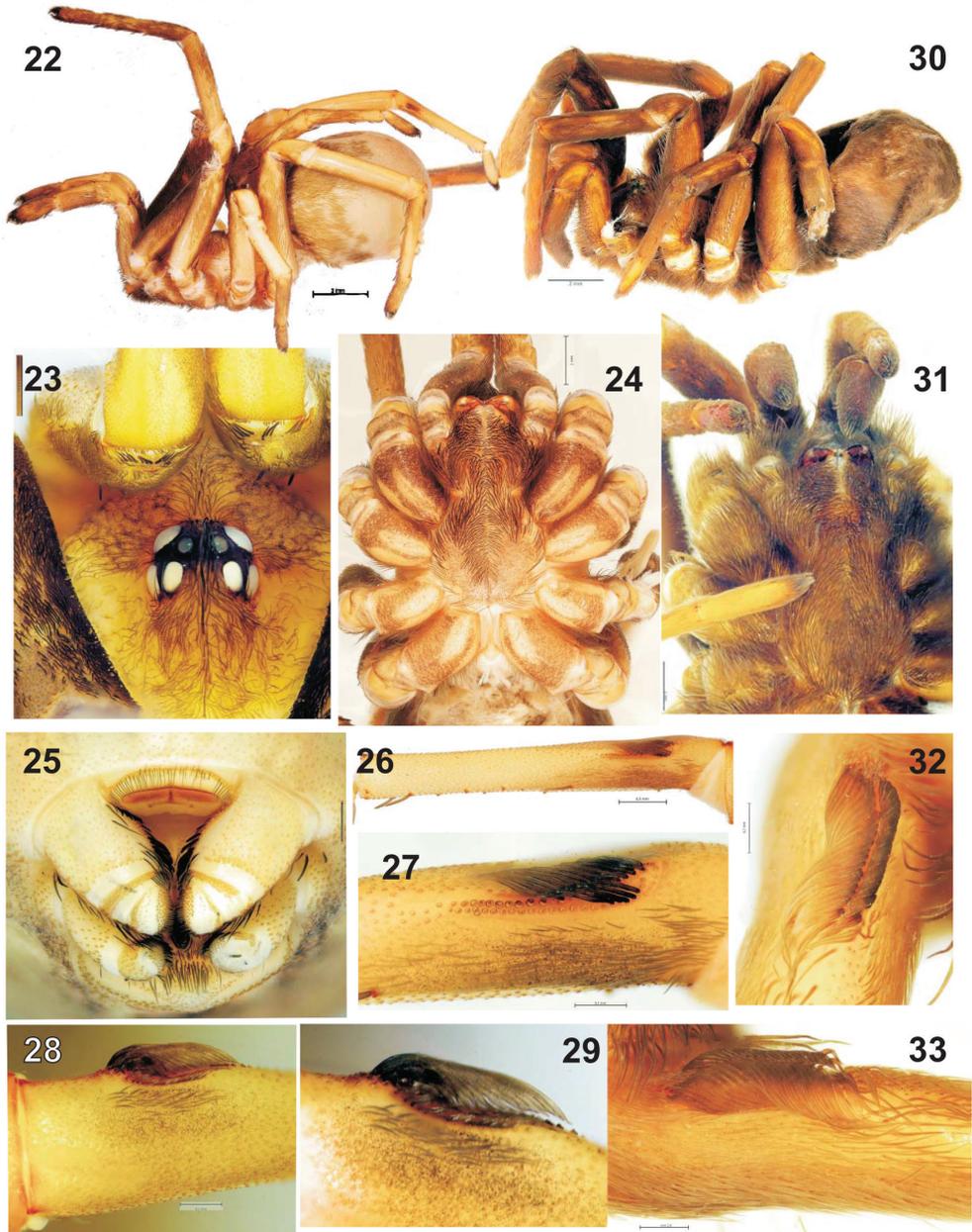
Distribution. The new species is known only from the type locality.

Filistatidae Simon, 1864***Sabastata* Benoit, 1968**

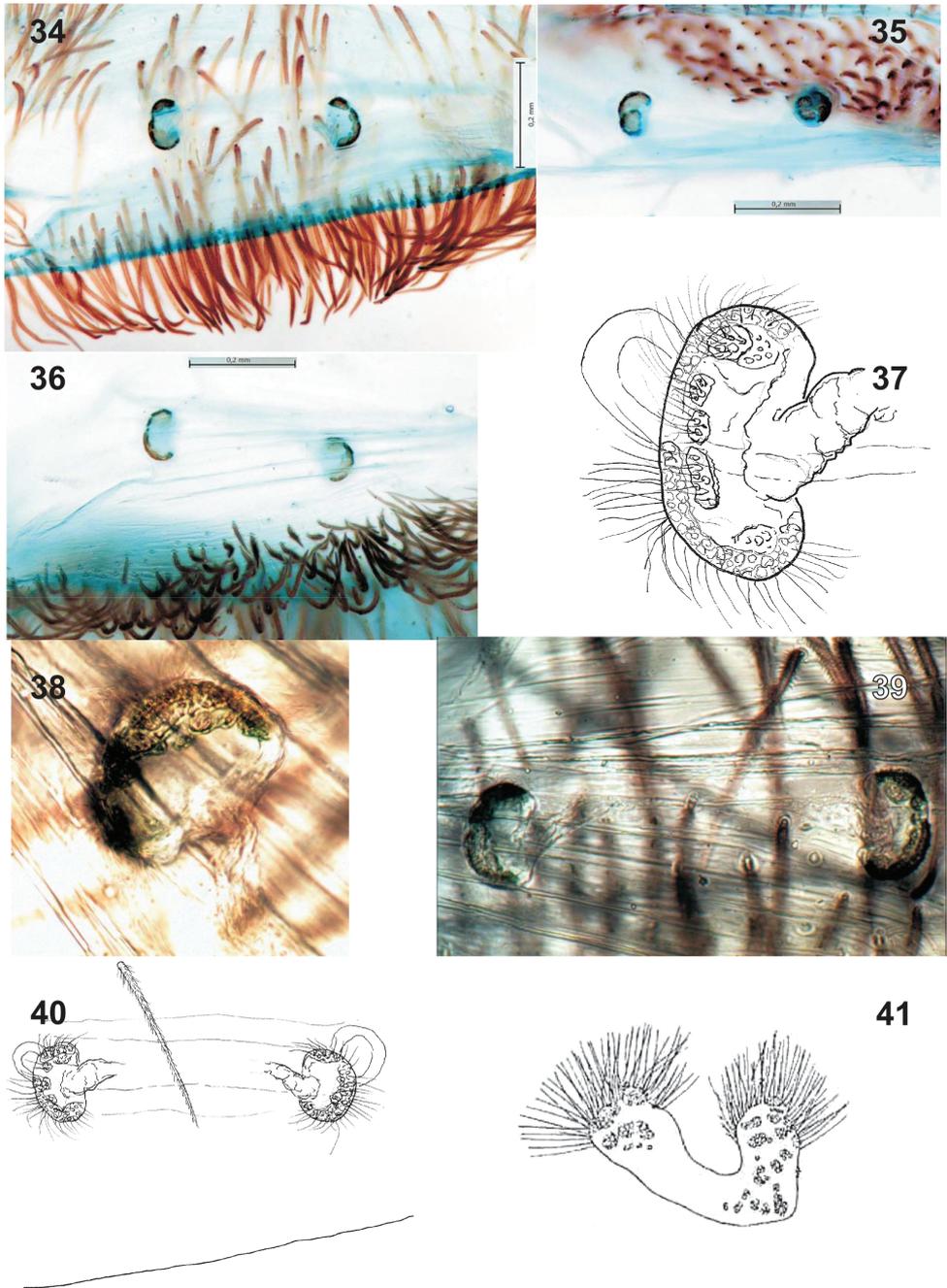
Comments. *Sabastata* is a small genus of Filistatinae spiders with three described species. It is known from the Mediterranean to India (Platnick 2014). Members of this genus differ distinctly from *Filistata* by their very hairy sternum+labium and a calamistrum having 2–3 rows of inclined hairs.



Figures 12–21. Habitus and male palp of three *Raveniola* species: *R. mazandaranica* sp. n. (12–18), *R. vonwicki* (19–20, after Zonstein 2000) and *R. niedermeyeri* (21). 12 male habitus, dorsal 13 prosoma, ventral 14 leg I, ventral 15, 19 palp, prolateral 16, 20 palp, ventral 17 whole palp, retrolateral 18 spinnerets, ventral 21 bulb, ventral.



Figures 22–33. Habitus and somatic characters of two *Sabastata* species: *S. sinuspersica* sp. n. (22–29) and *S. nigra* (30–33). 22, 30 habitus, lateral 23 eye group, dorsal 24, 32 prosoma, ventral 25 spinnerets and cribellum, ventral 26–29, 32–33 calamistrum.



Figures 34–41. Vulvae of two *Sabastata* species: *S. sinuspersica* sp. n. (34–40) and *S. nigra* (41, after Benoit 1968). 34, 39–40 dorsal 35 subapical 36 caudal 37 receptacle, subapical 38, 41 dorsal.

***Sabastata sinuspersica* sp. n.**

<http://zoobank.org/DE576BD3-D04B-486D-92C2-653FACA564EF>

Figs 22–29, 34–40

Material. Holotype ♀ (SMF), IRAN, *Hormozgān* Province, Bandar-e‘Abbās (found under a large rock, in a sandy substrate near the harbor), 27°11'N, 56°17'E, January 2014 (A. Zamani). Paratypes: 1♀ and 3 juv (SMF), IRAN, *Hormozgān* Province, Hormuz Island (found under a large rock, in a sandy substrate near the sea), 27°04'N, 56°28'E, January 2014 (A. Zamani).

Comparative material. Syntype ♀ of *S. nigra* (Simon, 1897) from Muscat, in Muséum National d'Histoire Naturelle, Paris.

Etymology. The specific epithet is derived from the Persian Gulf (Sinus Persicus in Latin); adjective.

Diagnosis. The new species differs distinctly from the type species, *S. nigra* by its lighter coloration and undivided receptacles (with two heads in *S. nigra*, Fig. 41). It differs from *S. sabaea* Brignoli, 1982 by its receptacles which are twice as large in size (6.1 in *S. sabaea*) and unbranched (with two “heads” in *S. sabaea*, f. 18, Brignoli 1982).

Description. Total length 12.0. Carapace 5.0 long, 4.0 wide; sternum 2.5 long, 2.25 wide. Habitus and pattern as in Figs 22–24. Palp: 2.75 + 1.45 + 1.65 + 1.6. Femur I 5.25 (other segments missing). Leg II: 4.2 + 1.7 + 3.25 + 3.35 + 1.6. Cribellar plates elongate, much longer than high (Fig. 25), calamistrum with three rows of hairs (Figs 26–29).

Vulva as in Figs 34–40; receptacles with one distinct head standing on a membranous and goffered stalk; in apical view the receptacle appears to have two heads; head covered with isolated patches of glands; receptacles separated by about 3 diameters.

Distribution. The new species is known only from the type locality in Bandar Abbas and Hormuz Island.

Acknowledgements

We would like to thank Sergei L. Zonstein for consultations and discussion about relationships of the three species described in this paper. Special thanks to Seppo Koponen (University of Turku) for providing museum facilities. The authors are thankful to Parham Beyhaghi, Fatemeh Abedi and Abbas Kazemi for field assistance. English of the earlier draft was kindly checked by Don Buckle. This study was supported in part by the Russian Foundation for Basic Research (grant № 12–04–01548).

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A new Eastern Asian *Hycleus* and key to the Chinese species of the *phaleratus* group (Coleoptera, Meloidae, Mylabrini)

Zhao Pan¹, Monica Carosi², Marco A. Bologna²

1 *The Key laboratory of Invertebrate Systematics and Application of Hebei Province, Hebei University, 071002, Baoding, Hebei Province, China* **2** *Dipartimento di Scienze, Università degli studi Roma Tre, Viale G. Marconi 446, 00146, Rome, Italy*

Corresponding author: Marco A. Bologna (marcoalberto.bologna@uniroma3.it)

Academic editor: W. Schawaller | Received 11 July 2014 | Accepted 11 November 2014 | Published 12 December 2014

<http://zoobank.org/2B639510-EEFB-4D96-B083-BC4B3548296F>

Citation: Pan Z, Carosi M, Bologna MA (2014) A new Eastern Asian *Hycleus* and key to the Chinese species of the *phaleratus* group (Coleoptera, Meloidae, Mylabrini). ZooKeys 463: 11–19. doi: 10.3897/zookeys.463.8261

Abstract

A new species of *Hycleus* belonging to the *phaleratus* group, and close to *H. phaleratus*, is described. The new species, *Hycleus marcipoli*, is distributed in China (Gansu and Taiwan), Laos, and northern Thailand. A key to the Chinese species of this group is presented.

Keywords

Blister beetles, new species, China, key to species, taxonomy

Introduction

Hycleus Latreille, 1817, tribe Mylabrini, is the most speciose genus of the blister beetle family with approximately 430 described species. However, the only study of the genus is a very old comprehensive one (Marseul 1872) devoted to the entire tribe. *Hycleus* itself remains inadequately studied and is in need of complete revision.

The genus is restricted to the Old World and centered in the Afrotropical region (Bologna and Pinto 2002). In the literature it has been confused with the genus *Mylabris* Fabricius, 1775 and other Mylabrini genera by several Authors. The very complex synonymy and generic definition of *Hycleus* were explained by Bologna (1978, 1991) and Bologna and Pinto (2002).

The taxonomy of some Palaearctic and Afrotropical species groups have been studied in the last 50 years (e.g. Pardo Alcaide 1954, 1955, 1958, 1968; Bologna 1978, 1979, 1990, 1991), while that of the Oriental species is still confused and the scanty contributions provide rough descriptions and figures (Saha 1972, 1979). Recently, a preliminary taxonomic study of Chinese *Hycleus* species was published by Pan et al. (2011a, in Chinese); this contribution considered 19 species belonging to both Palaearctic and Oriental lineages. As is widely known, the Chinese area belongs to both biogeographic regions and is also characterized by a transitional biogeographic subregion in its south-eastern portion (e.g., Palestrini et al. 1987; Brown and Lomolino 1998) thus representing a valuable and appropriate research zone.

Several Oriental species of *Hycleus* belong to the *phaleratus* group, which is widely distributed from Pakistan to eastern China and Indonesia. The *phaleratus* group is distinct, but more closely related to Afrotropical than to Palaearctic lineages. It is mostly distributed in the Oriental region and in the transitional biogeographic subregion, and marginally spread in some Palaearctic zones of Mongolia, China, Himalayan countries, India and Pakistan. This group of species belongs to the *Hycleus* lineage characterized by a mesosternum of the Mesoscutatus type (see Bologna 1991) with a large modified fore area (“scutum”). It is easily distinguishable from other *Hycleus* belonging to the Mesoscutatus lineage by the following characters: male maxillary galeae not distinctly modified; antennae with 11 antennomeres entirely black (Fig. 3); elytra black with two reddish yellow basal spots (one in the middle and one on the external margin) and two, middle and subapical, yellow-reddish transverse fasciae (Fig. 4).

The species of this group have been repeatedly confused in the literature and the future examination of types will be the basis for a taxonomic revision of all included species. The main taxonomic problem is that Pallas (1782) described “*Meloe phalerata*” from “*cisgangeticae Indiae*” (type locality: an old name indicating the Indian regions W of Ganges river), but its collection is missing and no types are currently available. The identification of *phaleratus* in the literature is doubtful and has always been based on the elytral pattern, which actually is similar in other Oriental species of this group. Considering that this taxonomic problem remains unclarified, in the present paper we defined as *phaleratus* the species occurring in India; it best corresponds to the Pallas’ description.

Working on Chinese specimens of this group housed in the M. Bologna’s collection (University Roma Tre: MAB), we discovered a new species not identified in the Pan et al. (2011a, b) studies. Aim of the present study is to describe this new species and to provide a key to the known Chinese species of the *phaleratus* group.

Results

Hycleus marcipoli Pan & Bologna, sp. n.

<http://zoobank.org/1EA7C534-A836-4854-A110-403CD7CFA9CC>

Figures 1a, 2–9

Type specimens. Holotype male (MAB), labelled “China, Kansu mer. Shinlong-Shan Mts. Yuzhong, 3200 m a.s.l., 6/7.VII.1998, L. Bieber leg.” (white, rectangular, printed).

Paratypes: 3 females (MAB) with the same label of holotype; 1 female (MAB), labelled “Formosa” (white, rectangular, printed); 1 male (MAB), labelled “Thailandia, Ghiang Dao, Chiang Mai” (white, rectangular, printed); 1 female (MAB) labelled “Nord Thailand, Doi Chiang Dao, 1300 m, 20.IX.1979, T. Racheli leg.” (white, rectangular, printed); 1 female (MAB), labelled “Laos, Luang Prabang, 20.VII.1975, Rossetto leg.” (white, rectangular, printed); 2 males and 1 female (MAB), labelled “Laos, Vientiane, Phu Khao Khoay, 15.V.2006, D. Macale leg.” (white, rectangular, printed); 6 males and 7 females (MAB) labelled “Laos, Oudomxay prov., Namom distr., Phouxiang, 10-26.VI.2008” (white, rectangular, printed). All types have additional labels “Holotypus (and Paratypus, respectively), *Hycleus marcipoli* sp. n. Z. Pan & M. Bologna det. 2014” (red, rectangular, printed and handwritten).

Type locality. “China, Kansu mer. Shinlong-Shan Mts. Yuzhong”. Shinlong-Shan Mts., as written on the label, is the transliterated name of the Xinglong-Shan Mts., located in the Yuzhong County, Lanzhou City, in Southeastern part of Gansu Province. These mountains represent the eastward extension of the Qilian-Shan Mts. This area is usually included in the Palaearctic region, but according to its animal and plant diversity, it belongs to the transitional Chinese area.

Diagnosis. This is a species of the *Mesoscutatus* type lineage, belonging to the *phaleratus* group and phenetically similar to *H. phaleratus* (Pallas, 1782). Body only with black setae except the elytral axillary fore spot, the protibiae and protarsi with mixed black and yellow-brown setae. Basal part of antennomere XI narrower than the apical part of antennomere X (Fig. 3). Elytral yellow-reddish fasciae wider and slightly flexuous (Figs 1a, 4). Fore margins of mesepisterna forming a median narrow groove, margins almost touching each other (Fig. 5). Apical setae on external side of protibiae distinctly longer than those on other parts of tibia, reaching the apical margin of protarsomere I. Proximal aedeagal dorsal hook positioned far from the distal one (Fig. 6).

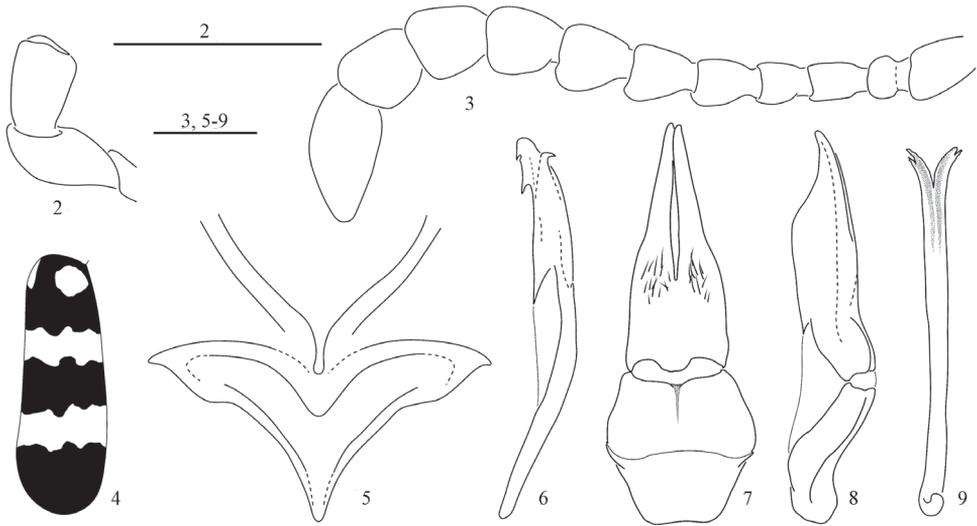
Description. Body (Fig. 1a) unicolour black, except elytra, which are black but with two testaceous fore spots (one axillary and one close to the scutellum), two slightly sinuate testaceous fasciae, a medial one and a subapical one (Fig. 4). Body with black setae, also on ventral side, but mixed with golden setae on the elytral axillary fore spot, on inner side of protibiae, and on protarsal pads. Body length (apex of mandibles–apex of elytra): 26–38 mm.

Head subquadrate, slightly longer than wide, with the maximum width at the level of eyes. Punctures shallow, medium in size and quite dense, in some specimens



Figure 1. Habitus, male, in dorsal view, **a** *Hycleus marcipoli*, holotype **b** *Hycleus biundulatus*.

reduced near the frontal suture, with an inconspicuous depression in the middle, between eyes. Eye globose, with the antero-dorsal margin slightly sinuate, just behind the antennal insertion. Temple subparallel, only slightly curved posteriad and subequal in length to the longitudinal diameter of eye. Clypeus, narrower than the interocular width, rounded on sides, posteriorly with same punctures of frons and anteriorly almost smooth and slightly sloping; labrum subreniform, scarcely narrower than clypeus, rounded on sides, the fore margin moderately sinuate in both sexes, medially slightly depressed. Male maxillary galeae non modified in both sexes, laterally and ventrally, with a tuft of elongate robust setae, not thickened, on posterior half; maxillary palpomeres slightly enlarged apically, particularly II and III, palpomere IV suboval; labial palpomere II slightly widening (Fig. 2). Mandibles curved and progressively narrowed on the apical third. Antennae with 11 antennomeres (Figs. 3): I-V more or less shiny, the remaining subopaque; antennomere I ca. as long as II-III together; II subglobose; III-IV subcylindrical and slender, III about 1.5 times as long as IV; V-VIII similar in length, subtrapezoidal, apically enlarged on external side, increasing in width from V to IX and then decreasing from X to XI, X subquadrate and slightly shorter



Figures 2–9. *Hycleus marcipoli* sp. n. **2** male labial palpi, in ventral view **3** antenna **4** elytral pattern **5** mesosternum and mesepisterna **6** aedeagus, in lateral view **7** tegmen, in ventral view **8** tegmen, in lateral view **9** *spiculum gastrale*. Bar scales: 1 mm.

than IX; antennomere XI distinctly narrower and ca 1.5 as long as X, subcylindrical but narrowed in the apical third.

Pronotum elongated, distinctly longer than wide, about as wide as head at eyes, subparallel on sides on the basal 2/3, and then distinctly narrowing anteriorly; fore portion greatly depressed, as well as on the middle of base, just in front of mesonotum; punctures similar to that on head, with a longitudinal medial small furrow, almost impunctate. Elytral pattern as in Figs 1a, 4. Mesosternum of the *Mesoscutatus*-type (Fig. 5); fore margins of mesepisterna forming a median narrow groove, margins almost touching each other. Legs slender; protibiae with two spurs, both tibial spurs on all legs slender; protarsi in both sexes with a distinct golden ventral pad; apical setae on external side of male distinctly longer than those on other parts of the tibia, reaching the apical margin of protarsomere I; external side of male protibiae with scattered longer setae, and inner side on both sexes with dense golden setation. Protarsi as long as protibiae, protarsomeres always longer than wide, slightly widened apically and with dense and longer setae at apex.

Posterior margin of the penultimate male abdominal sternite sublinear, that of the last visible sternite only slightly emarginated. Parameres (Figs 7, 8) distinctly elongate with slender and elongate apical lobes, much narrower than basal third in ventral view; aedeagus with two slender hooks, proximal one positioned far from the distal one (Fig. 6); endophallic hook small and slender.

Etymology. As a tribute to the collaboration established among the authors during the Ph.D. studies made in Italy by one of them (PZ), the new species is named after Marco Polo (1254–1324), the Venetian explorer who, during a long period of permanence

in China in the late XIII century (1271–1284), established the first well documented relationships between the Chinese and European worlds and opened western culture to the wide and rich Chinese heritage.

Taxonomic remarks. The species of the *phaleratus* group are phenetically similar in body shape, but variable in size and elytral colouration; *H. phaleratus* is the most similar to *H. marcipoli*. These species have been repeatedly confused due to their similar, but they can be identified by the following characters used in the key below: colour of setae on ventral side of body and on elytral yellow-reddish fasciae and spots, especially the axillary spot; length of setae on male protibiae and protarsi; shape of protarsi, mesosternum, and male genitalia; extension of the fore pronotal depression.

Distribution. China (SE Gansu, Taiwan); Laos; Thailand.

Key to the Chinese *Hycleus* species of the *phaleratus* group

- 1 Male protibiae with two apical spurs.....2
- 1' Male protibiae with one apical spur only. China (Fujian, Hubei, Sichuan, Yunnan)*hirtus* (Tan, 1992) (the validity of this species needs to be confirmed)
- 2 Setae black, except a mixture of black and golden setae on elytra, tarsi and protibiae3
- 2' Body setae mixed golden and black, at least on the ventral side of thorax, and possibly on other parts of body5
- 3 Elytral reddish-yellow fasciae narrow, distinctly flexuous and jagged (Fig. 1b). China (Fujian, Yunnan); Indonesia (Java); India; Sri Lanka; Pakistan ...
.....*biundulatus* (Pallas, 1782) (syn. *pustulatus* Thunberg, 1791)
- 3' Elytral reddish-yellow fasciae wider and slightly flexuous, not jagged.....4
- 4 Elytral axillary spot with few yellow setae mixed to black setae; setae at external apex of male protibiae longer than those on other sides and reaching the apical margin of protarsomere I; fore margins of mesepisterna forming a median narrow and drop-like groove, margins almost touching each other; proximal aedeagal hook positioned far from the distal one. (Figs 1a and 2–9). China (SE Gansu, Taiwan); Laos; Thailand.....*marcipoli* Pan & Bologna sp. n.
- 4' Elytral axillary spot with black setae only; setae at external apex of male protibiae longer than that on other parts, not reaching the apical margin of protarsomere I; fore margins of mesepisterna almost parallel along the median groove and posteriorly diverging, median groove wide and almost parallel; proximal aedeagal hook close to the distal one. SE China; Thailand; Indonesia (E to Timor Is.); Nepal; India; Sri Lanka; Pakistan (also in its Palaearctic part) (the true distribution must be better defined)*phaleratus* (Pallas, 1782)
- 5 Elytral yellow-reddish fasciae with mixed yellow and black setae, but the axillary spot.....6
- 5' Elytral yellow-reddish fasciae with black setae only, but the axillary spot7

- 6 Body small to middle sized (length 11.9–21.7 mm); eyes normal in size, ca. 0.6 as long as head; antennomere XI more than 1.5 as long as wide; proximal aedeagal hook relatively far from the distal one (Fig. 5J, in Pan et al. 2011a). SE China (Guangxi, Yunnan, Guangdong, Taiwan, Hong Kong); Vietnam; Laos; Cambodia; Thailand; Indonesia (Java); Nepal; Sikkim; N India. Doubtfully recorded from Japan *cichorii* (Linnaeus, 1758)
- 6' Body size small (length 10.0–13.3 mm); eyes longer, ca. 0.75 as long as head; antennomere XI distinctly less than 1.5 as long as wide; proximal aedeagal hook relatively close to the distal one (Fig. 9J, in Pan et al. 2011a). China (Yunnan); Vietnam..... *parvulus* (Fridvaldszky, 1892)
- 7 Protarsi short, especially in male, length of protarsomeres II-IV distinctly less than width. China (Fujian, Guangxi, Hainan, Yunnan, Taiwan, Hong Kong); Vietnam; Laos; Thailand; Myanmar; Sikkim; Nepal; N India *brevetarsalis* (Kaszab, 1960)
- 7' Protarsi normal in length, protarsomeres II-IV longer than wide 8
- 8 Pronotal anterior depression inconspicuous; body size large, usually more than 25 mm in length; proximal aedeagal hook close to the distal one (Fig. 6J, in Pan et al. 2011a). China (Fujian, Guangxi, Sichuan, Yunnan, Xizang); Laos; Thailand; N India (Uttar Pradesh); Nepal..... *dorsetiferus* Pan, Ren & Wang, 2011
- 8' Pronotal anterior depression distinct; body small to middle in size, usually less than 25 mm in length; proximal aedeagal hook relatively far from the distal one (Figs 7J, 8J, in Pan et al. 2011a)..... 9
- 9 Setae on dorsum of male protarsi much longer than on other surfaces; male protarsomere normally elongate and protarsomere I shorter than V; protarsi and maxillary palpi usually yellow-brown, black only in few individuals from S China; body length 14.6–24.5 mm. Mongolia; Central, Eastern and Southern China; N India (Himanchal Pradesh, Madhya Pradesh, Punjab); Nepal..... *medioinsignatus* (Pic, 1909)
- 9' Setae on dorsum of male protarsi not distinctly longer than on other surfaces; male protarsomeres slender, protarsomere I as long as V; protarsi and maxillary palpi black; body length 12.3–15.6 mm. China (Sichuan, Yunnan); N India; Sikkim..... *mannheimsi* (Kaszab, 1961)

Discussion

Most of the *Hycleus* species are distributed in the Afrotropical Region, particularly in savannah ecosystems; a large number of very distinct lineages is also spread in the Palaearctic Region, particularly in desert and steppe ecosystems. On the contrary the genus is poorly represented in the Oriental Region, probably because of the extension of primary forests, a habitat unsuitable for blister beetles.

Among the 20 *Hycleus* species distributed in China (Pan et al. 2011a, b; note that *bistillatus* (Tan, 1981), was referred erroneously to *Hycleus* but actually belongs to the genus *Mylabris*; Pan et al. in prep.), excluding *H. schoennerri* (Billberg, 1813) having a Mesogorbatius type mesosternum, the remaining 19 have a Mesoscutus type mesosternum. Nine of them belong to Palaearctic lineages and, in particular, the following species can be referred to the *polymorphus* group (as partially defined by Bologna 1991, 1994): *H. atratus* (Pallas, 1173), *H. biguttatus* (Gebler, 1811), *H. chodschenticus* (Ballion, 1878), *H. hokumanensis* (Kôno, 1940), *H. polymorphus* (Pallas, 1771), *H. quatuordecimpunctatus* (Pallas, 1781), *H. scabiosae* (Olivier, 1811), *H. solonicus* (Pallas, 1782), and *H. tekkensis* (Heyden, 1883). The remaining ten Chinese *Hycleus* with Mesoscutatus mesosternum, here studied, belong to the Oriental *phaleratus* group.

Other species were described from India and Pakistan in the genus *Mylabris* (or its synonym *Zonabris* Harold, 1879) by Pic (1916) and Saha (1972, 1979); however, these very short descriptions and rough figures are scarcely informative. According to the descriptions and/or after type examinations, some of these can be referred to the genus *Hycleus* and a few [*ajantaensis* (Saha, 1979), *goaensis* (Saha, 1979), *gonostilus* (Saha, 1972), *himalayaensis* (Saha, 1979), *horai* (Saha, 1972), *mandibularis* (Saha, 1979), *sahai* (Kaszab, 1981) new name] may belong to the *phaleratus* group and mostly are probably synonyms of *H. phaleratus*, *H. biundulatus*, *H. medioinsignatus* and *H. cichorii*. These species apparently differ from *H. marcipoli* and were never recorded from China.

The study of new characters useful in the taxonomy of Oriental lineages, such as the morphology of male genitalia, maxillae, palpomeres and mesosternal structure, utilized for the Afrotropical *Hycleus*, could support the study of Oriental species, never revised in more than one century.

Acknowledgements

We thank Alessandro Albani for the graphic help and Martin Bennet for the English revision.

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Contribution to the knowledge of the *Carabus (Archiplectes) satyrus* Kurnakov, 1962, species complex in Abkhazia (Coleoptera, Carabidae, Carabini)

Igor A. Solodovnikov¹, Alexandr S. Zamotajlov²,
Dmitriy D. Fominykh³, Andrey Y. Titarenko⁴

1 Vitebsk State P.M. Masherov University, Moskovskiy prospect, 33, Vitebsk 210038, Belarus **2** Kuban State Agrarian University, Kalinin St. 13, Krasnodar 350044, Russia **3** Russian Entomological Society, Kuban Branch, Kalinin St. 13, Krasnodar 350044, Russia **4** Publicly Traded Company “Morpho Absoloni”, Bolotnikovskaya St. 5/3, Moscow 117556, Russia

Corresponding author: Alexandr S. Zamotajlov (a_zamotajlov@mail.ru)

Academic editor: A. Casale | Received 26 August 2014 | Accepted 17 November 2014 | Published 12 December 2014

<http://zoobank.org/71C1AE92-B0CE-4D26-B1E5-076E480180AD>

Citation: Solodovnikov IA, Zamotajlov AS, Fominykh DD, Titarenko AY (2014) Contribution to the knowledge of the *Carabus (Archiplectes) satyrus* Kurnakov, 1962, species complex in Abkhazia (Coleoptera, Carabidae, Carabini). ZooKeys 463: 21–56. doi: 10.3897/zookeys.463.8499

Abstract

This study is based on a comparative analysis of extensive material of *Carabus (Archiplectes) satyrus* Kurnakov, 1962, its various forms and related taxa recently collected by the authors and some other collectors in Abkhazia. The status or specific affiliations of several subspecies are changed and a subspecies is described. *Carabus (A.) besleticus* Kurnakov, 1972, **stat. n.** is treated as a separate species housing six hitherto established subspecies in addition to the nominal type: *C. (A.) besleticus mtsaranus* Kurnakov, 1972, *C. (A.) besleticus duripshensis* Kurnakov, 1972, *C. (A.) besleticus napraensis* Belousov & Zamotajlov, 1993, *C. (A.) besleticus dychuensis* Kurnakov, 1972, *C. (A.) besleticus adzinbai* Retezár, 2013, and *C. (A.) besleticus resheviensis* **subsp. n.** *Carabus (A.) satyrus* is treated as monotypical while the specific status of *C. (A.) pseudopshuensis* Zamotajlov, 1991, earlier proposed by Fominykh and Zamotajlov (2012), is confirmed based on the morphological and morphometric data.

Keywords

Coleoptera, Carabidae, *Carabus (Archiplectes) satyrus* species complex, Abkhazia, taxonomy, distribution, new status, new subspecies

Introduction

Carabus (Archiplectes) satyrus Kurnakov, 1962, has been described from the vicinities of the settlement Gulripsh in the Gulripsh District of Abkhazia. Type material of the nominotypical subspecies originates from an interfluvium of the rivers Kealasur and Kodor. Other subspecies of *C. (Archiplectes) satyrus* were hitherto known from the south slope of Bzybian Mountain Range, spreading from the orographic left bank of River Bzyb in the west to the right bank of River Kealasur in the east. One further subspecies, *Carabus (Archiplectes) satyrus pseudopshuensis* Zamotajlov, 1991, described from a single specimen, descends from the right bank of River Bzyb (environs of the Village Pskhu) in Abkhazia. Our study provides several informative morphological features: first of all the fully inflated endophallus preparations, structure of aggonoporus (= copulatory pieces), and some morphometric characters. It revealed that *C. (Archiplectes) satyrus satyrus* actually differs essentially from the other known subspecies. Based on these data, we change the specific affiliation of *C. (Archiplectes) satyrus besleticus* Kurnakov, 1972, *C. (Archiplectes) satyrus duripshensis* Kurnakov, 1972, *C. (Archiplectes) satyrus mtsaranus* Kurnakov, 1972, *C. (Archiplectes) satyrus napraensis* Belousov & Zamotajlov, 1993, *C. (Archiplectes) satyrus adzinbai* Retezár, 2013; the next paginal valid name, *C. (Archiplectes) besleticus* Kurnakov, 1972, stat. n. is hereafter applied. This species comprises all subspecies listed above. The shape of the fully inflated endophallus preparations, the structure of the aggonoporus, and the shape of the apical lamella of aedeagus of populations of *Archiplectes* collected at Mt. Dzykhva – type locality of *C. (Archiplectes) satyrus dzykhvensis* Gottwald, 1985 – confirm that this taxon should be also attributed to *C. (Archiplectes) besleticus*, and thus its specific affiliation is changed to *C. (Archiplectes) besleticus dzykhvensis* Gottwald, 1985. Material collected by the authors in environs of Village Pskhu, including the recently defined by Prof. Dr. A. Kazadaev type locality (pers. comm) of *C. (Archiplectes) satyrus pseudopshuensis*, appreciably differ in some structures (fully inflated endophallus preparations, aggonoporus and apical lamella of aedeagus) from the other taxa of the *C. satyrus – besleticus* complex. This allows us to confirm its specific status, recently proposed by Fominykh and Zamotajlov (2012). Material from a valley of one of the left tributaries of River Bzyb – River Reshevie – at the north slopes of Bzybian Mountain Range, originated from an altitude of 700 m and higher, proved the sympatry of two taxa related to *C. (Archiplectes) satyrus*. It displays the well-known pattern of the genus *Carabus*: the larger sized form occurs together with smaller one. Studies of the fully inflated endophallus preparations have also allowed us to establish reliable distinctions between these forms and interpret them as two separate species, the smaller form as *C. (Archiplectes) pseudopshuensis* Zamotajlov, and the larger one as a new subspecies *Carabus (Archiplectes) besleticus resheviensis* subsp. n. A distribution map of *C. (Archiplectes) satyrus*, *C. (Archiplectes) besleticus* and *C. (Archiplectes) pseudopshuensis* is given in Fig. 7.

Species of the complex resemble habitually forms of *C. (Archiplectes) juentheri* Reitter, 1899. The latter species possesses very high morphological polymorphism in different features, this having resulted in description of its numerous forms and sub-

species. However, they differ in having generally more robust than in the *C. (Archiplectes) satyrus* species complex body, larger, more transverse, and stronger cordate pronotum. Nevertheless, some populations of *C. (Archiplectes) juenthneri* from the right bank of river Aguripsta near village Pskhu are hardly distinguishable in habitus from *C. (Archiplectes) pseudopshuensis* and can be reliably recognized only by the shape of aedeagus and structure of endophallus and aggonoporus. *C. (Archiplectes) juenthneri* possesses larger aedeagus, apical lamella with two sharper hollows and more prominent tubercles laterally; preputial tubercle smaller, strongly sclerotized laterally and posteriorly, aggonoporus of different shape, much smaller than in *C. (Archiplectes) besleticus* and *C. (Archiplectes) pseudopshuensis*, with lobes being prominently dilated apically and rounded laterally, separated amidst by membranous folder.

Forms with elytral sculpture resembling *C. (Archiplectes) reitteri reitteri* Retowsky, 1885 (in particular, the type specimens of *C. (Archiplectes) reitteri pshuensis* Gottwald, 1985, and *C. (Archiplectes) juenthneri acheicus* Zamotajlov, 1991) are not considered in the present publication. According to I. Retezár's personal communication as well as personal data of the authors, similar specimens are extremely rare in some local populations of both *C. (Archiplectes) juenthneri* Reitter, 1899, and *C. (Archiplectes) pseudopshuensis* Zamotajlov, 1991. Apparently, they should be interpreted as aberrations of the above-mentioned species or of their forms. Unquestionable identification of the taxa described as *C. (Archiplectes) reitteri pshuensis* and *C. (Archiplectes) juenthneri acheicus* seems to be impossible at present, since *C. (Archiplectes) reitteri pshuensis* Gottwald, 1985, has been described from the junction zone of geographic ranges (or hybridization zone) of *C. (Archiplectes) juenthneri* and *C. (Archiplectes) pseudopshuensis*, while the type locality of *C. (Archiplectes) juenthneri acheicus* is simply unknown, despite I. Retezár's conclusion (2013).

Material and methods

The following abbreviations are used for the depositories of the specimens examined:

cBAS	Coll. A.S. Bondarenko (Krasnodar, Russia)
cFDD	Coll. D.D. Fominykh (Krasnodar, Russia)
cKVM	Coll. V.M. Kotsur (Vitebsk, Belarus)
cPIG	Coll. I.G. Pljushch (Kiev, Ukraine)
cPNYu	Coll. N.Yu. Pichugin (Vladimir, Russia)
cPRYu	Coll. R.Yu. Panin (Lviv, Ukraine)
cPSM	Coll. S.M. Pavlyuchuk (Stavropol, Russia)
cSAA	Coll. A.A. Safronov (Tula, Russia)
cSIA	Coll. I.A. Solodovnikov (Vitebsk, Belarus)
cTAYu	Coll. A.Yu. Titarenko (Moscow, Russia)
cZAM	Coll. A.S. Zamotajlov (Krasnodar, Russia)
ZISP	Zoological Institute of the Russian Academy of Sciences (St. Petersburg, Russia)

Measurements were taken as follows, with abbreviations: GBL – general body length, measured from the tips of mandibles to the elytral apex; SBL – standard body length, measured from the anterior margin of the clypeus to the elytral apex; HW – width of head, measured as the maximum linear distance across the head, including the compound eyes; PW – maximum width of pronotum measured at its broadest point; PB – minimum width of pronotum, measured at its narrowest point near the hind angles; PL – length of pronotum, measured along its median line; EL – length of elytra, measured from the basal border in the scutellar region to the apex of the sutural angle; EW – maximum width of elytra measured at their broadest point; PW/HW ratio; PW/PL ratio; PW/PB ratio; EW/PW ratio; EL/EW ratio. All these features and distribution of their values were analyzed in course of the discriminant analysis.

Both digital photographs of imago and drawings of the genitalia were prepared by the first author, general view photographs of the holotype of *Carabus (Archiplectes) besleticus resheviensis* by the third author, and three photographs (Figs 60, 61, 65) were copied from I. Retezár (2008). For the present study, we measured 391 specimens of *Carabus*. Graphic building was executed with the help of computer program STATISTICA (data analysis software system), StatSoft Inc., 2001 (version 6).

Taxonomy

Carabus (Archiplectes) satyrus Kurnakov, 1962

Figs 1, 2, 7, 8–11, 34–41

Carabus (Neoplectes) satyrus Kurnakov, 1962: 33 (“Goulripch”).

Carabus (Archiplectes) satyrus satyrus: Gottwald 1985: 310.

Carabus (Archiplectes) satyrus satyrus: Bousquet et al. 2003: 132; Retezár 2008: 40.

Carabus (Tribax) satyrus satyrus Kurnakov: Deuve 2004: 274.

Comparative material examined. 86 specimens were examined (47 specimens measured, 15 male genitalia preparations studied): 1 male, Abkhazia, Gulripsh Distr., “Shervadshidzevskiy les” near Merkheul Village, 200 m, 17–20.V.2012, leg. D. Fominykh, A. Bondarenko (cFDD); 4 males, 4 females, Abkhazia, Gulripsh Distr., “Shervadshidzevskiy les” near Bagmarani Village, 200 m, 27.IV–25.VI.2013, leg. D. Fominykh, A. Bondarenko (cFDD); 3 males, 4 females, Abkhazia, Gulripsh Distr., NW slopes of Gurzul Mt. Range near Merkheul Village, 200 m, 27.IV–25.VI.2013, leg. D. Fominykh, A. Bondarenko (cFDD); 16 males, 31 females, Abkhazia, Gulripsh Distr., NW slopes of Gurzul Mt. Range near Merkheul Village, 170–230 m, left tributary of Machara River, hornbeam, alder, rhododendron (*Rhododendron ponticum*) forest site, 05.V–04.VII.2013, leg. I. Solodovnikov, S. Solodovnikova, V. Kotsur, S. Pavlyuchuk, N. Pichugin (cSIA, cFDD, cKVM, cPSM, cPNYu); 4 males, 5 females, Abkhazia, Gulripsh Distr., Gurzul Mt. Range near Merkheul Village, rivulet 1, left tributary of

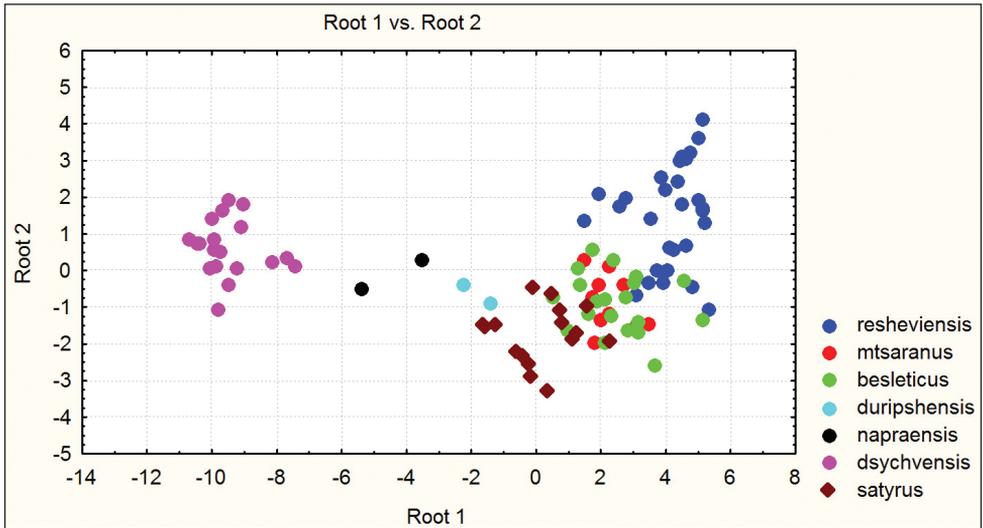


Figure 1. Distribution of morphometric characters in males of *Carabus (Archiplectes) besleticus* and *Carabus (Archiplectes) satyrus* subspecies constructed using discriminant analysis based on 8 parameters.

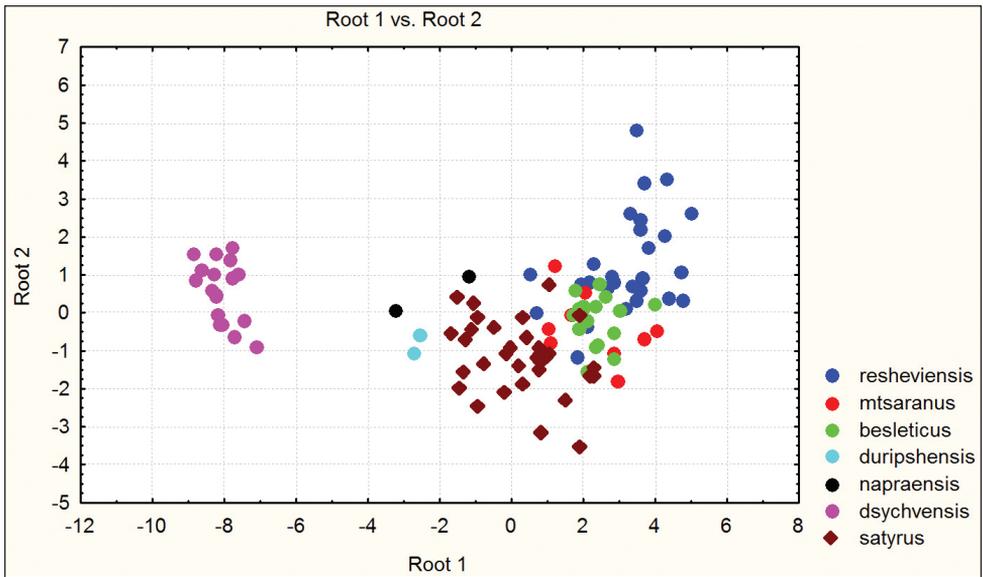


Figure 2. Distribution of morphometric characters in females of *Carabus (Archiplectes) besleticus* and *Carabus (Archiplectes) satyrus* subspecies constructed using discriminant analysis based on 8 parameters.

Machara River, hornbeam, alder, rhododendron (*Rhododendron ponticum*) forest site, 170 m, 43°59'17.91"N / 041°11'10.24"E , 11.V–08.VII.2014, leg. I. Solodovnikov, S. Solodovnikova, S. Pavlyuchuk (cSIA, cPSM); 6 males, 8 females, Abkhazia, Gulripsh Distr., left bank of River Kelasur, “Shervadshidzevskiy les”, gorge, hornbeam,

alder, rhododendron (*Rhododendron ponticum*) forest site, 123–130 m, 42°58'54.43"N / 041°06'15.63"E, 11.V–08.VII.2014, leg. I. Solodovnikov, S. Solodovnikova, S. Pavlyuchuk (cSIA, cPSM).

Description. Large form, males 31.1–35.7 (33.8) mm, females 32.2–39.8 (36.1) mm long, slender. Underside black, dorsum normally with bright metallic lustre, green, dark blue, bronze, crimson, violet, seldom black, with transitional color forms in males, females less nitidous, sometimes matte. Body shape is the narrowest within the studied species complex.

Head not inflated. Pronotum extremely variable in shape, from subquadrate to transverse, more often cordate, lateral sides with deep hollow before hind angles. PW/PL = 1.13–1.43 (1.32) in males and 1.03–1.57 (1.37) in females, hind angles strongly protruding backwards and sideways, pointed apically. Median groove smooth to completely obliterated in some female specimens. Disk transversally rugose, with rugosity gradually strengthening towards median groove. Elytra strongly elongate to ovate (generally the most slender within studied species complex), more elongate in males, with inconspicuous depression in the middle in some female specimens. EL/EW = 1.64–2.02 (1.84) in males and 1.60–1.97 (1.80) in females. Elytral sculpture nearly identical in males and females, forming precise series of elongate links. The main morphometric measurements of the studied populations are presented in Table 2.

Lamella of aedeagus short, of triangular form. Structure of endophallus testifies to the assignment of this form to the *reitteri*-group (since the previous authors did not properly analyze this morphological structure, it lead them to an erroneous interpretation of the subspecific structure of this species). Saccellus short, of rectangular shape, resembling saccellus of *C. (A.) juenthneri*, with S-shaped fold on the right, paracellular lobe rounded, protruding laterally, endophallus with asymmetric position of inner structures (when viewed frontally). Ostium lobe small, sometimes faintly developed. Aggonoporus small.

Differential diagnosis. Strongly resembles *C. (A.) besleticus besleticus* from which it differs in a more elongate and less ovate body shape, the more precise elytral sculpture, a more convex pronotum with sharper hind angles, a very narrow base of the pronotum (PW/PB being the highest in the species complex in question), and also by the structure of the male genitalia. For the illustration of morphometric characters of this species, see Figures 1 and 2.

Distribution. Populates low mountain forest belts in an interfluvium of the r. Kodor and Kelasur, from altitude of 50 m up to 500 m.

Habitat. Prefers forests of the Colchic (= Colchian) type admixed with beech, chestnut, and rhododendron (*Rhododendron ponticum*). Activity of imago proceeds from April until July. *Carabus (Archiplectes) koltzei koltzei* Rost, 1889, *C. (Megodontus) septemcarinatus* Motschulsky, 1840, and *C. (Sphodristocarabus) armeniacus laevilineatus* Ganglbauer, 1887, also occur together with this species (being much more abundant).

***Carabus* (*Archiplectes*) *besleticus* Kurnakov, 1972, stat. n.**

Figs 1–7, 16–77

Remarks. The structure of the endophallus testifies to the attribution of this form to the *reitteri* group. Saccellus large, conical, smoothly rounded apically, with faintly developed or missing S-shaped fold on the right, paracellar lobe very faintly developed, endophallus with rather symmetric position of inner structures (when viewed frontally). Ostium lobe large, of dulled conical shape. Lamella of aedeagus elongated, with prominent hollow on the right before apex. Aggonoporus large, strongly sclerotized. This type of endophallus is characteristic for all subspecies described subsequently, earlier attributed to *C. (Archiplectes) satyrus*. Based on such pronounced differences in the structure of the endophallus from that of *C. (Archiplectes) satyrus*, it is proposed to raise the status of *C. (Archiplectes) besleticus* from subspecies to species.

***Carabus* (*Archiplectes*) *besleticus besleticus* Kurnakov, 1972**

Figs 1–4, 7, 16–18, 42–49

Carabus (Neoplectes) satyrus besleticus Kurnakov, 1972: 112 (“Vallée de la Besléta”).

Neoplectes reitteri gaskoi Kenyeri, 1975: 113.

Carabus (Archiplectes) satyrus besleticus: Gottwald 1985: 310; Bousquet et al. 2003: 132; Retezár 2008: 40.

Carabus (Tribax) satyrus besleticus: Deuve 2004: 274.

Comparative material examined. 176 specimens were examined (41 specimens measured, 11 male genitalia preparations studied): 59 males, 73 females, Abkhazia, Sukhum Distr. near Sukhum city, N slope of Mt. Birtzkha, 200 m, 26.IV–25.VI.2013, leg. D. Fominykh, A. Bondarenko (cFDD, cBAS, cSIA, cKVM); 1 female, Abkhazia, Sukhum Distr., vicinities of Village Abzhakva, left bank of River Basla, 80–90 m, box and beech forest site, 05–16.V.2013, leg. I. Solodovnikov, S. Solodovnikova, V. Kotsur, N. Pichugin (cSIA); 1 male, Abkhazia, Sukhum Distr., vicinities of Village Kvenolinda, N slope of Mt. Birtskha, 120–140 m, box and beech forest site, N43°02'49.81", E041°04'01.23", 05–13.05.2012, leg. I. Solodovnikov (cSIA); 11 males, 10 females, Abkhazia, Sukhum Distr., vicinities of Village Kaman, N slope of Mt. Birtskha, 160 m, beech, linden, box, elder forest site, 05.V–04.VII.2013, leg. I. Solodovnikov, S. Solodovnikova, V. Kotsur, S. Pavlyuchuk, N. Pichugin (cSIA, cKVM, cPSM, cP-NYu); 4 males, 12 females, Abkhazia, Sukhum Distr., right bank of River Kelasur, E slope of Mt. Anykhapaara, beech, alder, chestnut forest site, 135 m, 42°59'30.67"N / 041°05'59.66"E, 11.V–08.VII.2014, leg. I. Solodovnikov, S. Solodovnikova, S. Pavlyuchuk (cSIA, cPSM); 2 males, 3 females, Abkhazia, Sukhum Distr., vicinities of Village Kaman, N slope of Mt. Birtskha, right bank of River Basla, beech, linden, box,

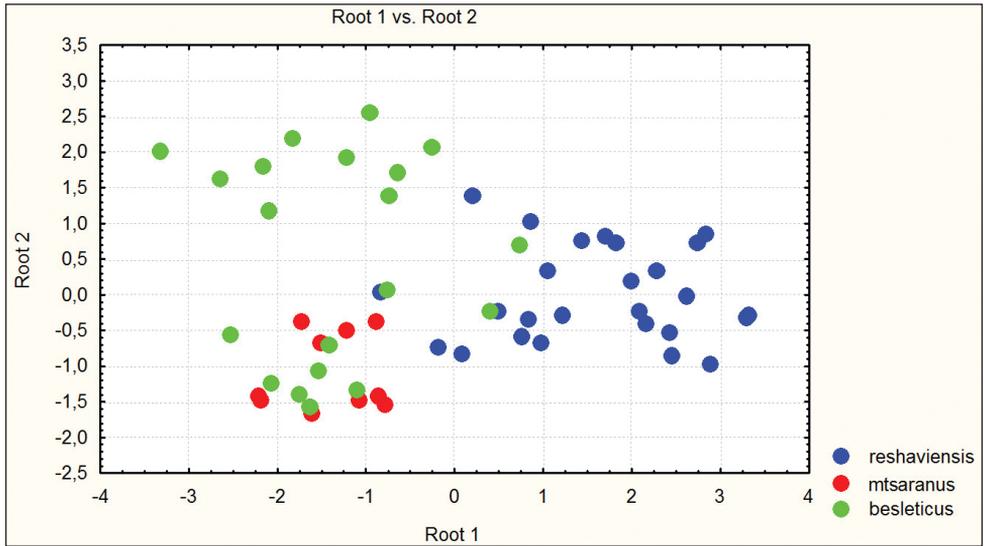


Figure 3. Distribution of morphometric characters in males of *Carabus (Archiplectes) besleticus* subspecies constructed using discriminant analysis based on 8 parameters.

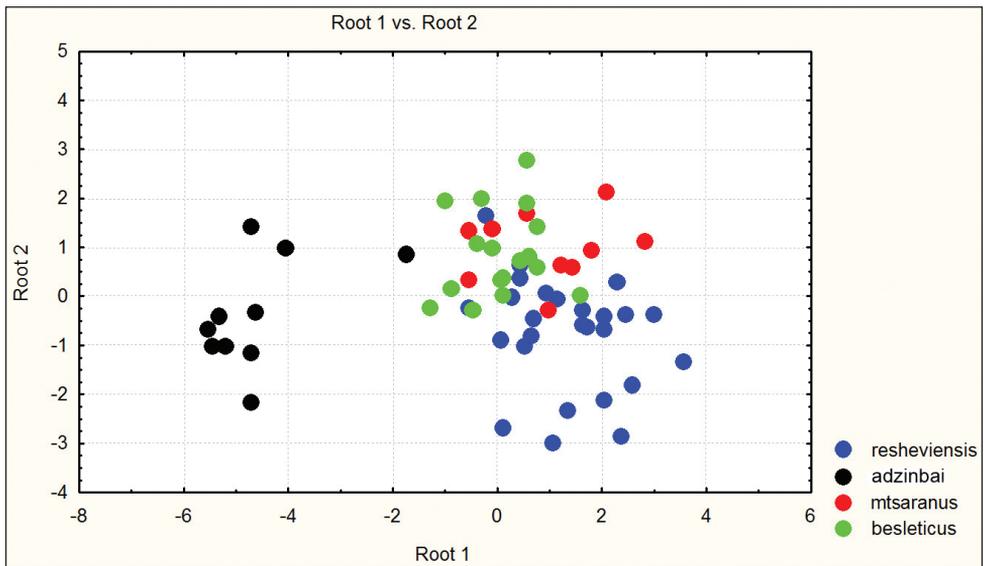


Figure 4. Distribution of morphometric characters in females of *Carabus (Archiplectes) besleticus* subspecies constructed using discriminant analysis based on 8 parameters.

elder forest site, 160 m, 43°02'57.59"N / 041°03'48.67"E, 11.V–08.VII.2014, leg. I. Solodovnikov, S. Solodovnikova, S. Pavlyuchuk (cSIA, cPSM).

Description. Large form, males 32.0–38.0 (34.7) mm, females 38.0–40.75 (39.0) mm long, robust. Underside black, dorsum normally with bright metallic luster, various

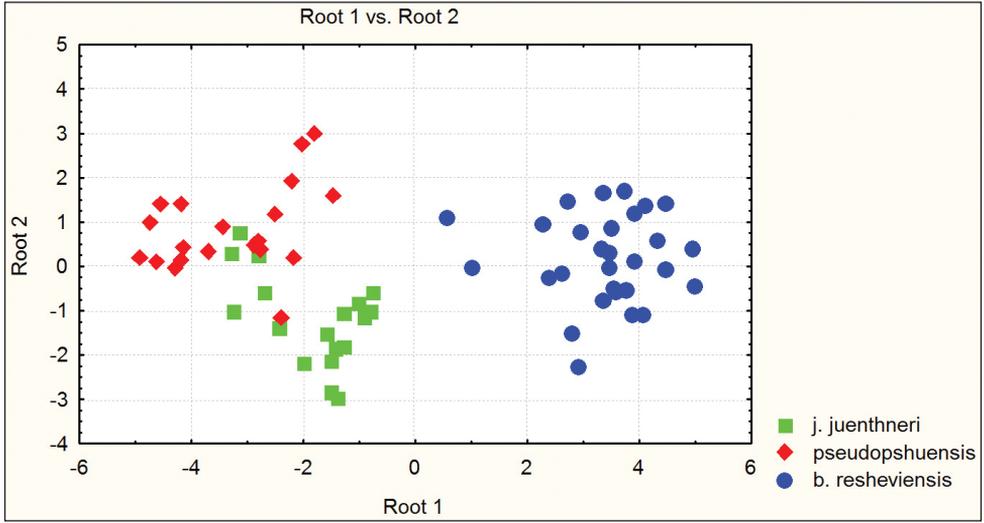


Figure 5. Distribution of morphometric characters in males of *Carabus (Archiplectes) besleticus resheviensis* (River Reshevie), *C. (Archiplectes) pseudopshuensis* (River Reshevie), and *C. (Archiplectes) juentneri juentneri* (Village Pskhu env.) constructed using discriminant analysis based on 8 parameters.

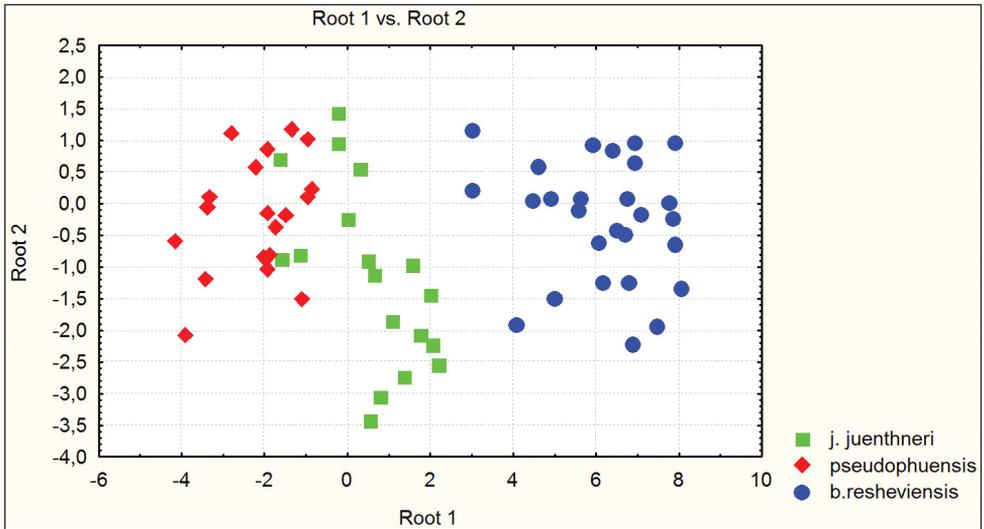


Figure 6. Distribution of morphometric characters in females of *Carabus (Archiplectes) besleticus resheviensis* (River Reshevie), *C. (Archiplectes) pseudopshuensis* (River Reshevie), and *C. (Archiplectes) juentneri juentneri* (Village Pskhu env.) constructed using discriminant analysis based on 8 parameters.

colours of green, dark blue, bronze, crimson, violet, seldom black, with transitional color forms in males, females matte. Body massive, less slender than in *C. (Archiplectes) satyrus*.

Head not inflated. Pronotum of variable shape, from subcordate to transverse, lateral sides not to faintly sinuated. PW/PL = 1.26–1.53 (1.37) in males and 1.25–1.62 (1.46)

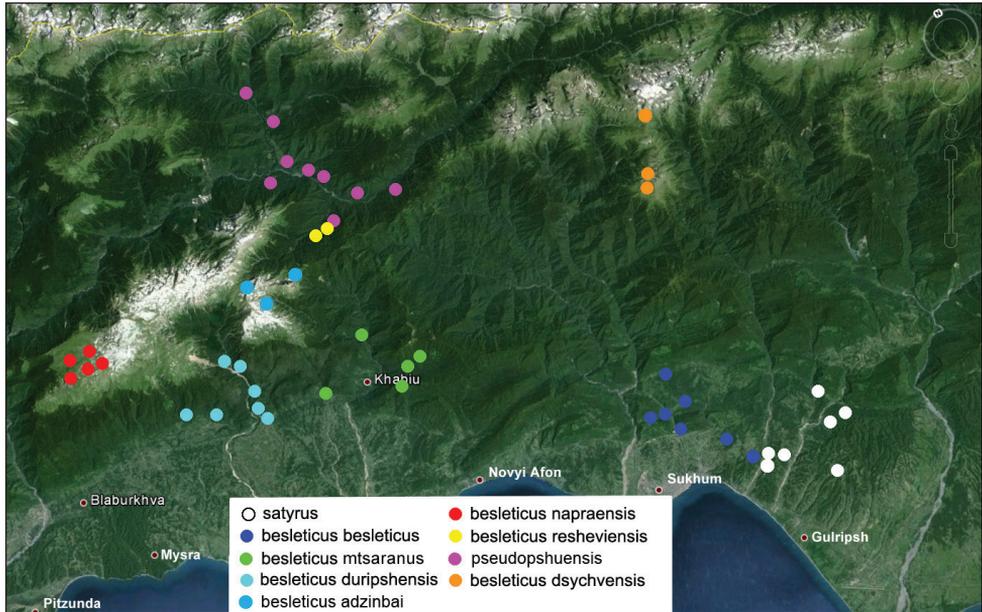


Figure 7. Distribution map of *C. (Archiplectes) satyrus*, *C. (Archiplectes) besleticus*, and *C. (Archiplectes) pseudopsuensis* in Abkhazia.

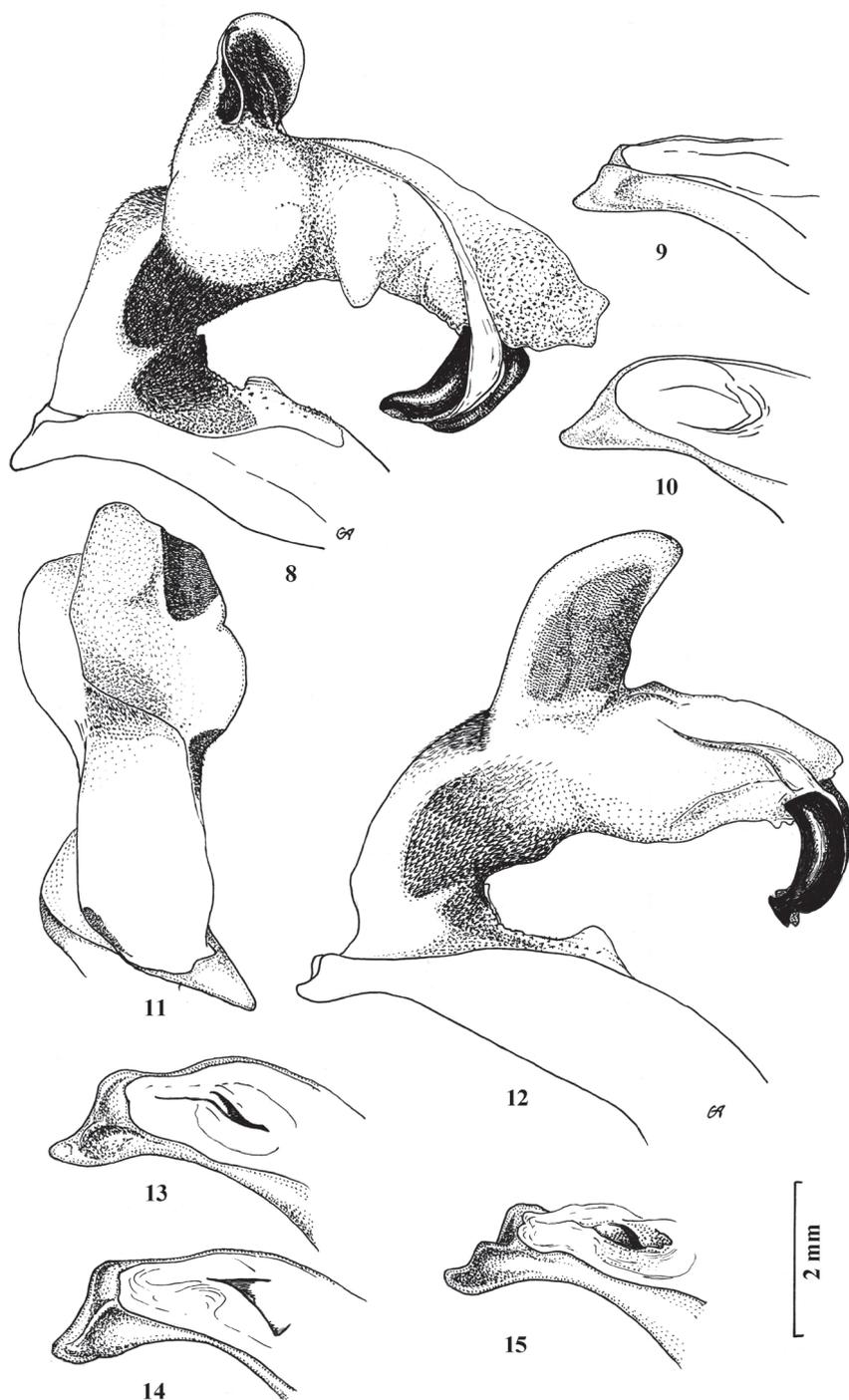
in females, base rather broad, $PW/PB = 1.03–1.33$ (1.17) in males and $1.11–1.31$ (1.19) in females, hind angles distinctly protruding backwards and faintly sideways, rounded apically. Median groove distinct, microsculpture forming transversal rugosity, gradually strengthening towards median groove. Elytra strongly elongate to ovate, more elongate in males, with inconspicuous depression in the middle in both males and females. $EL/EW = 1.62–1.86$ (1.75) in males and $1.64–1.86$ (1.78) in females. Elytral sculpture nearly identical in males and females, forming faint and smoothed series of elongated links. The main morphometric measurements of the studied populations are given in Table 2.

Lamella of aedeagus elongate, with a prominent hollow on the right side before the apex. Saccellus large, conical, smoothly rounded apically, paracellar lobe hardly developed, endophallus with symmetrical position of inner structures (when viewed frontally). Ostium lobe large, of blunted conical shape.

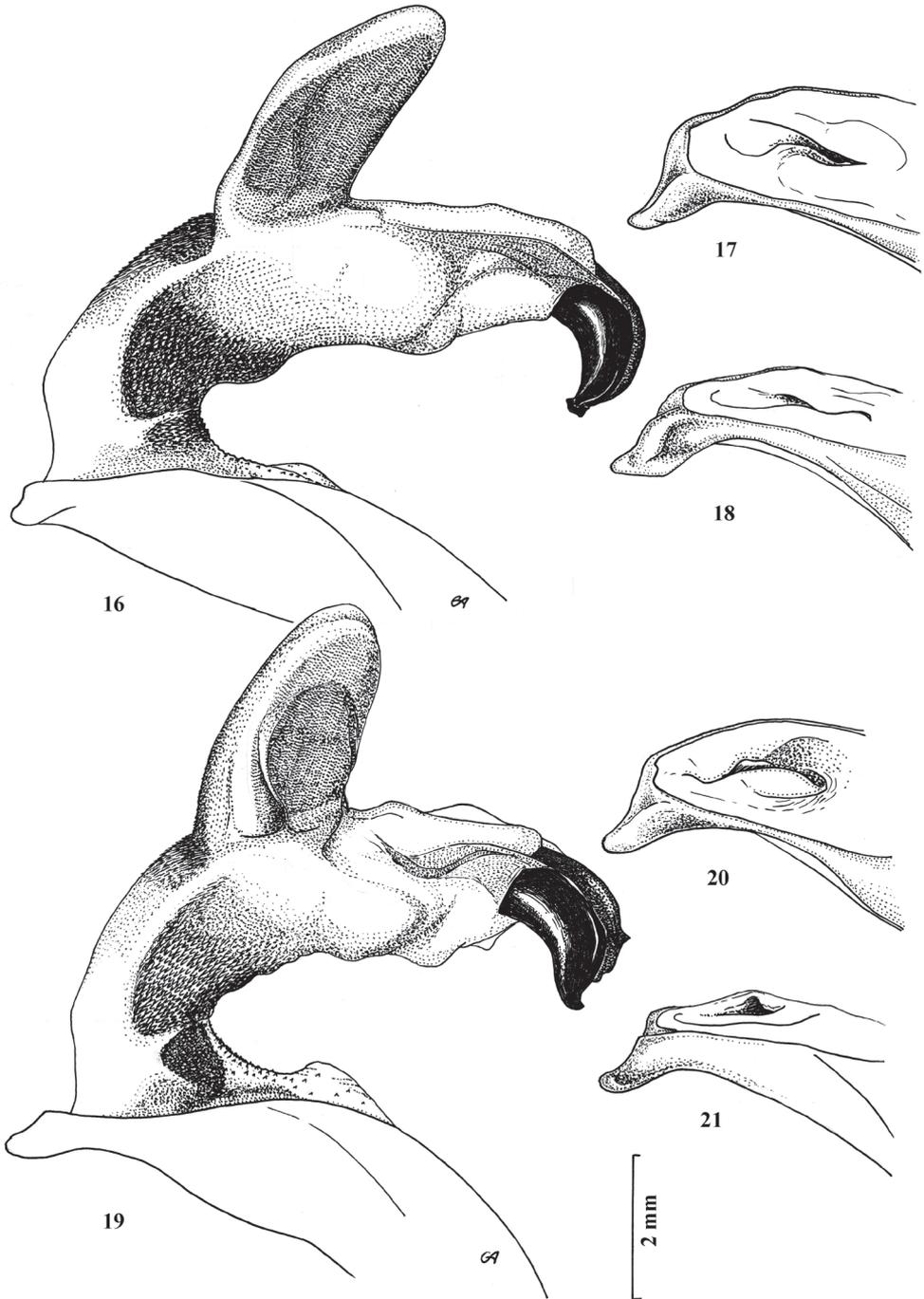
Differential diagnosis. Habitually strongly resembles *C. (A.) satyrus* from which it differs in the less elongate and more rounded body shape, the different shape of pronotum, smoothed elytral sculpture with longer links, the different shapes of pronotum and male genitalia. The morphometric characters of this subspecies are illustrated in Figures 1–4.

Distribution. Populates a low mountain forest belt in an interfluvium of the River Gumista – East Gumista and Kelasur.

Habitat. Prefers beech and beech-chestnut forest sites admixed with box, rich in ground litter on karstic landforms at altitudes from 50 to 500 m. Activity of imago proceeds from April until July. *Carabus (Archiplectes) apollo phoebus* Kurnakov, 1962,



Figures 8–15. Fully inflated endophallus preparation and apical lamella of aedeagus of *Carabus (Archiplectes) satyrus* and *C. (Archiplectes) pseudopsuensis*. **8–11** *C. (Archiplectes) satyrus* **12–15** *C. (Archiplectes) pseudopsuensis*.



Figures 16–21. Fully inflated endophallus preparation and apical lamella of aedeagus of *Carabus (Archiplectes) besleticus besleticus* and *C. (Archiplectes) besleticus mtsaranus*. **16–18** *C. (Archiplectes) besleticus besleticus* **19–21** *C. (Archiplectes) besleticus mtsaranus*.

C. (Megodontus) septemcarinatus, *C. (Sphodristocarabus) armeniacus rugatus* Breuning, 1934 (natio *novotnyorum* Mandl, 1975), and *C. (Procerus) caucasicus colchicus* Motschulsky, 1844, occur together with this subspecies.

***Carabus (Archiplectes) besleticus mtsaranus* Kurnakov, 1972**

Figs 1–4, 7, 19–21, 50–57

Carabus (Neoplectes) satyrus mtsaranus Kurnakov, 1972: 114 (“Chaîne Bzybienne près du village de Mtsara”).

Carabus (Archiplectes) satyrus mtsaranus: Gottwald 1985: 310; Bousquet et al. 2003: 132; Retezár 2008: 41.

Carabus (Tribax) satyrus mtsaranus: Deuve 2004: 274.

Comparative material examined. 134 specimens were examined (31 specimens measured, 18 male genitalia preparations studied): 12 males, 17 females Abkhazia, Gudauta Distr., valley of River Aapsta, 700 m, V–VII.1993, leg. A. Zamotajlov, F. Miroshnikov (cZAM, cFDD); 49 males, 56 females, Abkhazia, Gudauta Distr, vicinities of Mtsara (Chiryuta), Zashirbara Mt. Range, source of River Mtsara, beech, blackberry, fern site, 575–690 m, 11.V-05.VII.2013, leg. I. Solodovnikov, S. Solodovnikova, V. Kotsur, N. Pichugin (cSIA, cKVM, cPSM, cPNYu, cFDD).

Description. Large form, males 35.3–37.1 (35.8) mm, females 37.5–41.3 (39.3) mm long, robust. Underside black, dorsum normally with bright metallic lustre, dark blue, violet, black-violet, black, rather seldom green, bronze, crimson, females matte. Body massive.

Head not inflated. Pronotum of variable shape, from subcordate to cordate, transverse. PW/PL = 1.14–1.48 (1.35) in males and 1.26–1.56 (1.41) in females, with base narrower than in the nominotypical subspecies, PW/PB = 1.15–1.26 (1.20) in males and 1.13–1.32 (1.23) in females, hind angles strongly protruding backwards and sideways, seldom only backwards, pointed apically. Median groove distinct, disk transversally or irregularly rugose, with rugosity gradually strengthening towards median groove. Elytra strongly elongate to ovate, more elongate in males, with quite inconspicuous depression in the middle in females and seldom in males. EL/EW = 1.65–1.85 (1.75) in males and 1.73–1.98 (1.80) in females. Elytral sculpture identical in males and females, forming coarse and precise series of short links. Table 2 lists the main morphometric measurements of the studied populations.

The shape of the male genitalia is practically identical to that of the other *C. (A.) besleticus* taxa. The endophallus differs from the one in *C. (A.) satyrus*, mainly in the shape of the dorsal appendix, which is more elongate and possesses a more extended form, characteristic for populations dwelling in an interfluvium of r. Kealasar and Bzyb.

Differential diagnosis. Resembles *C. (A.) besleticus besleticus* from which it differs in a more elongate and less ovate body shape, the different form of the hind angles of the pronotum, and in having a more coarse elytral sculpture with precise series of rather short

links. The color of dorsum is usually more dull and darker than in the nominotypical and other subspecies. For the morphometric characters of this subspecies see Figures 1–4.

Distribution. Populates southern slopes of Bzybian Mt. Range at an altitude of 400–1500 m in an interfluvium of r. Gumista – Western Gumista and Khipsta.

Habitat. Prefers beech and beech–chestnut forest sites, sometimes admixed with box, rich in ground litter at karstic landforms (sometimes even populating also quite sharp and steep ones). This subspecies also occurs at alpestrine and alpine meadows. Activity of imago, depending upon the altitude of the habitation, proceeds from April to August. *Carabus (Archiplectes) apollo tenebricosus* Kurnakov, 1962, *C. (Microplectes) argonautarum reischitzi* Mandl, 1955, *C. (Tribax) apschuanus apschuanus* Rost, 1893, *C. (Tribax) constantinovi otcharensis* Kurnakov, 1970. *C. (Megodontus) septemcarinatus*, *C. (Sphodristocarabus) armeniacus dvorschaki* Mandl, 1975, and *C. (Procerus) caucasicus colchicus* occur together with this subspecies.

***Carabus (Archiplectes) besleticus duripshensis* Kurnakov, 1972**

Figs 1–2, 7, 22–24, 58–61

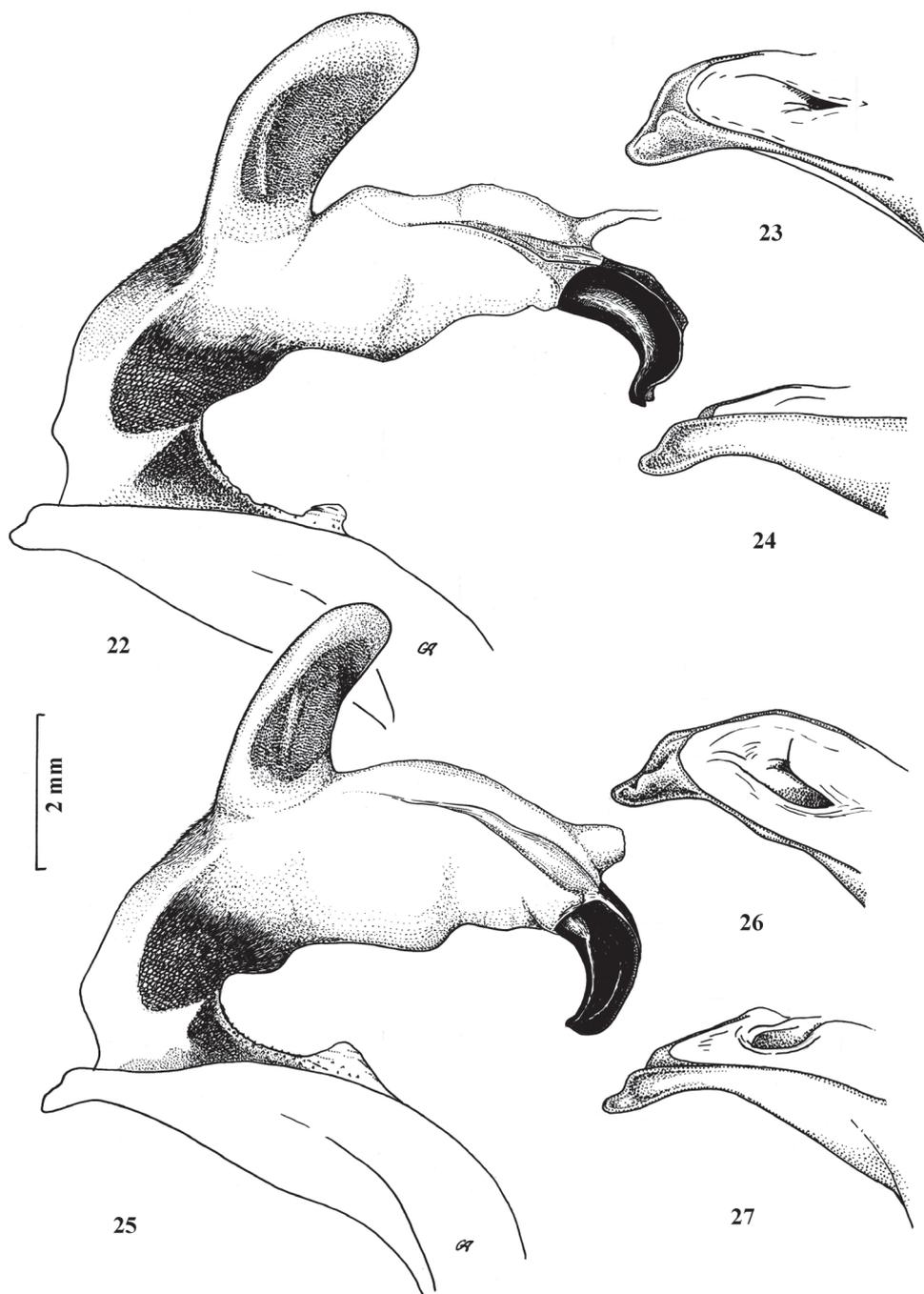
Carabus (Neoplectes) satyrus duripshensis Kurnakov, 1972: 114 (“Chaîne Bzybienne près du village de Douripch”)

Carabus (Archiplectes) satyrus duripshensis: Gottwald 1985: 310; Bousquet et al. 2003: 132; Retezár 2008: 40.

Carabus (Tribax) satyrus duripshensis: Deuve 2004: 275.

Comparative material examined. 69 specimens were examined (4 specimens measured, 2 male genitalia preparations studied): 15 male, 18 female, Abkhazia, Gudauta Distr. near Village Khuap, V–VII.1993, leg. A. Zamotajlov, A. Miroshnikov (cZAM, cFDD); 1 female, Abkhazia, Bzybian Mt. Range, vicinities of Village Duripsh, 04.VI.1988, leg. V. Karmanian (cSIA); 1 male, Abkhazia, Gudauta Distr. near Village Khuap, 25.V–05.VIII.1986 (cSIA); 1 male, Abkhazia, Gudauta Distr., Khipsta Gorge, 580 m (cP-NYu); 1 male, Abkhazia, Gudauta Distr., valley of River Khipsta, vicinities of Village Tvanaarkhu, karst crater with cave, beech, blackberry site, 425 m, N43°14', E040°39'9", 08.V–05.VII.2013, leg. I. Solodovnikov, S. Solodovnikova, S. Pavlyuchuk (cSIA); 1 male, 1 female, Abkhazia, Gudauta Distr., valley of River Khipsta, vicinities of Village Tvanaarkhu, valley of small brook, 380–425 m, hornbeam, beech, box forest site, N43°13', E040°39', 08.V–05.VII.2013, leg. I. Solodovnikov, S. Solodovnikova, S. Pavlyuchuk (cSIA, cPSM); 13 males, 17 females, Abkhazia, Gudauta Distr. near Village Khuap, 700 m, 11.IV–6.VI.2014, leg. D. Fominykh and A. Bondarenko (cFDD, cBAS).

Description. The medium-sized form, males 32.5–32.5 (32.5) mm, females 32.5–32.6 (32.6) mm long (according to Kurnakov 1972 – 28–33 mm long). Underside black, dorsum normally with bright metallic lustre, violet, black-violet, black, rather seldom green, bronze, crimson, females matte. Body slender.



Figures 22–27. Fully inflated endophallus preparation and apical lamella of aedeagus of *Carabus* (*Archiplectes*) *besleticus duripshensis* and *C. (Archiplectes) besleticus napraensis*. **22–24** *C. (Archiplectes) besleticus duripshensis* **25–27** *C. (Archiplectes) besleticus napraensis*.

Head not inflated. Pronotum variable in shape, mainly transverse. PW/PL = 1.30–1.40 (1.35) in males and 1.27–1.28 (1.28) in females, with approximately same PW/PB as in the nominotypical subspecies: 1.27–1.32 (1.30) in males and 1.16–1.26 (1.21) in females, hind angles strongly protruding backwards and somewhat side-wards, pointed apically. Median groove distinct. Disk transversally rugose, rugosity gradually strengthening towards median groove. Elytra oblong-ovate, more elongate and somewhat convex in males, with quite inconspicuous depression in the middle in females. EL/EW = 1.77–1.80 (1.79) in males and 1.81–1.86 (1.83) in females. Elytral sculpture nearly identical in males and females, forming precise series of short links. The main morphometric measurements are presented in Table 2.

The endophallus differs from that of *C. (A.) satyrus* in the shape of its dorsal appendix, which is more elongate and possesses a more extended form, characteristic for populations dwelling in an interfluvium of r. Kealasur and Bzyb.

Differential diagnosis. Habitually resembles *C. (A.) besleticus napraensis* from which it differs in the more elongate and less ovate elytra, cordate pronotum with more elevated and sharper lateral borders, and stronger protruding hind angles. Elytral sculpture is more coarse, often with faintly developed tertiary interspaces, especially in females, body size on average larger. It also differs in habitat: *C. (A.) besleticus duripshensis* populates forest belts, rising up to the subalpine belt, while *C. (A.) besleticus napraensis* dwells exclusively at alpestrine and alpine zones. Morphometric characters are illustrated in Figures 1–2.

Distribution. Populates southern slopes of Bzybian karstic plateau at altitudes ranging from 380 to 1800 m, to the west from the River Khipsta.

Habitat. Prefers beech and beech-chestnut forest sites, rich in ground litter on karstic landforms. Activity of imago proceeds from April until July. *Carabus (Archiplectes) polychrous polychrous* Rost, 1892, *C. (Archiplectes) apollo tenebricosus*, *C. (Microplectes) argonautarum reischitzi*, *C. (Tribax) apschuanus apschuanus*, *C. (Tribax) constantinovi otcharensis*, *C. (Tribax) circassicus circassicus* Ganglbauer, 1886 (natio *abasinus* Rost, 1893), *C. (Megodontus) septemcarinatus*, *C. (Sphodristocarabus) armeniacus dvorschaki* Mandl, 1975, and *C. (Procerus) caucasicus colchicus* occur together with this subspecies.

***Carabus (Archiplectes) besleticus napraensis* Belousov & Zamotajlov, 1993**

Figs 1–2, 7, 25–27, 62–65

Carabus (Archiplectes) satyrus napraensis Belousov & Zamotajlov, 1993: 53 (“Bzybian Mt Range, vicinity of Mt Chibzharga”); Bousquet et al. 2003: 132; Retezár 2008: 41.

Carabus (Tribax) satyrus napraensis: Deuve 2004: 275.

Comparative material examined. 50 paratype specimens were examined (4 specimens measured, 6 male genitalia preparations studied): 21 males, 29 females, Abkhazia, Gudauta Distr., Bzybian Mt. Range, vicinities of Mt. Chibzharga, 1900–2000 m, 20.VI–26.VII.1992, leg. I. Belousov, A. Zamotajlov, A. Miroshnikov (cFDD, cSIA, cZAM).

Description. Small or medium-sized form, 22–31 mm long (see Belousov and Zamotajlov 1993). Underside black, dorsum normally with bright metallic lustre,

green, bronze, less often dark blue, violet, black-violet, black, females matte to faintly nitidous. Body slender.

Head not inflated. Pronotum variable in shape, subcordate, transverse. PW/PL = 1.27–1.31 (1.29) in males and 1.48–1.49 (1.48) in females, PW/PB = 1.18–1.27 (1.22) in males and 1.20–1.22 (1.21) in females, hind angles strongly protruding backwards, somewhat pointed apically. Median groove distinct in females, microsculpture of pronotum fine, disk transversally or irregularly rugose, rugosity gradually strengthening towards median groove. Elytra oblong-ovate, more elongate and somewhat convex in males, with inconspicuous depression in the middle in females. EL/EW = 1.67–1.74 (1.70) in males and 1.70–1.81 (1.75) in females. Elytral sculpture distinctly heterodynamous, forming distinct series of short links in females and somewhat smoothed in males. The main morphometric measurements of studied populations see Table 2.

Shape of male genitalia is practically identical to other *C. (A.) besleticus* taxa. The endophallus differs from *C. (A.) satyrus* in the shape of saccellus, which is more elongate and more redundant, characteristic for populations dwelling in an interfluvium of r. Kealasur and Bzyb. The drawing of the paratype aedeagus by Belousov and Zamotajlov (1993) shows different apical lamella with two characteristic tubercles on the sides.

Differential diagnosis. Habitually resembles *C. (A.) besleticus duripshensis* from which it differs in a less elongate and more ovate, often ovoid, elytral shape, less cordate pronotum with fainter protruding hind angles, smooth elytral sculpture, and smaller average body size. This subspecies also differs in habitat – *C. (A.) besleticus duripshensis* populates forest belt, and less often an alpestrine belt of Mt. Chipshira, while *C. besleticus napraensis* dwells in alpestrine and alpine belts. Morphometric characters of this subspecies are illustrated in Figures 1–2.

Distribution. As far as it is known, populates alpine and alpestrine belts of Bzybian karstic plateau near mountains Napra and Chibzharga at 1900–2250 m.

Habitat. *Carabus (Archiplectes) satyrus napraensis* prefers herb alpine and subalpine meadows. Activity of imago proceeds from May to August, beetles being active when snow cover starts melting. *Carabus (Megodontus) septemcarinatus*, *C. (Procechenochilus) adangensis gusevi* Zamotajlov & Koval, 1989, *C. (Procrustes) clypeatus kurnakovi* Kryzhanovskij, 1968, *C. (Tribax) certus* Reitter, 1896, and *C. (Tribax) circassicus circassicus* (natio *abasinus*) occur together with this subspecies.

***Carabus (Archiplectes) besleticus adzinbai* Retezár, 2013**

Figs 4, 7

Carabus (Archiplectes) satyrus adzinbai Retezár, 2013: 2

Comparative material examined. 15 specimens were examined (12 specimens measured, 1 male genitalia preparations studied): 1 male, 2 females, Abkhazia, Bzybian Mt. Range, N slope of Mt. Akibakhu (=Turetskaya shapka), 2000 m, alpine zone,

14.VI.-09.VIII.1986, leg. A. Koval (cZAM); 1 male, 10 females, Abkhazia, Bzybian Mt. Range, N slope of Mt. Akibakhu (=Turetskaya shapka), 2000 m, alpine zone, 7–10.VII.2010, leg. D. Fominykh, A. Bondarenko (cFDD, cSIA); 1 female, Abkhazia, Gudauta distr., S slope Bzybian Mt.R., NW Mt.Akugra, 43°18'N / 40°43'E, h = 2130–1150 m, alpine zone, 08.08.2014, leg. I. Solodovnikov, E. Tatun (cSIA).

Description. Large form, males 31.0–32.0 mm, according to Retezár (2013) 32–34 mm long, females 32.0–35.8 mm, according to Retezár (2013) 33–37 mm long. Underside black, dorsum usually with bright metallic lustre, dark bronze, greenish-bronze, dark blue, reddish-bronze or black, pronotum often greenish; mandibles, palpi, antennae, and legs black. Habitus see Retezár, 2013.

Head normal, frons coarsely, neck moderately wrinkled. Pronotum subquadrate, broadest in anterior one third, PW/PL = 1.14–1.42 (1.25), PW/PB = 1.0–1.26 (1.14), lateral sides of pronotum slightly sinuated before hind angles, the latter strongly protruding backwards and sideways, pointed apically. Median groove distinct, disk moderately, basal foveae coarsely rugose. Elytra oblong-ovate, broadest behind their middle, EL/EW = 1.61–1.77 (1.69) in males and 1.64–1.85 (1.72) 1.73–1.98 in females. Elytral sculpture somewhat identical in males and females, forming coarse and precise series of links, primary interspaces elevated stronger than secondary ones, regularly interrupted by large foveae. Table 2 lists the main morphometric measurements of one studied population.

The shape of the male genitalia is practically identical to that of the other *C. (A.) besleticus* taxa.

Differential diagnosis. This form recently described by Retezár (2013), resembles habitually some populations of *C. (A.) besleticus mtsaranus*, but unlike them represents somewhat different combination of features. However, the significant and stable difference is not still ascertained, accumulation of the further material from the upper forest belt will apparently make possible unequivocal precision of its taxonomic relationships with other neighboring populations.

Distribution. Populates the alpine belt of Mt. Khipsta, Mt. Akugra, and Mt. Akibakhu at an altitude of 2000–2300 m.

Habitat. Prefers alpine herb meadows. Activity of imago proceeds from May to August, beetles being active at melting of snow cover. *Carabus (Procechenochilus) gusevi*, *C. (Tribax) circassicus circassicus* (natio abasinus), *C. (Tribax) constantinovi otcharensis*, *C. (Tribax) agnatus*, *C. (Lipaster) stjervalli humboldti* Faldermann, 1835, and *C. (Pachycarabus) imitator katharinae* Reitter, 1896 occur together with this subspecies.

Carabus (Archiplectes) besleticus dsykhvensis Gottwald, 1985

Figs 1–2, 7, 28–30, 74–77

Carabus (Archiplectes) juentneri dsykhvensis Gottwald, 1985: 304 (“Mt. Dsykhwa-Nordhang”); Retezár 2008: 39.

Carabus (*Archiplectes*) *reitteri dsychnensis*: Bousquet et al. 2003: 132.

Carabus (*Tribax*) *juenthneri dsychnensis*: Deuve 2004: 273.

Carabus (*Archiplectes*) *satyrus dsychnensis*: Retezár 2013: 4.

Comparative material examined. 278 specimens were examined (37 specimens measured, 12 male genitalia preparations studied): 151 males, 127 females, Abkhazia, Bzybian Mt. Range, SW slopes of Mt. Dzykhva, 2000–2300 m, alpine zone, N43°13', E041°08', 29.VI–03.VII.2013, leg. D. Fominykh (cFDD, cTAYu, cSAA, cSIA, cKVM).

Description. Small form, males 23.3–26.5 (25.2) mm and females 23.3–26.5 (25.2) mm long. Underside black, dorsum normally with bright metallic lustre, green, bronze, less often dark violet or dark blue. Red femoral forms are also rather frequent. Body slender.

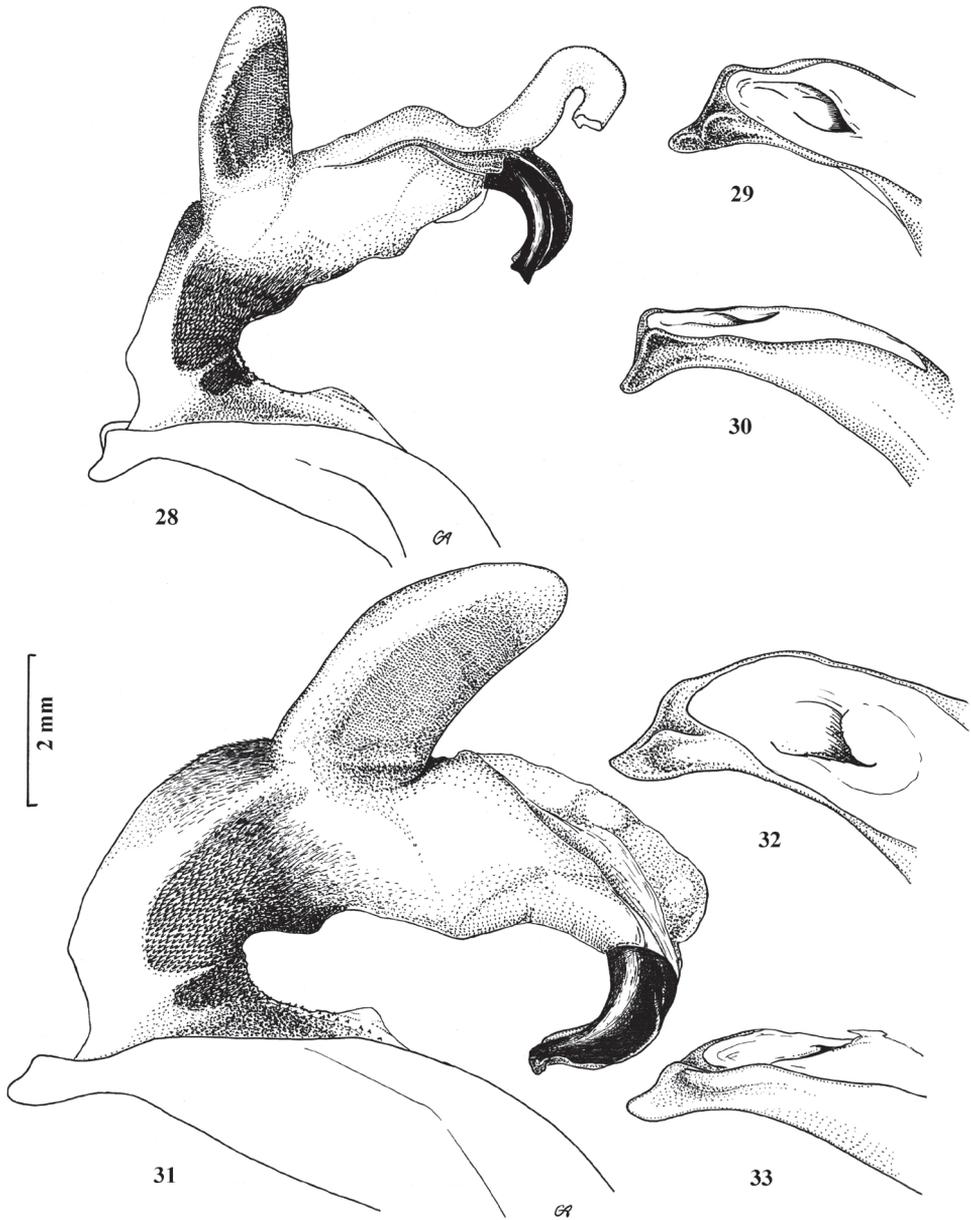
Head not inflated. Pronotum variable in shape, subcordate, transverse. PW/PL = 1.20–1.58 (1.43) in males and 1.30–1.62 (1.46) in females, PW/PB = 1.07–1.37 (1.22) in males and 1.03–1.30 (1.17) in females, hind angles protruding backwards, pointed apically. Median groove distinct in females, and inconspicuous and smoothed in males, disk with fine rugosity, gradually strengthening towards median groove. Elytra oblong-ovate, more elongate and somewhat convex in males, with inconspicuous to missing middle depression in the females. EL/EW = 1.56–1.85 (1.68) in males and 1.50–1.79 (1.66) in females. Elytral sculpture smooth in males and precise, forming distinct series of short links in females. The main morphometric measurements are presented in Table 2.

Apical lamella of aedeagus of transitional between *C. (A.) besleticus* and *C. (A.) pseudopshuensis* shape, possessing a sharp hollow on the right between apex and tubercle. Also sharply differs in this respect from *C. (A.) juenthneri* (previously considered as its subspecies). The endophallus differs from *C. (A.) satyrus* in the shape of the dorsal appendix, which is more elongate and possesses a more extended form, characteristic for populations dwelling in an interfluvium of the r. Kealatur and Bzyb.

Differential diagnosis. Habitually resembles *C. (A.) juenthneri adsypschi* Gottwald, 1985, from which differs in more elongate and more ovate elytra, hind angles of pronotum more strongly protruding, elytral sculpture more coarse, and larger average body size. Also easily distinguishable by male genitalia. The apical lamella of this form combines some features of both *C. (A.) besleticus* and *C. (A.) pseudopshuensis*. The shape of the sacculus and aggonoporus seems, however, to be closer to *C. (A.) besleticus*. The study of the further high-mountain populations of *Archiplectes* from adjacent woodless alpine massifs is required for correct interpretation of its taxonomic status within the species-complex in question. Morphometric characters are illustrated in Figures 1–2.

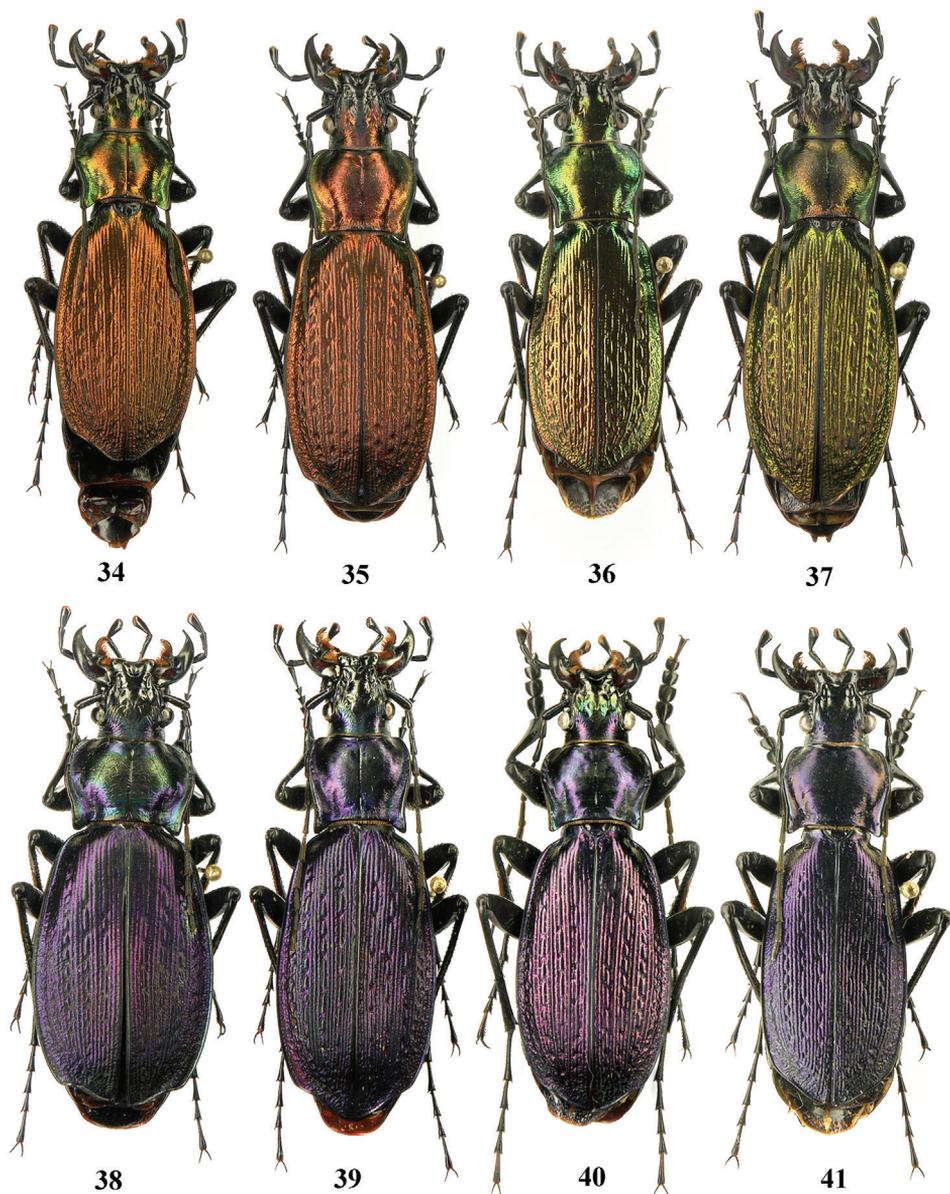
Distribution. Populates the alpine belt of Mt. Dzykhva at 2000–2300 m altitude.

Habitat. Prefers alpine herb meadows. Activity of imago proceeds from May to August, beetles being active at melting of snow cover. *Carabus* (*Procechenochilus*) *adagensis*, *C. (Tribax) circassicus circassicus* (natio *tshchaltensis* Novotný & Voříšek, 1988),



Figures 28–33. Fully inflated endophallus preparation and apical lamella of aedeagus of *Carabus (Archiplectes) besleticus dsychnvensis* and *C. (Archiplectes) besleticus resheviensis* **28–30** *C. (Archiplectes) besleticus dsychnvensis* **31–33** *C. (Archiplectes) besleticus resheviensis*.

C. (Tribax) constantinovi otcharensis, *C. (Tribax) agnatus pseudoagnatus* Novotný & Voříšek, 1988, and *C. (Pachycarabus) imitator katharinae* Reitter, 1896 occur together with this subspecies.

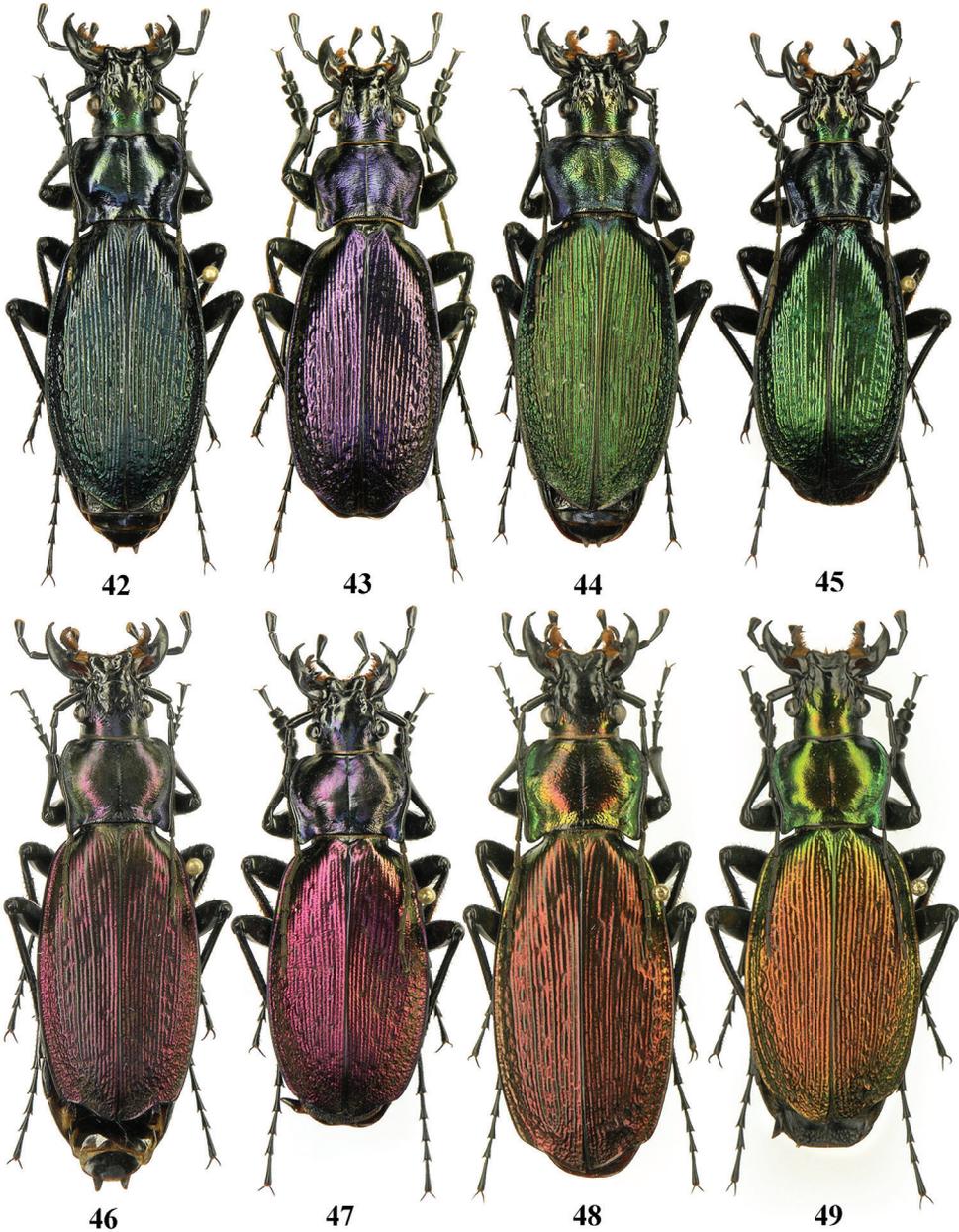


Figures 34–41. Dorsal habitus, *Carabus* (*Archiplectes*) *satyrus*, Abkhazia, Village Merkheul env.

Carabus (*Archiplectes*) *besleticus resheviensis* Solodovnikov, Zamotajlov & Fominykh, subsp. n.

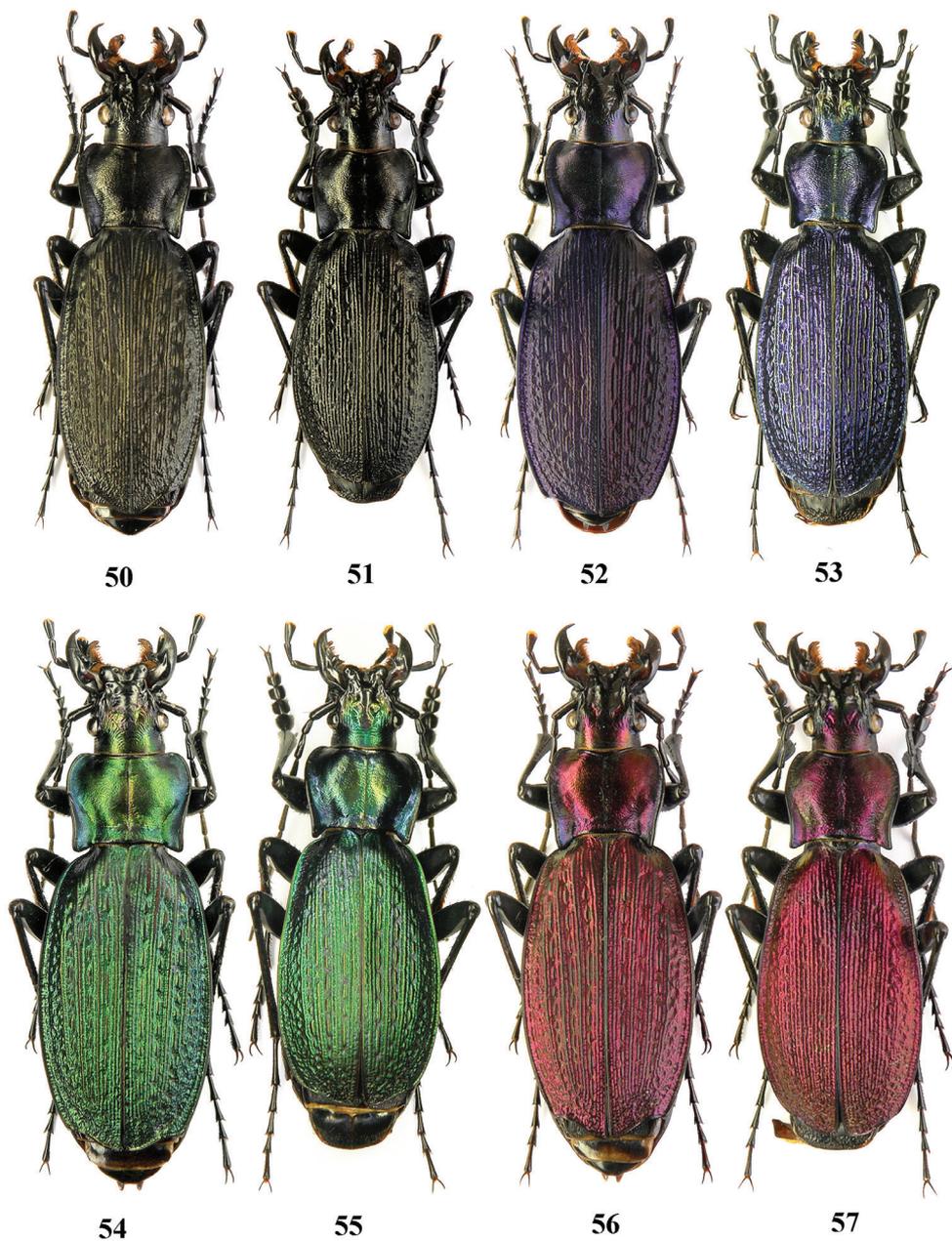
Figs 1–6, 7, 31–33, 66–73

Type material. Holotype, a male: Abkhazia, N Slopes of Bzybian Mt. Range, right bank of River Reshevie (= Reshava) (left tributary of River Bzyb), 700–1000 m, 13.V–02.



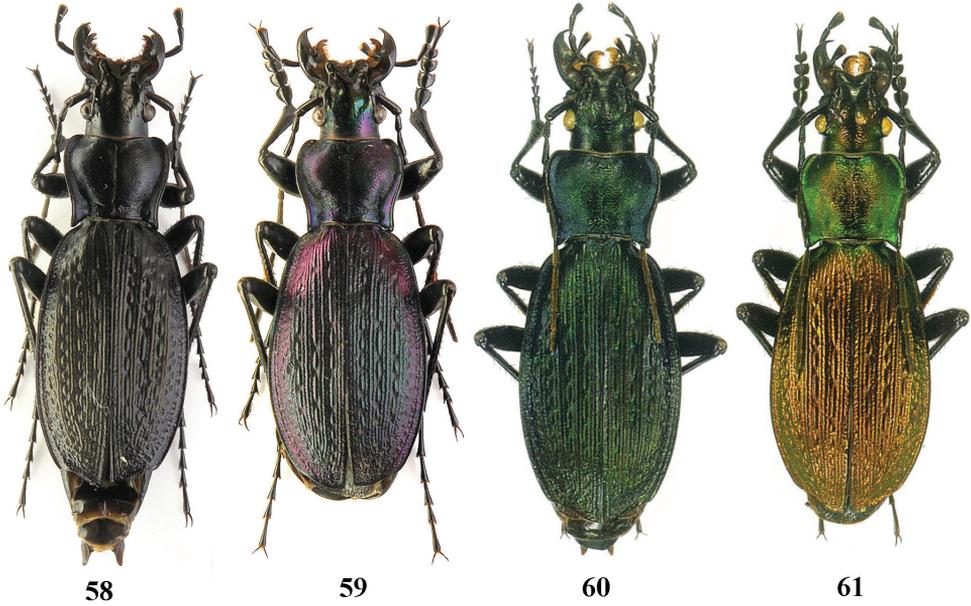
Figures 42–49. Dorsal habitus, *Carabus (Archiplectes) besleticus besleticus*, Abkhazia, Mt. Birtzkha.

VII.2010, leg. D. Fominykh, I. Solodovnikov (ZISP). 577 paratypes: 34 males, 48 females, Abkhazia, N Slopes of Bzybian Mt. Range, right bank of River Reshevie (left tributary of River Bzyb), 700–1000 m, 13.V–02.VII.2010, leg. D. Fominykh, I. Solodovnikov (cZAM, cFDD, cSIA); 234 males, 261 females, same locality, 04.V–20.VII.2012, leg D.

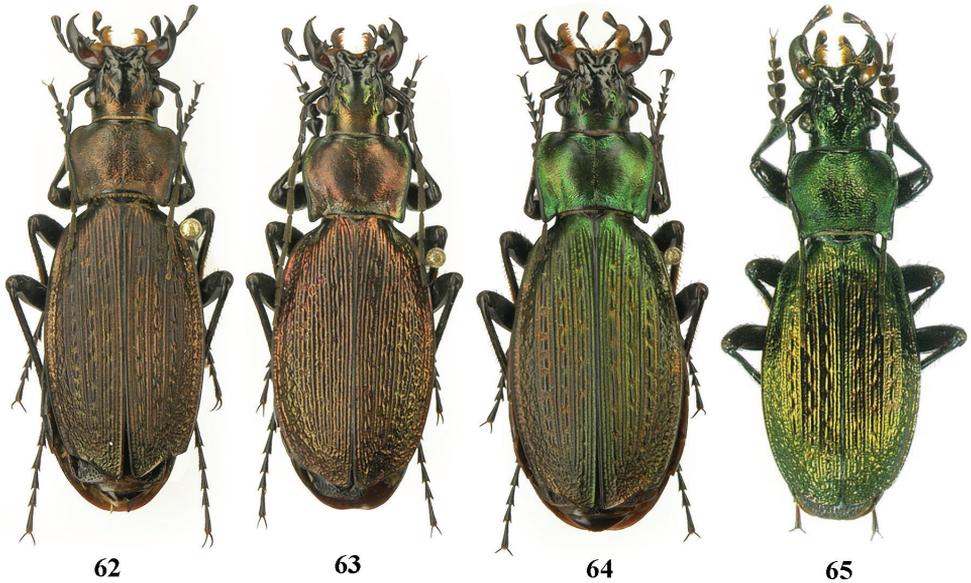


Figures 50–57. Dorsal habitus, *Carabus* (*Archiplectes*) *besleticus mtsaranus*, Abkhazia, Zashirbara Mt. Range, valley of River Mtsara.

Fominykh, A. Safronov (cZAM, cFDD, cSIA, cSAA, cBAS, cTAYu); 3 females, Abkhazia, Bzybian Mt. Range, right bank of River Reshevie (left tributary of River Bzyb), 670–720 m, 13–14.V.2010, leg. D. Fominykh, I. Solodovnikov (cPRYu); 5 males, 3 fe-



Figures 58–61. Dorsal habitus, *Carabus (Archiplectes) besleticus duripshensis*. **58–59** Abkhazia, S slope of Bsybian Mt. Range, valley of River Khipsta **60–61** Abkhazia, Bsybian Mt. Range, Duriph env. (after Retezár 2008).



Figures 62–65. Dorsal habitus, *Carabus (Archiplectes) besleticus napraensis*. **62–64** Abkhazia, Bzybian Mt. Range, Mt. Chibzharga (paratypes) **65** same locality (paratype) (after Retezár 2008).

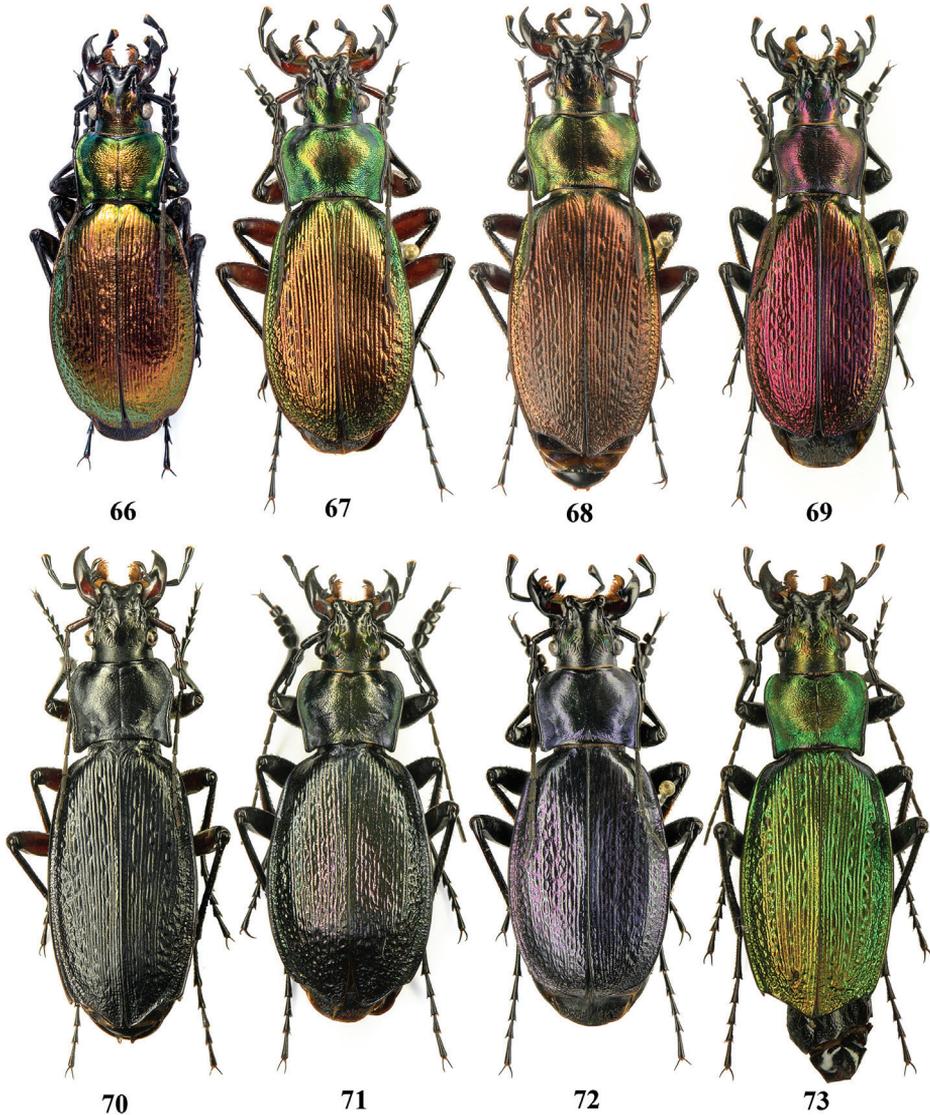
males, Abkhazia, Sukhum Distr., left bank of River Bzyb, right bank of River Reshevie, beech, maple, fern forest site, 670–720 m, 13–14.V.2010, leg. I. Solodovnikov (cSIA); 5 males, 10 females, same locality, 13.V–02.VII.2010 leg. I. Solodovnikov, D. Fominykh (cSIA, cPIG, cKVM); 1 male, labeled “Cauc. occ. Abchasia Pskhu 1910, *Plectes protensus* Schaum” (ZISP); 1 female, labeled “West Caucasus, Pskhu, VII.1913, Satunin” (ZISP). Holotype and 57 paratype specimens measured, 30 male genitalia preparations studied.

Description. Large form, body size 34.5–43.0 mm, males 34.5–39.0 (37.6) mm, females 37.2–43.0 (40.6) mm long. Underside black, dorsum bright bronze, red-gold, green, violet, dark blue, black, with metallic lustre in males and matte in females. Appendages black, rarely the femora are red and basal antennomeres reddish-brown (approx. 5 % of individuals). Body usually monochromatic dorsally, less frequently bicolored (head and pronotum being usually greenish, the elytra bronze or reddish-bronze). Body massive and rather high (Figs 66–73).

Head huge, somewhat inflated. Pronotum transverse to subquadrate, hind angles protruding backwards and in some individuals sideways. $PW/PL = 1,18–1,55$ (1,37) in males and $1,29–1,67$ (1,45) in females. Elytra faintly elongate, ovate; more elongate, sometimes with depression in the middle in females, $EL/EW = 1,52–1,92$ (1,72); generally more ovate, convex, and smoothed in males, $EL/EW = 1,42–1,78$ (1,59). Elytral sculpture precise to homodynamous and confused, with hardly any distinguishable primary interspaces in males. The main morphometric measurements are presented in Table 2. Male genitalia practically identical to other taxa of *C. (A.) besleticus*.

Differential diagnosis. *C. (A.) besleticus resheviensis* resembles habitually a population of *C. (A.) besleticus besleticus*, inhabiting valley of River Basla (city of Sukhum vicinities), but differs in the following characters. Pronotum with a rather shallow median depression, being only poorly marked in males; disk impressed; hind angles huge, appreciably larger, lateral sides of pronotum strongly sinuated before hind angles; elytra broader in males, $EL/EW = 1.59$, while 1.75 in *C. (A.) besleticus besleticus* and 1.61–1.75 in *C. (A.) besleticus mtsaranus*. The new subspecies is the closest geographically to *C. (A.) besleticus mtsaranus*, populating southern slopes of Bzybian Mt. Range, but differs in having a larger body size, more ovate elytra, smooth elytral sculpture, more transverse pronotum with weaker protruding hind angles, and general dorsal coloration ($PW/PL = 1.14–1.48$ (1.35) in males and $1.26–1.56$ (1.41) in females of *C. (A.) besleticus mtsaranus*); furthermore, the disk of the pronotum is more convex than in the new subspecies. The new subspecies differs from the recently described *C. (A.) besleticus adzinbai* first of all in having a larger body size, more transverse and faintly cordate pronotum with more narrow base; *C. (A.) besleticus adzinbai* possesses subquadrate pronotum with stronger protruding sideways hind angles, $PW/PL = 1.14–1.42$ (1.25), $PW/PB = 1.00–1.26$ (1.14); elytra of *C. (A.) besleticus resheviensis* are more ovate and shorter both in males and females.

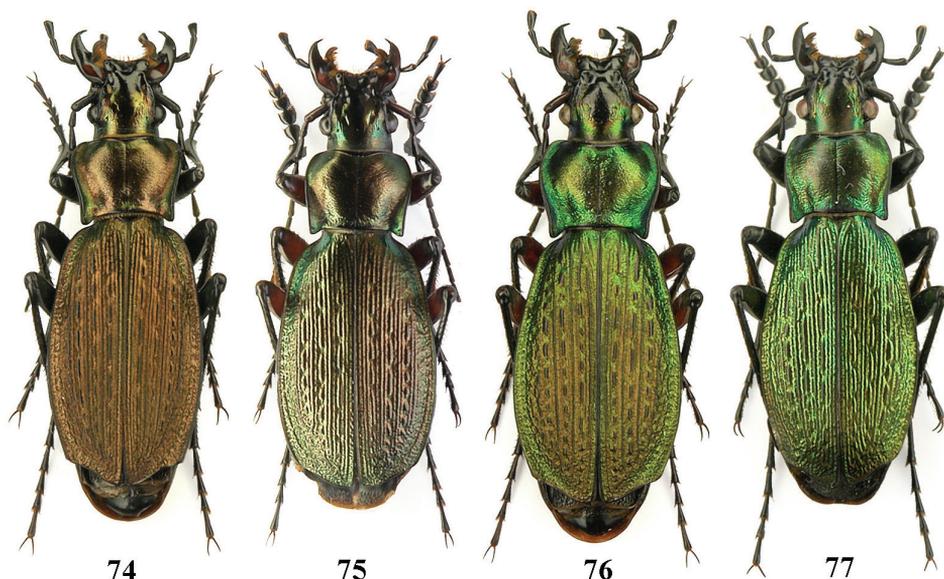
The bulk of studied individuals of *C. (A.) besleticus resheviensis* (males) differ from the other subspecies, namely *C. (A.) besleticus besleticus*, *C. (A.) besleticus mtsaranus*, *C. (A.) besleticus duripshensis*, and *C. (A.) besleticus adzinbai* in their elytral sculpture: tertiary interspaces are elevated almost as secondary ones, forming a smooth sculpture, primary



Figures 66–73. Dorsal habitus, *Carabus (Archiplectes) besleticus resheviensis*. **66** Abkhazia, N slopes of Bzybian Mt. Range, right bank of River Reshevie (holotype) **67–73** same locality (paratypes).

interspaces interrupted more frequently. In the other subspecies tertiary interspaces are normally hardly raised. Morphometric characters are illustrated in Figures 1–6.

Distribution. Populates boreal slopes of Bzybian Mt. Range on the right bank of River Reshevie (=Reshava) at 700–1000 m. Occurs sympatrically with *C. (A.) pseudopshuensis*, the population density of the latter being somewhat higher. Occurrence of this subspecies at the left bank of River Reshevie and downstream River Bzyb seems also possible, but collected material does not confirm this possibility at present.



Figures 74–77. Dorsal habitus, *Carabus* (*Archiplectes*) *besleticus dychuensis*, Abkhazia, Bzybian Mt. Range, SW slopes of Mt. Dzykhva.

Habitat. Prefers slightly sloping beech and fir-beech forest sites rich in ground litter on karstic landforms. Activity of imago proceeds from April to July. *Carabus* (*Archiplectes*) *pseudopshuensis*, *C. (Tribax) apschuanus apschuanus*, *C. (Tribax) constantinovi otcharensis*, *C. (Tribax) circassicus circassicus* (*natio abasinus*), *C. (Microplectes) argonautarum reischitzi*, *C. (Megodontus) septemcarinatus*, *C. (Sphodristocarabus) armeniacus dvorschaki*, and *C. (Procerus) caucasicus colchicus* occur together with this subspecies.

Subspecific epithet. The subspecific epithet refers to the name of the River Reshevie, the type locality of subspecies.

Carabus (*Archiplectes*) *pseudopshuensis* Zamotajlov, 1991

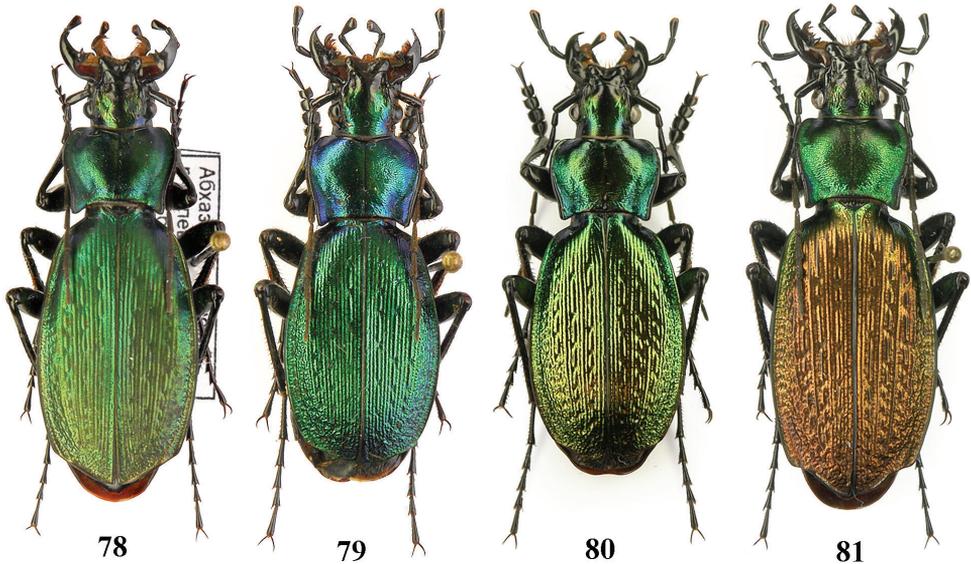
Figs 5–6, 7, 12–15, 78–89

Carabus (*Archiplectes*) *satyrus pseudopshuensis* Zamotajlov, 1991: 36 (“Environs of Pskhu”); Bousquet et al. 2003: 132; Retezár 2008: 41;

Carabus (*Tribax*) *satyrus pseudopshuensis*: Deuve 2004: 275.

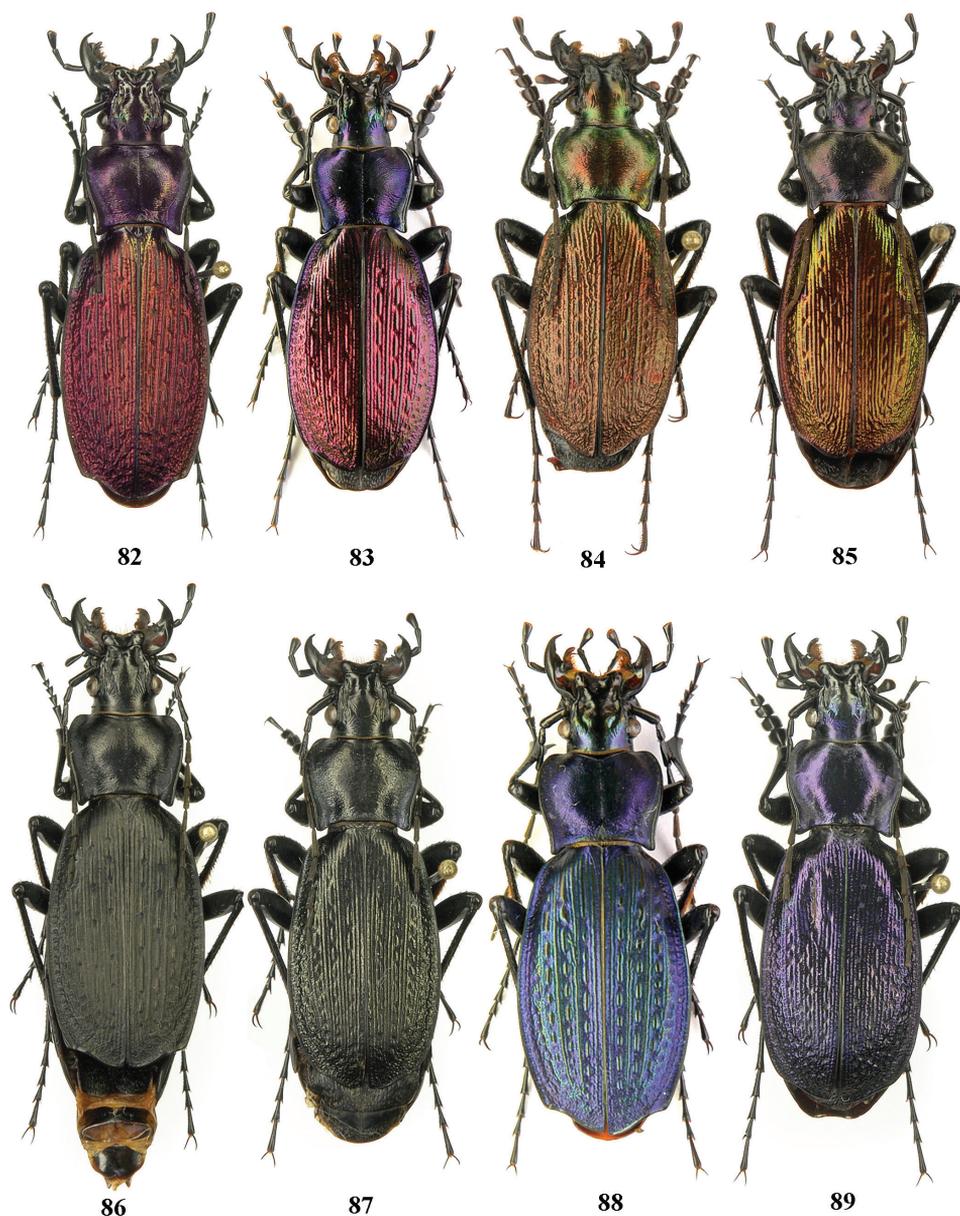
Carabus (*Archiplectes*) *pseudopshuensis*: Fominykh and Zamotajlov 2012: 444; Retezár 2013: 4.

Comparative material examined. 3351 specimens were examined (135 specimens measured, 60 male genitalia preparations studied): 2 males, 4 females, Abkhazia, Sukhum Distr., left bank of River Aguripsta near outfall of River Belaya, beech forest



Figures 78–81. Dorsal habitus, *Carabus (Archiplectes) pseudopshuensis*. **78–79** Abkhazia, Village Pskhu env **80–81** Abkhazia, N slopes of Bzybian Mt. Range, Village Serebryani env.

site, 800–1000 m, 11.V–27.VI.2010, leg. D. Fominykh, I. Solodovnikov (cZAM, cFDD, cSIA); 5 males, 5 females, Abkhazia, Sukhum Distr., left bank of River Aguripsta near Mt. Svyataya, 800 m, 10.V–28.VI.2010, leg. D. Fominykh, I. Solodovnikov (cZAM, cFDD); 4 males, 2 females, Abkhazia, Sukhum Distr., vicinities of Village Pskhu, S slope of Mt. Svyataya, beech forest site, 650–700 m, 10.V–28.VI.2010, leg. I. Solodovnikov, D. Fominykh, (cSIA); 21 males, 25 females, Abkhazia, Sukhum Distr., SE of Village Pskhu, hamlet Bitaga, Mt. Bzybskaya, 550–650 m, beech forest site, 12.V–30.VI.2010, leg. I. Solodovnikov, D. Fominykh, (cSIA); 547 males, 763 females, Abkhazia, Sukhum Distr., left bank of River Aguripsta near Village Pskhu, W slopes of Mt. Chibiskha, 700 m, 25.IV–04.VII.2013, leg. D. Fominykh (cZAM, cFDD, cSAA, cBAS); 48 males, 62 females, Abkhazia, Sukhum Distr., right bank of River Bzyb, S slopes of Mt. Chibiskha, 550 m, 25.IV–04.VII.2013, leg. D. Fominykh (cZAM, cFDD); 5 males, 4 females, Abkhazia, Sukhum Distr., right bank of River Bzyb, S slopes of Mt. Chibiskha upstream hamlet Bitaga, karst, beech forest site, 600–620 m, N43°21'29.36" / E040°49'58.89", 25.IV–04.VII.2013, leg. D. Fominykh (cSIA); 6 males, 6 females, Abkhazia, Sukhum Distr., right bank of River Baul near Village Sanchara, 1030 m, N43°24,9', E040°51,4', VII.2010, leg. I. Retezár (cZAM, cFDD); 2 males, 2 females, Abkhazia, Sukhum Distr., vicinities of Village Sanchara, River Baul, beech forest site, 20.VII.1991, leg. M.N. Maksimenkov (cSIA); 2 females, same locality, 800 m, 10.VIII.1989, leg. M.N. Maksimenkov (cSIA); 2 males, Village Sanchara, VI.1991, leg. M.N. Maksimenkov (cSIA); 1 male, Abkhazia, Sukhum Distr., Pskhu, 10.IX.1991, local collector (cSIA); 3 males, 4 females, Abkhazia, Sukhum Distr., Bzybian Mt. Range, upper reaches of RRiver West Gumista, Dou



Figures 82–89. Dorsal habitus, *Carabus (Archiplectes) pseudopshuensis*. **82–83, 88–89** Abkhazia, N slopes of Bzybian Mt. Range, Village Serebryanyi env **84** Abkhazia, Village Sanchara env **85** Abkhazia, Village Pskhu env., Mt. Svyataya **86–87** Abkhazia, Village Pskhu env.

Pass, 1300 m, 30.IV–19.VII.2012, leg. D. Fominykh (cFDD); 10 males, 13 females, Abkhazia, Sukhum Distr., N slopes of Bzybian Mt. Range near Bzyb valley, 1000 m, 30.IV.2012, leg. D. Fominykh (cZAM, cFDD, cSAA); 40 males, 30 females,

Abkhazia, Sukhum Distr., N slopes of Bzybian Mt. Range near Bzyb valley, 800 m, 30.IV–19.VII.2012, leg. D. Fominykh (cZAM, cFDD, cSIA, cSAA); 351 males, 449 females, Abkhazia, Sukhum Distr., N slopes of Bzybian Mt. Range, right bank of River Reshevie, 700–1000 m, 1.V–20.VII.2012, leg. D. Fominykh (cZAM, cFDD, cSAA, cBAS); 2 males, 5 females, Abkhazia, Sukhum Distr., left bank of River Bzyb, right bank of River Reshevie, beech, maple, fern forest site, 670–720 m, 13–14.V.2010, leg. I. Solodovnikov (cSIA); 9 males, 18 females, same locality, 13.V-02.VII.2010, leg. I. Solodovnikov, D. Fominykh (cSIA, cPIG, cKVM); 14 males, 16 females, same locality, 04.V–20.VII.2012, leg. D. Fominykh, A. Safronov (cSIA); 386 males, 516 females, Abkhazia, Sukhum Distr., N Slopes of Bzybian Mt. Range near Village Serebryanyi, 500–600 m, 25.IV–05.VII.2013, leg. D. Fominykh (cZAM, cFDD); 5 males, 8 females, Abkhazia, Sukhum Distr., vicinities of Village Pskhu, hamlet Serebryanyi, left bank of River Bzyb, karst, beech forest site, 600–620 m, N43°21'52.90" / E040°48'52.90", 25.IV–05.VII.2013, leg. D. Fominykh (cSIA).

Description. Medium-sized form, length 26.5–34.0 mm, males 28.0–32.0 mm, females 28.5–34.0 mm long. Underside black, dorsum normally with bright metallic lustre, green, dark blue, bronze, crimson, violet, less often black, with transitional color forms in males, dichromatic and trichromatic individuals being also known, females matte. Body slender.

Head not inflated. Pronotum variable in shape, from transverse to subquadrate. PW/PL of individuals from the right bank of River Bzyb hardly depends upon altitude in males and constitute constantly 1.32–1.39, in females, upon decrease of altitude, PW/PL varies from 1.38 at 700 m to 1.48 at 1100 m. Hind angles slightly protruding backwards. In the left-bank populations, pronotum of nearly the same proportions or less transverse, particularly in females. PW/PL varies there in males of three studied populations from 1.26 to 1.39, and in females – from 1.34 to 1.42, reaching extreme value of 1.23 in the population, inhabiting environs of the hamlet Serebryanyi. Elytra oblong-ovate in the right-bank populations, also vary in shape from distinctly elongate to almost ovate. EL/EW gradually varies in males depending upon altitude decrease from 1.89 to 1.69, in females such correlations are not obviously revealed and irregularly varies from 1.69 to 1.76. Elytral sculpture varies from almost smooth to coarsely granular, with strongly pronounced punctuation in the middle interspaces. EL/EW is more or less stable in the left-bank populations and measures 1.66–1.70 in males and 1.60–1.75 in females. Elytral sculpture granular, interspaces regular, nearly straight, some male specimens possess somewhat confused elytral sculpture. The main morphometric measurements are presented in Table 1.

The structure of endophallus testifies to the assignment of this form to the *reitteri*-group. It is easily distinguishable from *C. (A.) satyrus*, *C. (A.) besleticus*, and *C. (A.) juenthneri* by the shape of the dorsal appendix, which is less elongate and possesses a more rectangular form.

Differential diagnosis. Strongly resembles *C. (A.) juenthneri juenthneri*, which occurs sympatrically in some localities on the right bank of River Bzyb; however, it differs in smaller body size, more elongate and ovate body, and also in the structure of the male genitalia. Upstream, in the valley of River Aguripsta, *C. (A.) juenthneri juenthneri*

Table 1. Morphometric characteristic of males (n = 67) and females (n = 68) of *C. (Achipectes) pseudopsbuenis*.

Species/subspecies, locality, number of specimens studied	GBL*	SBL	HW	PW	PB	PL	EL	EW	PW/PB	EL/EW	EL/PL	EW/PW
Males												
<i>pseudopsbuenis</i> vall. riv. Belaya, 1000 m, 1 ex	30.0	27.0	4.5	7.0	5.0	4.5	17.0	9.0	1.56	1.89	3.78	1.29
<i>pseudopsbuenis</i> vall. riv. Byaul, 1100 m, 5 ex	29.0–32.0 30.6	26.0–29.0 27.6	4.5–5.5 4.84	6.5–7.5 6.84	5.5–6.0 5.74	5.0	16.5–18 17.36	9.0–10.0 9.56	1.3–1.5 1.37	1.78–1.86 1.82	3.3–3.6 3.47	1.33–1.49 1.4
<i>pseudopsbuenis</i> Village Sanchara, 800 m, 5 ex	28.4–32.75 30.11	26.2–30.3 27.77	4.4–5.45 4.85	6.6–8.35 7.18	5.0–6.1 5.51	4.75–5.4 5.18	16–18.85 17.24	9.15–11.1 10.14	1.28–1.55 1.39	1.64–1.84 1.7	3.19–3.49 3.33	1.33–1.49 1.42
<i>pseudopsbuenis</i> Village Bitaga (Bskhu), 700 m, 20 ex	26.45–32 29.47	24.25–30.0 27.22	4.25–5.0 4.69	5.9–7.2 6.7	4.4–5.8 5.24	4.5–5.5 5.09	14.75–18 16.7	8.8–11 9.87	1.2–1.41 1.32	1.51–1.86 1.69	2.91–3.5 3.28	1.34–1.66 1.48
<i>pseudopsbuenis</i> vall. riv. Reshevie, 700 m, 20 ex	29.0–32.0 30.39	26.55–30.0 28.22	4.4–6.0 5.13	6.35–8.2 7.17	4.85–7.0 5.75	4.9–5.5 5.16	16.5–22.7 17.84	9.2–12.4 10.6	1.21–1.64 1.39	1.45–2.17 1.69	3.09–4.63 3.47	1.33–1.6 1.48
<i>pseudopsbuenis</i> Dou Pass, 1300 m, 1 ex	31.0	29.0	5.0	7.0	6.0	6.0	17.0	10.4	1.17	1.63	2.83	1.49
<i>pseudopsbuenis</i> vall. riv. Bzyb, 900 m, 5 ex	29.0–31.0 30.3	27.0–29.5 28.4	5.0	6.5–7.0 6.86	5.0–6.5 5.84	5.0–6.0 5.46	17.0–18.0 17.56	10.0–11.0 10.32	1.17–1.4 1.26	1.59–1.8 1.7	3–3.56 3.23	1.43–1.69 1.51
<i>pseudopsbuenis</i> Village Serebryanyi, 600 m, 10 ex	28.0–31.0 29.4	26.0–29.0 27.45	4.8–6.0 5.28	6.5–8.0 7.21	5.0–7.0 6.11	5.2–5.7 5.43	16.0–18.0 17.5	9.6–11.6 10.58	1.18–1.51 1.33	1.38–1.88 1.66	2.91–3.4 3.22	1.37–1.55 1.47
Females												
<i>pseudopsbuenis</i> vall. riv. Belaya, 1000 m, 1 ex	31.0	29.0	5.0	7.5	5.5	5.0	17.0	8.0	1.5	2.13	3.4	1.07
<i>pseudopsbuenis</i> vall. riv. Byaul, 1100 m, 5 ex	31.0–33.0 32.26	28.5–31.0 30.1	4.5–5.5 5.1	7.0–8.0 7.4	5.0–7.8 6.16	4.5–5.5 5.0	15.3–19.0 16.96	9.0–11.0 10.08	1.4–1.56 1.48	1.47–1.89 1.69	3.06–3.78 3.4	1.29–1.43 1.36
<i>pseudopsbuenis</i> Village Sanchara, 800 m, 4 ex	31.0–32.2 31.63	29.0–29.65 29.26	4.8–5.55 5.15	7.0–8.0 7.58	5.85–6.5 6.11	5.3–5.0 5.33	18.25–19.0 18.53	10.45–10.8 10.56	1.32–1.56 1.42	1.69–1.81 1.75	3.34–3.8 3.49	1.31–1.49 1.4

Species/subspecies, locality, number of specimens studied	GBL*	SBL	HW	PW	PB	PL	EL	EW	PW/PPL	PW/PB	EL/EW	EL/PL	EW/PW
<i>pseudopsbuenis</i> Village Bitaga (Pskhu), 700 m, 20 ex	29.55–33 31.99	27.75–30.5 29.46	4.65–5.35 5.01	7.0–8.5 7.42	5.35–6.5 5.98	5.0–5.8 5.4	16.8–19.4 17.98	9.6–10.95 10.25	1.21–1.55 1.38	1.08–1.42 1.24	1.6–1.98 1.76	3.08–3.59 3.33	1.13–1.51 1.39
<i>pseudopsbuenis</i> vall. riv. Reshevie, 700 m, 20 ex	29.0–34.0 31.58	27.0–32.0 29.13	4.5–5.45 4.92	6.5–8.55 7.4	5.2–6.8 6.04	4.75–6.3 5.25	16.5–19.4 18.19	9.0–11.25 10.4	1.25–1.63 1.42	1.1–1.35 1.23	1.59–1.9 1.75	3.02–3.8 3.48	1.3–1.62 1.41
<i>pseudopsbuenis</i> Dou Pass, 1300 m, 3 ex	31.5–33.0 32.17	29.5–31.0 30.17	5.0	7.3–7.8 7.53	6.0–6.3 6.1	5.0–5.3 5.17	17.5–19.0 18	9.6–11.6 10.53	1.38–1.5 1.46	1.22–1.25 1.23	1.64–1.82 1.71	3.5–3.58 3.48	1.28–1.59 1.4
<i>pseudopsbuenis</i> vall. riv. Bryzb, 900 m, 5 ex	30.0–33.0 31.5	27.5–30.5 29.2	5.2–5.5 5.4	7.0–7.5 7.14	6.0	5.0–6.0 5.36	17.0–18.0 17.7	10.0–12.0 11.08	1.25–1.4 1.34	1.17–1.25 1.19	1.5–1.7 1.6	3.0–3.6 3.32	1.43–1.63 1.55
<i>pseudopsbuenis</i> Village Serebryanyi, 600 m, 10 ex	28.5–32.0 30.3	26.5–30.0 28.3	4.5–5.8 5.22	5.8–8.0 6.8	5.0–7.0 5.9	5.0–6.5 5.58	16.5–19.5 17.75	9.6–11.0 10.32	0.89–1.44 1.23	1.07–1.2 1.16	1.63–1.84 1.72	2.83–3.45 3.19	1.28–1.83 1.53

* for abbreviations see text.

Table 2. Morphometric characteristic of males (n = 16) and females (n = 31) of *C. (Achiplectes) satyrus* and males (n = 83) and females (n = 91) of *C. (Achiplectes) besleticus* subspecies.

Species/subspecies, locality, number of specimens studied	GBL*	SBL	HW	PW	PB	PL	EL	EW	PW/PL	PW/PB	EL/EW	EL/PL	EW/PW
Males													
<i>satyrus</i>	31.1–35.7	28.6–33.1	5.0–5.65	6.8–8.6	5.75–6.85	5.65–6.6	18.2–21.4	9.95–11.35	1.13–1.43	1.06–1.36	1.64–2.02	3.03–3.68	1.22–1.49
Village Merkleul, 120–230 m, 16 ex.	33.84	31.22	5.39	7.84	6.33	5.97	19.75	10.73	1.32	1.24	1.84	3.32	1.37
<i>besleticus</i>	34.5–39.0	32.6–37.0	5.75–6.35	8.0–9.5	6.8–8.2	5.5–7.0	21–22.7	12.1–15	1.18–1.55	1.1–1.3	1.42–1.78	3–3.79	1.41–1.83
<i>rebmanensis</i>	37.62	35.15	6.03	8.58	7.19	6.27	21.45	13.51	1.37	1.19	1.59	3.43	1.58
vall. riv. Reshevie, 700 m, 29 ex.													
<i>besleticus</i>	31.0	29.0	6.5	7.5	6.5	6.0	20.0	12.4	1.25	1.15	1.61	3.33	1.65
<i>adzinbai</i>													
Mt. Akibakhu, 2000 m, 1 ex.													
<i>besleticus</i>	35.25–37.1	31.8–34.0	5.5–5.75	7.5–8.85	6.4–7.2	5.55–6.9	19.6–22.15	11.15–12.55	1.14–1.48	1.15–1.26	1.65–1.85	2.84–3.87	1.3–1.63
<i>msaranus</i>	35.77	32.82	5.59	8.19	6.81	6.1	20.79	11.87	1.35	1.2	1.75	3.42	1.45
vall. riv. Mtsara, 550–750 m, 10 ex.													
<i>besleticus</i>	32.0–38.0	30.5–34.65	5.4–6.3	7.55–9.75	6.25–8.0	5.65–6.5	20–22.5	10.9–13	1.26–1.53	1.03–1.33	1.62–1.86	3.29–3.75	1.23–1.63
<i>besleticus</i>	34.68	32.29	5.87	8.36	7.21	6.12	21.34	12.23	1.37	1.17	1.75	3.49	1.47
Mt. Birzkhba, 300 m, 20 ex.													
<i>besleticus</i>	23.3–26.5	21.7–25.4	4.0–5.0	5.65–6.4	4.6–5.6	4.0–4.6	13.4–15.8	8.0–9.2	1.2–1.58	1.07–1.37	1.56–1.85	3.08–3.59	1.29–1.51
<i>dykhovensis</i>	25.2	23.41	4.46	6.13	5.06	4.29	14.56	8.65	1.43	1.22	1.68	3.39	1.41
Mt. Dzykhva, 2000 m, 19 ex.													
<i>besleticus</i>	32.45–32.5	29.75–30.0	4.75–5.3	7.2–7.6	5.65–5.75	5.15–5.85	19.1	10.6–10.8	1.30–1.40	1.27–1.32	1.77–1.80	3.26–3.71	1.42–1.47
<i>duripshensis</i>	32.48	29.88	5.03	7.4	5.7	5.5	19.1	10.7	1.35	1.30	1.79	3.49	1.45
Bzyblian Mt. Range. 420–550 m, 2 ex.													
<i>besleticus</i>	28.8–30.7	26.45–28.15	4.85–5.15	6.65–6.85	5.25–5.8	5.25–5.25	17.0–17.65	9.8–10.55	1.27–1.31	1.18–1.27	1.67–1.74	3.24–3.36	1.48–1.54
<i>napraensis</i>	29.75	27.3	5.0	6.75	5.53	5.25	17.33	10.18	1.29	1.22	1.70	3.30	1.51
NW of Bzyblian Mt. Range, 1900–2000 m, 2 ex.													
Females													
<i>satyrus</i>	32.2–39.75	29.5–37.25	5.25–6.3	7.5–9.5	6.0–7.6	5.35–8.0	18.0–24.15	10.9–13.4	1.03–1.57	1.08–1.36	1.6–1.97	2.48–3.79	1.22–1.51
Village Merkleul, 120–230 m, 31 ex.	36.11	33.24	5.81	8.58	6.9	6.33	21.04	11.71	1.37	1.24	1.80	3.35	1.37

Species/subspecies, locality, number of specimens studied	GBL*	SBL	HW	PW	PB	PL	EL	EW	PW/PL	PW/PB	EL/EW	EL/PL	EW/PW
<i>besleticus</i> <i>resheviciensis</i> vall. riv. Reshevie, 700 m, 28 ex.	37.15–43	34.15–41	5.7–7.2	8.25–10	6.5–9.0	5.6–7.2	19.8–25	12.25–16	1.29–1.67	1.06–1.33	1.52–1.92	2.96–4.08	1.3–1.67
	40.61	37.9	6.6	9.43	7.92	6.5	23.59	13.74	1.45	1.2	1.72	3.64	1.46
<i>besleticus</i> <i>adzinbai</i> Mt. Akibakhu, 2000 m, 10 ex.	32–35.75	30.0–32.9	5.85–6.5	7.5–9.5	6.5–8.5	6.0–7.5	20.65–22.5	11.25–13	1.14–1.42	1.0–1.26	1.64–1.84	2.93–3.67	1.32–1.73
	33.33	31.24	6.06	8.33	7.31	6.66	21.7	12.65	1.25	1.14	1.72	3.27	1.53
vall. riv. Mitsara, 550–750 m, 10 ex.	37.5–41.25	34.5–37.75	5.8–6.25	8.3–9.5	7.0–8.15	5.85–7.0	21.7–24	12.1–13.5	1.26–1.56	1.13–1.32	1.73–1.98	3.29–3.86	1.29–1.47
	39.28	36.11	6.01	9.12	7.43	6.51	22.74	12.67	1.41	1.23	1.8	3.5	1.39
Mt. Birtzkha, 300 m, 20 ex.	38.0–40.75	35.15–38.0	5.85–6.5	8.5–11.0	7.0–9.0	6.0–7.2	22.45–24.0	12.15–14.4	1.25–1.62	1.11–1.31	1.64–1.86	3.19–3.88	1.13–1.47
	38.95	36.45	6.27	9.74	8.19	6.68	23.22	13.06	1.46	1.19	1.78	3.48	1.35
Village Abzhakva, 70 m, 1 ex.	39.0	36.0	6.5	10.3	8.1	7.0	22.5	13.5	1.46	1.27	1.67	3.21	1.32
	23.3–26.5	23.65–26.3	4.0–4.9	6.0–7.3	5.0–6.8	4.2–4.9	14.65–17.0	8.65–10	1.3–1.62	1.03–1.3	1.5–1.79	3.33–3.67	1.34–1.59
Mt. Drykha, 2000 m, 18 ex.	25.2	25.18	4.44	6.47	5.53	4.44	15.5	9.38	1.46	1.17	1.66	3.49	1.45
	32.5–32.6	30.0–30.3	5.25–5.25	7.25–7.3	5.75–6.3	5.65–5.75	19.0–20.0	10.5–10.75	1.27–1.28	1.16–1.26	1.81–1.86	3.36–3.48	1.45–1.47
Bzybian Mt. Range, 420–550 m, 2 ex.	32.55	30.15	5.25	7.28	6.03	5.7	19.5	10.63	1.28	1.21	1.83	3.42	1.46
	31.7–33.7	29.35–30.6	5.35–5.5	7.6–7.9	6.35–6.45	5.15–5.3	19.0–20.35	10.5–12.0	1.48–1.49	1.20–1.22	1.70–1.81	3.69–3.84	1.38–1.52
NW of Bzybian Mt. Range, 1900–2000 m, 2 ex.	32.7	29.98	5.43	7.75	6.4	5.23	19.68	11.25	1.48	1.21	1.75	3.76	1.45

*for abbreviations see text.

completely substitutes this taxon. On the left bank of River Bzyb it also occurs sympatrically with *C. (A.) besleticus resheviensis* from which it differs in considerably smaller body size and different male genitalia. The authors have succeeded in collecting in such localities few transitional individuals, apparently being hybrid forms. Morphometric characters are illustrated in Figures 5–6.

Distribution. Populates the left bank of the River Aguripsta from the confluence of River Belaya (its left tributary) up to its outfall, and also right board of River Bzyb, upstream confluence of River Aguripsta, also occurs at northern slopes of Bzybian Mt. Range, reaching its watershed at 1300 m, where dwells together with *C. (A.) apollo tenebricosus*, however it has not been found at its southern slopes, where apparently it is completely substituted by the latter.

Habitat. Inhabits mainly beech and fir-beech mixed forests, developed on rich ground litter, and also petrous forest taluses at karstic landforms. The population density is rather high in its known geographic range, except for the middle flow of River Aguripsta (natural border of its distribution area), the maximum density of imago is recorded for the altitude interval of 600–900 m. Activity of imago proceeds from April to July, solitary individuals are sometimes observed at the end of summer or the middle of September. The following forms of *Carabus* occur sympatrically on the left bank of River Bzyb: *C. (A.) besleticus resheviensis*, *C. (A.) apollo tenebricosus*, *C. (Tribax) apschuanus apschuanus*, *C. (T.) constantinovi otcharensis*, *C. (T.) circassicus circassicus* (*natio abasinus*), *C. (Microplectes) argonautarum reischitzi*, *C. (Megodontus) septemcarinatus*, *C. (Eucarabus) cumanus* Fischer von Waldheim, 1823, *C. (Sphodristocarabus) armeniacus dvorschaki*, and *C. (Procerus) caucasicus colchicus*; on the right bank of River Bzyb: *C. (A.) juenthneri juenthneri*, *C. (Tribax) apschuanus schoeni* Novotný & Voříšek, 1988, *C. (T.) constantinovi otcharensis*, *C. (T.) circassicus circassicus* (*natio abasinus*), *C. (Microplectes) argonautarum reischitzi*, *C. (Megodontus) septemcarinatus*, *C. (Eucarabus) cumanus*, *C. (Pachycarabus) imitator katharinae* Reitter, 1896, *C. (Sphodristocarabus) armeniacus janthinus* Ganglbauer, 1887, and *C. (Procerus) caucasicus colchicus*.

Acknowledgements

The authors are very grateful to Dr. A. Bondarenko and E. Khomitskiy (Krasnodar), V. Kotsur and S. Solodovnikova (Vitebsk), S. Pavlyuchuk (Stavropol), N. Pichugin (Vladimir), A. Safronov and D. Safronov (Tula), for their assistance in field investigations during the collecting trips to Abkhazia. We would also like to thank Dr. B. Kataev (Zoological Institute of the Russian Academy of Sciences, St. Petersburg) for making some specimens retained at this institution available for study. We also wish to express our appreciations to I. Retezár (Budapest), Prof. Dr. A. Kazadaev (Rostov-on-Don), and Dr. A. Koval (St. Petersburg) for providing comparative material and useful distributional information on certain forms, and Drs R. Dbar and V. Malandzia (Sukhum) and Drs A. Belyi and L. Esipenko (Krasnodar) for their kind help in organizing and providing logistic support for our expeditions.

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Revision of *Chaetocnema semicoerulea* species-group (Coleoptera, Chrysomelidae, Galerucinae, Alticini) in China, with descriptions of three new species

Yongying Ruan^{1,3}, Alexander S. Konstantinov², Siqin Ge¹, Xingke Yang¹

1 Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China **2** Systematic Entomology Laboratory, USDA, ARS, Washington DC, USA **3** University of Chinese Academy of Sciences, Beijing, 100039, China

Corresponding authors: Xingke Yang (yangxk@ioz.ac.cn); Alexander S. Konstantinov (Alex.Konstantinov@ars.usda.gov)

Academic editor: Ron Beenen | Received 20 July 2014 | Accepted 4 November 2014 | Published 12 December 2014

<http://zoobank.org/322323E8-1A72-4D42-BD6A-1E597DECCD05>

Citation: Ruan Y, Konstantinov AS, Ge S, Yang X (2014) Revision of *Chaetocnema semicoerulea* species-group (Coleoptera, Chrysomelidae, Galerucinae, Alticini) in China, with descriptions of three new species. ZooKeys 463: 57–74. doi: 10.3897/zookeys.463.8147

Abstract

Chinese species of *Chaetocnema semicoerulea* group are revised and three new species described as new: *C. salixis* **sp. n.**, *C. yulongensis* **sp. n.** and *C. deqinensis* **sp. n.**. A key to all five species of this group occurring in China and the illustrations of habitus and genitalia are provided. A map of species distribution is given.

Keywords

Coleoptera, species group, new species, China, flea beetles

Introduction

There are more than 400 species of *Chaetocnema* known in the world (Konstantinov et al. 2011). Approximately 43 species are known to occur in China; however, Chinese *Chaetocnema* species still remained mostly unknown and need to be collected, properly documented and ultimately revised. The Chinese *Chaetocnema picipes* species-group has been studied previously (Ruan et al. 2014), and this paper is a second contribution to the revision of *Chaetocnema* in China.

Chaetocnema semicoerulea species-group is similar to *Chaetocnema picipes* species-group (Ruan et al. 2014). They share a number of character states, such as: vertex sparsely and unevenly covered with punctures near each eye; frontal ridge narrow and convex; base of pronotum with two short longitudinal impressions; deep row of large punctures at base of pronotum present on sides, lacking in middle. *Chaetocnema semicoerulea* species-group can be differentiated from *picipes* species-group by the following character states: apical part of median lobe in ventral view with polygonal line on lateral sides; apex of median lobe in lateral view sinuated.

Species of the *semicoerulea* species-group usually feed on *Salix* or *Rubus*.

Material and methods

Photographic technique, morphological terminology and anatomy method used in Ruan et al. (2014) are followed.

Distributional records of species are arranged from north to south. Province names in “Material” paragraphs are in bold.

Abbreviations of collections: BMNH, The Natural History Museum, London, United Kingdom; IZCAS, Institute of Zoology, Chinese Academy of Sciences, Beijing, China; HMB, Switzerland, Basel, Natural History Museum; SYSU, Sun Yat-Sen University, Guangzhou, China; USNM, National Museum of Natural History, Washington DC, USA; ZMHB, Museum für Naturkunde der Humboldt-Universität, Berlin, Germany.

Taxonomy

Chaetocnema semicoerulea species-group

Diagnosis. Body length usually 1.60–3.00 mm. Apex of median lobe narrowing with polygonal line on sides, apical denticle weak or absent; median lobe in lateral view sinuated on apex; spermathecal receptacle pear-shaped, basal part of spermathecal duct straight; frontal ridge narrow and convex; vertex sparsely and unevenly covered with punctures near eyes; all rows of punctures on elytra regular.

In history, many authors erroneously used *Tlanoma* Motschulsky as a subgenus name in the genus *Chaetocnema*. This mistake was fully discussed by Konstantinov et al. (2011). They pointed out that *C. concinna* Marsham is the correct type of genus *Chaetocnema* designated by Westwood 1838, instead of *C. hortensis* (Geofroy) designated by Maulik (1926) which was erroneously used by many authors in history and recently; the valid name for subgenus should be *Chaetocnema* (s. str.) (subgeneric type *C. concinna*) and *Udorpes* (subgeneric type *C. splendens*); *Tlanoma* Motschulsky fact is a subjective junior synonym of *Chaetocnema* in the strict sense. We agree with their proposal to use *Chaetocnema* and *Udorpes* as two valid subgeneric names in the genus

Chaetocnema. Based on the narrow and raised frontal ridge and sparse punctures near each eye, species of the *semicoerulea* group can be classified in the subgenus *Chaetocnema* (s. str.) Marsham. Although the same paper suggested not to use any subgeneric classification until rigorous phylogenetic analysis has been conducted in this genus, in this study the species group is used for practical reasons.

Key to species of *Chaetocnema semicoerulea* species-group

- 1 Male body length exceeds 2.00 mm; ratio of width of frontal ridge (excluding margin) to width of antennal socket (excluding margin) exceeds 1.20..... 2
- Male body length less than 1.90 mm; ratio of width of frontal ridge (excluding margin) to width of antennal socket (excluding margin) less than 1.10..... 4
- 2 Head with 15–20 punctures on vertex near each eye..... *C. semicoerulea* (Koch)
- Head with 7–10 punctures on vertex near each eye..... 3
- 3 Frontolateral angle of pronotum round or blunt; longitudinal groove and minute transverse wrinkles on ventral side of median lobe present *C. transbaicalica* Heikertinger
- Frontolateral angle of pronotum strongly protruding, acute laterally; longitudinal groove and minute transverse wrinkles on ventral side of median lobe absent *C. salix* sp. n.
- 4 Body copperish; apex of median lobe narrowly rounded, lateral view of median lobe evenly curved..... *C. yulongensis* sp. n.
- Body bronzish; apex of median lobe broadly rounded, maximum curvature of median lobe from lateral view situated apically *C. deqinensis* sp. n.

Chaetocnema semicoerulea (Koch)

Figure 1

Chaetocnema semicoerulea Koch, 1803: 40 (type locality: Germany, Rheinland, “Kusel und Meisenheim”; type missing *teste* Doguet, 1994); as *Haltica*.

Chaetocnema saltitans Stephens, 1831: 327 (type locality: “Suffolk”; type depository: unknown); Weise 1886: 760 (synonymized).

Chaetocnema meridionalis Allard, 1859: cv (type locality: “France méridionale”; type depository: unknown); as *Plectroscelis*; Heikertinger 1951: 211 (synonymized).

Chaetocnema saliceti Weise, 1886: 758 (as variety of *semicoerulea*; type locality: not given; type depository: ZMHB); Heikertinger 1951: 211 (synonymized).

Chaetocnema femoralis Weise, 1886: 758 (as variety of *semicoerulea*; type locality: not given; type depository: ZMHB); Heikertinger 1951: 211 (synonymized).

Distribution. China (Heilongjiang); Russia [Siberia (Heikertinger 1951), Far East (Bukejs 2008)]; Middle Asia (Heikertinger 1951); Europe (Konstantinov et al. 2011).

Host plants. *Salix alba*, *S. purpurea*, *S. triandra*, *S. incana*, *S. viminalis*, *Calamagrostis* sp., *Phalaris* sp. (Heikertinger, 1925); *Salix alba*, *S. purpurea*, *S. triandra*, *S. viminalis*, *S. elaeagnos* (Doguet, 1994); *Salix alba*, *S. purpurea* (Fogato & Leonardi, 1980).

Description. Body length: 2.05–3.00 mm, without head: 2.08–2.70 mm; body width: 1.24–1.67 mm. Ratio of elytron length at suture to maximum width: 2.26–2.46. Ratio of pronotum width at base to length at middle: 1.61–1.65. Ratio of length of elytron at suture to length of pronotum at middle: 3.13–3.16. Ratio of width of both elytra at base to width of pronotum at base: 1.15–1.16.

Elytron bronzyish, blueish or copperish. Pronotum bronzyish, greenish or copperish. Antennomere 1–2 completely yellow. Antennomeres 3–4 completely yellow or partly brown. The remaining antennomeres brown. Tibia and tarsi yellow. Pro- and mesofemur dark yellow. Metafemur brown. Tarsi dark yellow.

Head hypognathous. Frontal ridge between antennal sockets narrow and convex. Frontolateral sulcus present. Orbital sulcus deep. Suprafrontal sulcus relatively deep, well-defined, retuse. Ratio of width of frontal ridge (excluding margin) to width of antennal socket (excluding margin): 1.35–1.45. Vertex flat, situated on same level as orbit. Surface of vertex covered with 15–20 punctures next to each eye.

Base of pronotum with two longitudinal impressions. Deep row of large punctures at base of pronotum present on sides, lacking in middle. Pronotal base evenly convex. Sides of pronotum slightly convex with maximum width near base. Anterolateral prothoracic callosity protruding laterally forming a round angle. Posterolateral prothoracic callosity poorly developed. Diameter of pronotal punctures 2–4 times smaller than distance between them.

Elytra with convex sides. All rows of punctures of elytra regular. Elytral humeral callus well-developed. Interspace between stria of punctures on the elytra smooth. Numbers of lines of minute punctures on each interspace: 2–3.

First male protarsomere length to width ratio: 2.20–2.25. First and second male protarsomeres length to length ratio: 1.13–1.19. First and second male protarsomeres width to width ratio: 1.61–1.67. Length of metatibia to distance between denticle and metatibial apex: 2.37–2.45. Large lateral denticle on metatibia sharp. Metatibial serration proximal to large lateral denticle present, sharp. First male metatarsomere length to width ratio: 2.97–3.06. First male protarsomere maximum width to width at base ratio: 2.12–2.19. First and second male metatarsomeres length to length ratio, 1.71–1.78. First and second male metatarsomeres width to width ratio: 1.00–1.06. Third and fourth male metatarsomeres length to length ratio: 1.54–1.59.

Apical part of median lobe narrower than middle. Apical part in ventral view narrowing gradually with polygonal line on sides. Ventral longitudinal groove poorly developed, shallow or absent. Apical and basal parts of longitudinal groove usually subequal in width, wider than middle. Apical denticle in ventral view absent. Minute transverse wrinkles on ventral side present. Median lobe in lateral view sinusoidal near apex with maximal curvature situated medially.

Spermathecal receptacle pear-shaped. Spermathecal pump much shorter than receptacle. Apex of spermathecal pump cylindrical. Spermathecal receptacle piriform.

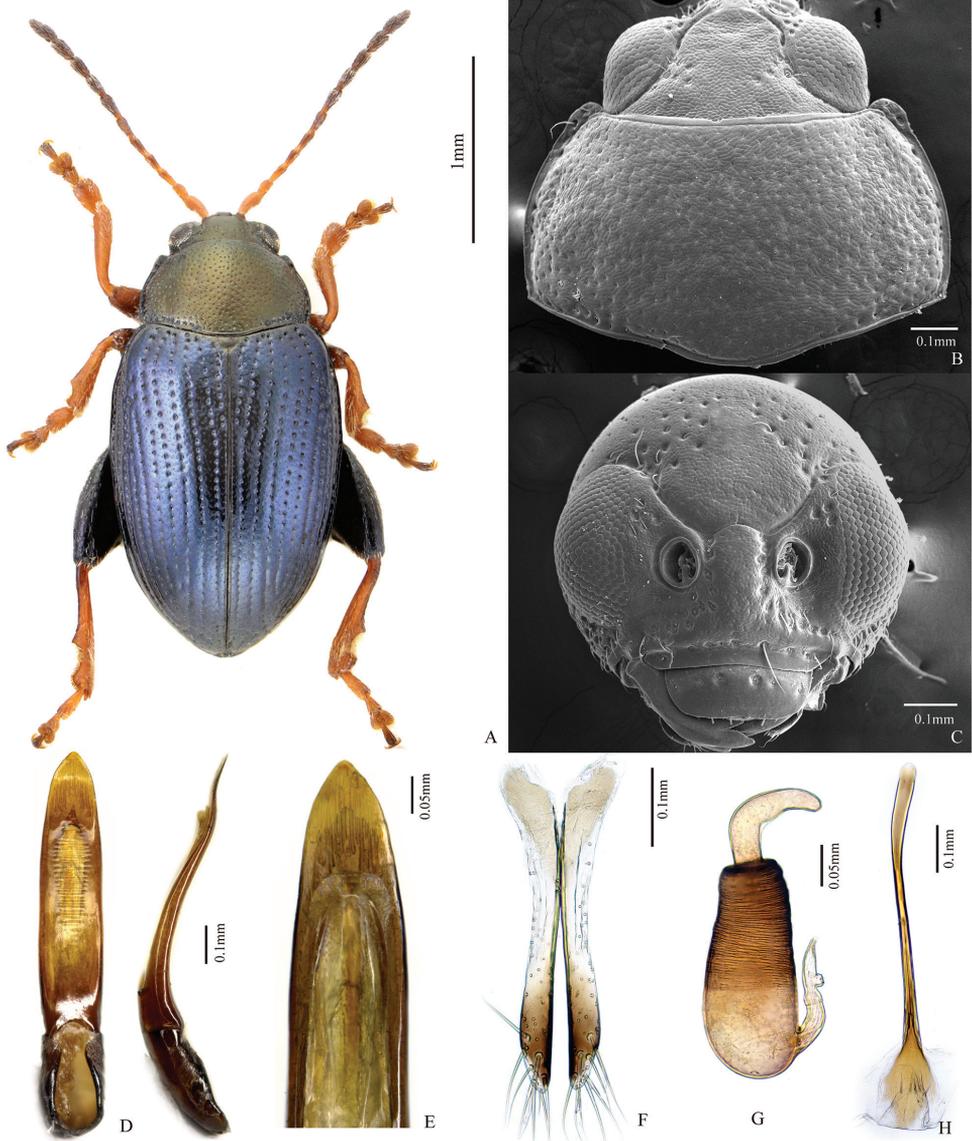


Figure 1. *Chaetocnema semicoerulea*. **A** Male habitus **B** Prothorax, dorsal view **C** Head, frontal view **D** Adeagus, ventral and lateral view **E** Apical part of Adeagus, dorsal view **F** Vaginal palpus **G** Spermatheca **H** Tignum.

Spermathecal pump attached to middle of receptacle top. Maximum width of receptacle situated at about middle. Basal part of receptacle wider than apical. Posterior sclerotization of tignum spoon shaped, wider than midsection. Midsection of tignum curved. Sides of midpart of vaginal palpus narrowed. Anterior end of anterior sclerotization narrowly rounded. Length of posterior sclerotization greater than width. Width of anterior sclerotization greater than width of posterior sclerotization.

Material. 1♂, China, Wuyiling, Yichun, **Heilongjiang**, 31.VIII.1970 (IZCAS).

Remarks. *Chaetocnema semicoerulea* from the Palearctic Region has been recently revised by Konstantinov et al. (2011). This species is recorded in China for the first time. Only found one male specimen was found in China with all the characters in accordance with the European specimens that are available for study except the reduced body size (2.05 mm in body length).

***Chaetocnema transbaicalica* Heikertinger**

Figure 2

Chaetocnema transbaicalica Heikertinger, 1951: 173 (as subspecies of *semicoerulea*; type locality: Russia, Ulan-Ude, “Werchne Udinsk”; type depository: NHMB; lectotype designated by Bechyné 1956: 583); Konstantinov et al. 2011: 333 (elevated to species).

Distribution. China (Heilongjiang); Mongolia; Russia (Southern Siberia, Far East) (Heikertinger 1951, Konstantinov et al. 2011).

Host plants. unknown.

Description. Body length: 2.05–2.25 mm, excluding head: 1.94–2.05 mm; Body width 1.18–1.24 mm. Ratio of elytron length at suture to maximum width: 2.59–2.68. Ratio of pronotum width at base to length at middle: 1.70–1.86. Ratio of length of elytron at suture to length of pronotum at middle: 3.28–3.38. Ratio of width of both elytra at base to width of pronotum at base: 1.07–1.19. Ratio of maximum width of both elytra to maximum width of pronotum: 1.40–1.44.

Elytron and pronotum bronzyish. Antennomere 1 completely yellow or partly dark brown. Antennomeres 2–3 completely yellow. Antennomere 4 completely yellow or partly brown. Antennomere 5 partly brown. The remaining antennomeres brown. Tibia yellow or partly brown. Pro- and mesofemur partly brown. Metafemur brown. Tarsi yellow.

Head hypognathous. Frontal ridge between antennal sockets narrow and convex. Frontolateral sulcus present. Suprafrontal sulcus shallow and faint, retuse. Ratio of width of frontal ridge (excluding margin) to width of antennal socket (excluding margin): 1.30–1.40. Surface of vertex with 8–10 punctures near each eye.

Base of pronotum with two short longitudinal impressions. Deep row of large punctures at base of pronotum present on sides, lacking in middle. Pronotal base evenly convex. Sides of pronotum slightly convex with maximum width near base. Anterolateral prothoracic callosity protruding laterally. Posterolateral prothoracic callosity poorly developed. Diameter of pronotal punctures 2–4 times smaller than distance between them.

Elytra with convex sides. All rows of punctures on elytra regular, scutellar row single. Elytral humeral callus well-developed. First male protarsomere length to width ratio: 1.48–1.51. First male protarsomere maximum width to width at base ratio: 1.98–2.04. First and second male protarsomere length to length ratio: 1.79–1.83. First

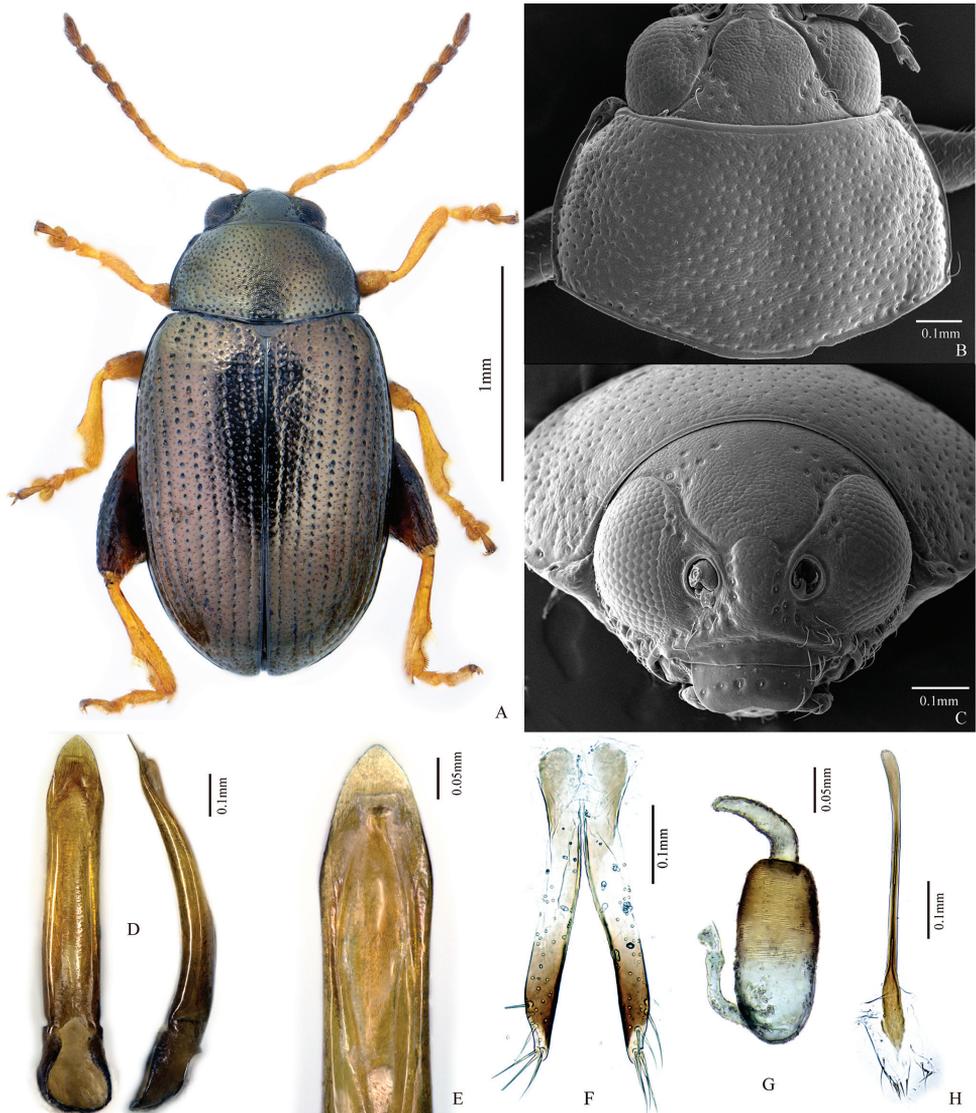


Figure 2. *Chaetocnema transbaicalica*. **A** Male habitus **B** Prothorax, dorsal view **C** Head, frontal view **D** Adeagus, ventral and lateral view **E** Apical part of Adeagus, dorsal view **F** Vaginal palpus **G** Spermatheca **H** Tignum.

and second male protarsomeres width to width ratio: 1.06–1.09. Length of metatibia to distance between denticle and metatibial apex: 2.27–2.32. Large lateral denticle on metatibia sharp. Metatibial serration proximal to large lateral denticle present, sharp. First male metatarsomere length to width ratio: 2.96–3.05. First and second male metatarsomeres length to length ratio: 1.30–1.70. First and second male metatarsomeres width to width ratio: 0.85–0.91. Third and fourth male metatarsomeres length to length ratio, 1.63–1.69.

Apical part of median lobe in ventral view narrowing gradually with polygonal line on sides. Apical denticle in ventral view absent. Minute transverse wrinkles on ventral side present. Ventral longitudinal groove poorly developed in apical and basal part, shallow, with obtuse margins; obscure or absent in middle. Apical part of longitudinal groove wider than basal; middle part narrower than basal and apical. Median lobe in lateral view sinusoidal near apex with maximal curvature situated medially.

Spermathecal pump much shorter than receptacle. Apex of spermathecal pump cylindrical. Spermathecal receptacle pear-shaped. Spermathecal pump attached to middle of receptacle top. Maximum width of receptacle situated at about middle. Basal part of receptacle about as wide as apical. Posterior sclerotization of tignum spatulate, wider than midsection. Apex of vaginal palpus subdeltoid, with sides abruptly tapering. Sides of midpart of vaginal palpus (before apex) narrowing from base, slightly widening towards apex. Anterior sclerotization of vaginal palpus as wide posteriorly as anteriorly before apex; sharply curved at apex. Anterior end of anterior sclerotization broadly rounded or acute. Length of posterior sclerotization greater than width. Width of posterior sclerotization great or greater than width of anterior sclerotization.

Type material. *Chaetocnema transbaicalica*: Lectotype: 1♂, 1) Werchne-Udinsk, Trabaikal. Mandl, 2) nicht, semicoer. Aedeagus, 1. Tarsingl., 3) Chaetocn., det. Heiktingr., semicoerul. transbaicalica m. Type, 4) Chaetocn. semicoer. transbaicalica m. Typus, 5) 1953, Coll. Heikertinger, 6) lectotype, J. Bechyné det., 1956 (NHMB);

Paralectotype: 1, 1) Sutschanski-Rudnik, Ussuri Juli, 2) semicoerulea transbaicalica m. det. Heiktingr., 3) Cotypus, 4) 1953, Coll. Heikertinger (NHMB); 1, 1) Werchne-Udinsk, Trabaikal. Mandl, 2) Punktirnug der Fld.anders!, 3) Chaetocn. semicoerul. Transbaicalica m. Type, det. Heiktingr., 4) Chaetocn. semicoer. transbaicalica m. Typus, 5) 1953, Coll. Heikertinger (NHMB).

Material. 2♂, China, Errenban, Mishan, **Heilongjiang**, 10.VIII.1970 (IZCAS); 1♀, Dabaishu, Daxinganling, **Heilongjiang**, 19.VIII.1970. 1♂1♀, Mongolia, 27.VI.1924 (IZCAS).

Remarks. *Chaetocnema transbaicalica* from the Palearctic Region has been recently revised by Konstantinov et al. (2011). This species is previously recorded in Russia and Mongolia. This species is recorded in China for the first time.

***Chaetocnema salix* Ruan, Konstantinov & Yang, sp. n.**

<http://zoobank.org/BA6C51B8-E65F-417B-B7B4-955FD7C9A53C>

Figure 3

Etymology. This species is named after the host plant.

Host plants. *Salix* sp.

Distribution. China: Shannxi, Gansu, Sichuang.

Diagnosis. *Chaetocnema salix* resembles *C. transbaicalica*. It can be differentiated from the latter by the following characters: frontolateral angle of pronotum long and sharp

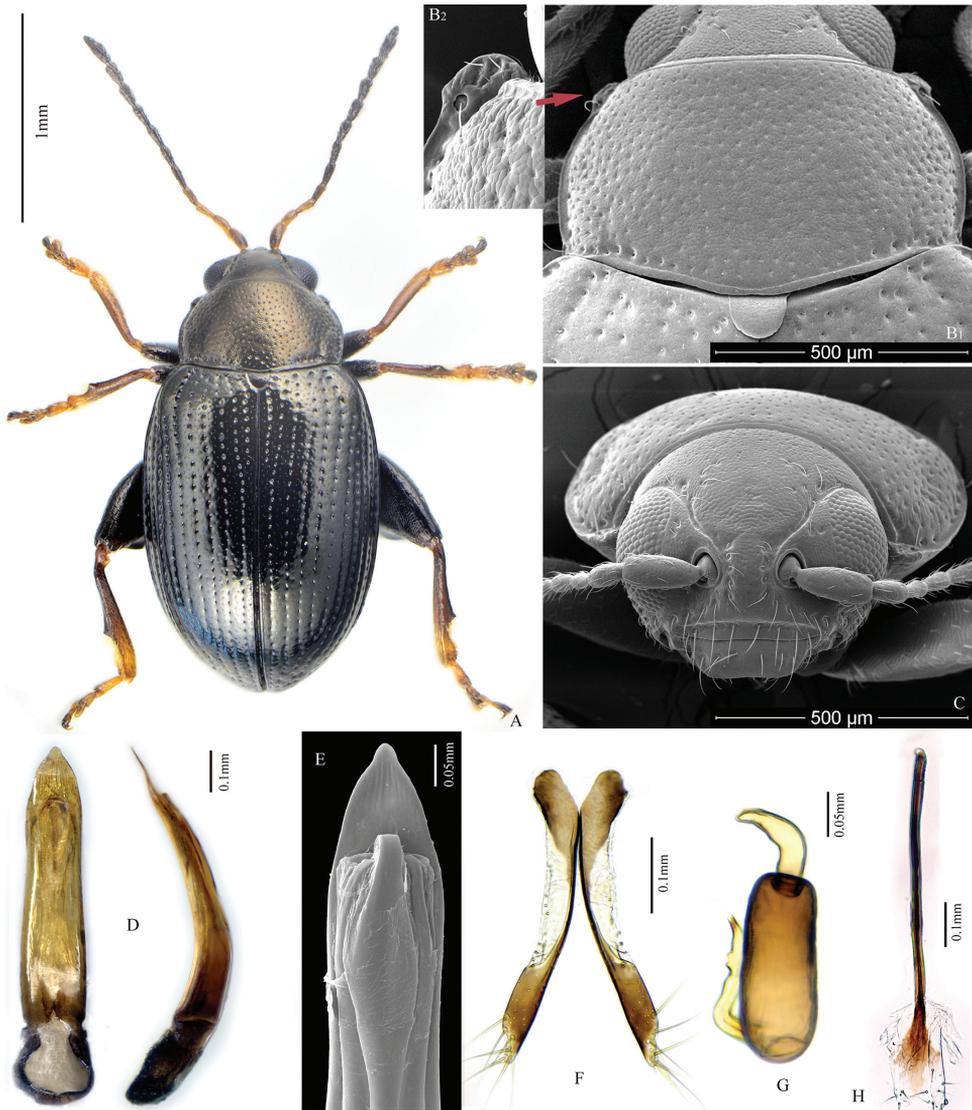


Figure 3. *Chaetocnema salixis*. **A** Male habitus **B1** Prothorax, dorsal view **B2** frontolateral angle of pronotum **C** Head, frontal view **D** Adeagus, ventral and lateral view **E** Apical part of Adeagus, dorsal view **F** Vaginal palpus **G** Spermatheca **H** Tignum.

laterally; both longitudinal groove and transverse wrinkles on ventral surface of median lobe absent; metatibial serration proximal to large lateral denticle absent or obscure.

Description. Body length: 2.10–2.50 mm, without head: 1.9–2.30 mm. Female body length: 2.30–2.50 mm, without head: 2.10–2.30 mm. Length of antenna to length of body: 0.60. Body width: 1.13–1.17 mm. Elytron length (along suture) to width (maximum): 2.70–2.75. Pronotum width (at base) to length: 1.74–1.79. Length of elytron to length of pronotum (along middle): 3.47–3.49. Width of elytra at

base (in middle of humeral calli) to width of pronotum at base: 1.16–1.19. Maximum width of elytra to maximum width of pronotum: 1.44–1.47.

Color of elytron differs from color of pronotum. Elytra black, without metallic lustre. Pronotum and head bronzy. Antennomere 1 partly dark brown. Antennomeres 2–3 partly brown or completely yellow. Antennomere 4 brown. The remaining antennomeres black. Tibia and tarsi partly brown. Femora brown.

Head hypognathous. Frontal ridge between antennal sockets narrow and convex. Frontolateral sulcus present. Suprafrontal sulcus deep laterally, absent in middle. Orbital sulcus deep. Ratio of width of frontal ridge (excluding margin) to width of antennal socket (excluding margin): 1.20–1.25. Width of frontolateral sulcus to width of antennal socket: 0.29–0.38. Width of orbital sulcus to width of frontolateral sulcus: 0.72. Numbers of punctures on vertex next to each eye: 7–9. Numbers of punctures on orbit: 2. Numbers of hairs along frontolateral sulcus: 9–11. Numbers of hairs on front (triangle area surrounded by frontolateral sulcus and clypeus): 0. Numbers of hairs on clypeus: 8. Numbers of hairs on labrum: 6. Anterior margin of labrum slightly concave in middle.

Base of pronotum with two obscure longitudinal impressions visible only near basal margin. Deep row of large punctures at base of pronotum present on sides, lacking in middle. Pronotal base slightly expanded in middle. Lateral sides of pronotum slightly convex with maximum width near base. Anterolateral prothoracic callosity protruding laterally, forming a sharp angle laterally (Fig. 3: B2). Posterolateral prothoracic callosity poorly developed. Diameter of pronotal punctures 2 to 4 times smaller than distance between them.

Elytra with convex sides. All rows of punctures regular. Elytral humeral callus well developed. Interspace between stria of punctures smooth and glabrous. Numbers of stria of minute punctures on each interspace: 2.

First male protarsomere slightly larger than second one. First male protarsomere, length to width ratio: 1.74–1.78. First and second male protarsomeres, length to length ratio: 1.60–1.80. First and second male protarsomeres, width to width ratio: 1.04–1.20. First male protarsomere, width at apex to width at base: 1.50–1.53. Length of metatibia to distance between denticle and metatibial apex: 2.28–2.36. Large lateral denticle on metatibia sharp. Metatibial serration proximal to large lateral denticle absent or obscure. First male metatarsomere, length to width ratio: 2.80–3.40. First and second male metatarsomeres, length to length ratio: 2.03–2.15. First and second male metatarsomeres, width to width ratio: 0.87–0.97. Third and fourth male metatarsomeres, length to length ratio: 0.52–0.55.

Apical part of median lobe in ventral view narrowing gradually with polygonal line on sides. Ventral longitudinal groove absent. Apical denticle in ventral view absent. Minute transverse wrinkles on ventral side absent. Median lobe in lateral view evenly and strongly curved, slightly sinusoidal near apex. Maximal curvature of median lobe in lateral view situated medially.

Spermathecal receptacle pear-shaped. Basal part of spermatheca duct straight. Spermathecal pump much shorter than receptacle. Apex of spermathecal pump cylin-

dricul or pointed. Spermathecal pump attached to middle of receptacle top. Basal part of receptacle about as wide as apical. Posterior sclerotization of tignum spoon-shaped, wider than mid section. Mid section of tignum nearly straight. Anterior sclerotization of tignum about as wide as mid section. Apex of vaginal palpus subdeltoid, with lateral side slightly arching. Sides of mid part of vaginal palpus (before apex) narrowing from base, slightly widening towards apex. Anterior sclerotization of vaginal palpus nearly parallel. Anterior end of anterior sclerotization broadly rounded. Length of posterior sclerotization greater than width. Width of posterior sclerotization smaller than width of anterior sclerotization.

Type material. Holotype: 1♂, Yangxian, Qinling Mountains, **Shannxi**, alt. 1700m, VII.2013, Leg. Yongying Ruan, host: *Salix* sp. "*Chaetocnema salix* sp. n., Des. Ruan, Konstantinov, Yang. 2014" (IZCAS).

Paratypes (all in IZCAS, except those that are indicated as USNM): 2♂4♀, Qinling Mountain, **Shannxi**, VII–VIII.2013, Leg. Yongying Ruan, host: *Salix* sp.; 3♂4♀ same label except Leg. A. Konstantinov (USNM); 1♂2♀, Shatang forestry station, Zhouqu, **Gansu**, alt. 2400m, 5–27.VII.1998, Leg. Shuyong Wang et al.; 1♀, Bifenggou, Bikou, Wenxian, **Gansu**, 25.VII.1998, alt. 2360m, Leg. Xingke Yang; 1♀, Daheba, Tanchang, **Gansu**, 5.VII.1998, alt. 1700–2350m, Leg. Shuyong Wang; 4♀, Miyaluo, Lixian, **Sichuang**, alt. 2780–3300m, 7.VII.1963, Leg. Xuezhong Zhang; 19♂48♀, Sanshenggou, Wolong, **Sichuang**, alt. 2500–2700m, 6–8.VIII.1983, Leg. Shuyong Wang.

***Chaetocnema yulongensis* Ruan, Konstantinov & Yang, sp. n.**

<http://zoobank.org/0C04C63E-43BA-4440-89A6-4DCA2F93237E>

Figure 4

Etymology. We named this species after the “Yulong snow mountain” in Yunnan province where the holotype was collected.

Host plants. Unknown.

Distribution. China, Yunnan.

Diagnosis. *Chaetocnema yulongensis* and *C. deqinensis* are extremely alike externally, but differ significantly in the shape of the median lobe. In *C. yulongensis*, maximal curvature of the median lobe in lateral view is situated medially; apical end of the median lobe is narrowly rounded; the suprafrontal sulcus is obtuse in the middle. In *C. deqinensis*, the maximal curvature of the median lobe is situated apically; the apical end of the median lobe is broadly rounded; the superfrontal sulcus is absent in the middle.

Description. Body length: 1.66–2.15 mm, without head: 1.46–1.99 mm. Body width: 0.92–1.17 mm. Length of antenna to length of body: 0.60–0.61 mm. Elytron length (along suture) to width (maximum): 2.54–2.65. Pronotum width (at base) to length: 1.72–1.73. Length of elytron to length of pronotum (along middle): 3.25–3.30. Width of elytra at base (in middle of humeral calli) to width of pronotum at base: 1.10–1.15. Maximum width of elytra to maximum width of pronotum: 1.41–1.43.

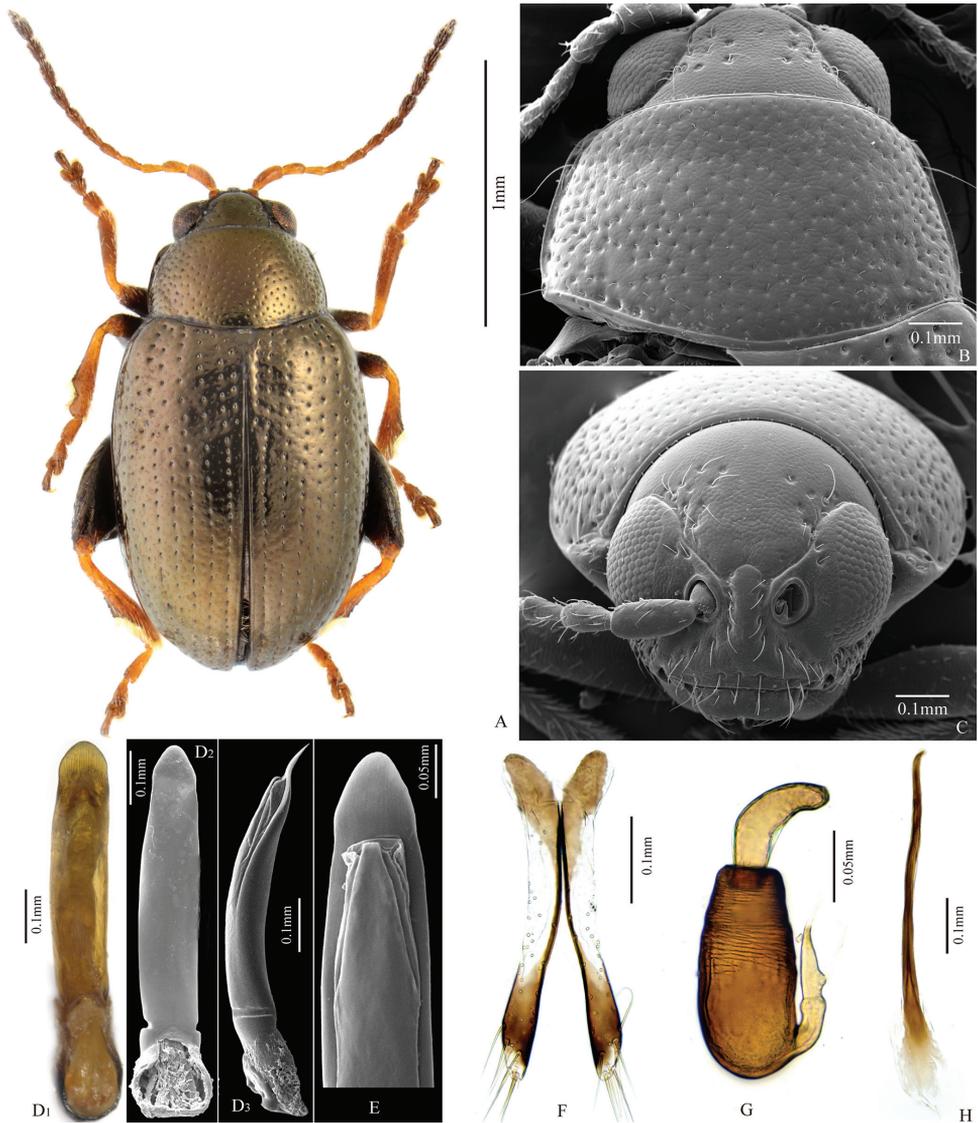


Figure 4. *Chaetocnema yulongensis*. **A** Male habitus **B** Prothorax, dorsal view **C** Head, frontal view **D1–D2** Adeagus, ventral view **D3** Adeagus, lateral view **E** Apical part of Adeagus, dorsal view **F** Vaginal palpus **G** Spermatheca **H** Tignum.

Color of elytron copperish, similar to color of pronotum and head. Antennomere 1 partly dark brown. Antennomeres 2–4 completely yellow. Antennomere 5 partly brown. The remaining antennomeres brown. Protibia partly brown. Meso- and metatibia partly brown. Femora brown.

Head hypognathous. Frontal ridge between antennal sockets narrow and convex. Frontolateral sulcus present. Orbital sulcus deep. Suprafrontal sulcus deep laterally,

shallow in middle. Suprafrontal sulcus obcordate. Ratio of width of frontal ridge (excluding margin) to width of antennal socket (excluding margin): 0.86–0.90. Width of orbital sulcus to width of frontolateral sulcus: 0.54–0.61. Numbers of punctures on vertex: 8–12. Numbers of punctures on orbit: 2. Numbers of hairs along frontolateral sulcus: 8–9. Numbers of hairs on frons (triangle area surrounded by frontolateral sulcus and clypeus): 0. Numbers of hairs on clypeus: 7. Numbers of hairs on labrum: 6. Anterior margin of labrum slightly concave in middle.

Base of pronotum with two obscure longitudinal impressions visible only near basal margin. Deep row of large punctures at base of pronotum present on sides, lacking in middle. Pronotal base evenly convex. Lateral sides of pronotum slightly convex with maximum width near base. Anterolateral prothoracic callosity protruding laterally, forming a round angle fronto-laterally. Posterolateral prothoracic callosity poorly developed. Diameter of pronotal punctures 2 to 4 times smaller than distance between them.

Elytra with convex sides. All rows of punctures regular and single including scutellar row. Elytral humeral callus well developed. Interspaces between stria of punctures smooth and glabrous. Numbers of lines of minute punctures on each interspace: 2.

First male protarsomere slightly larger than second one. First male protarsomere, length to width ratio: 1.64–1.70. First and second male protarsomeres, length to length ratio: 1.57–1.62. First and second male protarsomeres, width to width ratio: 1.03–1.04. First male protarsomere, width at apex to width at base: 1.53–1.58. Length of metatibia to distance between denticle and metatibial apex: 2.38–2.41. Large lateral denticle on metatibia sharp. Metatibial serration proximal to large lateral denticle present, obtuse. First male metatarsomere, length to width ratio: 2.63–2.73. First and second male metatarsomeres, length to length ratio: 1.91–2.04. First and second male metatarsomeres, width to width ratio: 0.93–0.96. Third and fourth male metatarsomeres, length to length ratio: 0.60–0.61.

Apical third of median lobe narrowing with polygonal line on sides. Apical part in ventral view narrowing abruptly. Ventral longitudinal groove absent. Apical denticle in ventral view absent. Minute transverse wrinkles of ventral side absent. Median lobe in lateral view evenly and slightly curved with apex sinuated. Maximal curvature in lateral view situated medially.

Spermathecal receptacle pear-shaped. Basal part of spermathecal duct straight. Spermathecal pump much shorter than receptacle. Apex of spermathecal pump cylindrical. Spermathecal pump attached to middle of receptacle top. Basal part of receptacle wider than apical. Posterior sclerotization of tignum spoon-shaped, wider than mid section. Mid section of tignum nearly straight. Anterior sclerotization of tignum narrower than mid section. Apex of vaginal palpus subdeltoid, with lateral sides slightly arching. Sides of mid part of vaginal palpus (before apex) narrowing from base, slightly widening towards apex. Anterior sclerotization of vaginal palpus narrowed at apex and base, widened at middle. Anterior end of anterior sclerotization narrowly rounded. Width of posterior sclerotization smaller than width of anterior sclerotization.

Type material. Holotype: 1♂, 1) China: Yulong Mountain, Lijiang, **Yunnan**, alt.2700m. 2) 1984.VII.21, Leg.Shuyong Wang; 3) Holotype, *Chaetocnema yulongensis* sp. n., Des. Ruan, Konstantinov, Yang . 2014. (IZCAS)

Paratypes (all in IZCAS, except those that are indicated as USNM or SYSU): 8♂10♀, China: Yulong Mountain, Lijiang, **Yunnan**, alt.2700m, 1984.VII.21, Leg. Shuyong Wang, 1♀ USNM; 2♂5♀, Gezha, Zhongdian, **Yunnan**, alt.3150m, 1981. VIII.4, Leg.Shuyong Wang, 1♂ USNM; 1♂5♀, Xiaozhongdian, **Yunnan**, alt.2500–3200m, 1984.VIII.5, Leg.Shuyong Wang; 4♀, Lidiping, Weixi, **Yunnan**, alt.3400m, 1984.VIII.13, Leg.Shuyong Wang, 1♀ USNM); 1♂, Fengyi, **Yunnan**, alt.2000m, 1955.VI.1, Leg.B. Popov; 2♂, Xiaguan, **Yunnan**, alt.2050m, 1955.V.30, Leg.B. Popov; 6♂, Kunming, **Yunnan**, alt.1900m, 1940.VII.4, Leg.J. L. Gressitt (SYSU).

***Chaetocnema deqinensis* Ruan, Konstantinov & Yang, sp. n.**

<http://zoobank.org/A17ADFB8-C1C3-4E3B-8A51-A3307B8F1A83>

Figure 5

Etymology. This species is named after the type locality situated in Deqin county of Yunnan province.

Host plants. *Duchesnea indica* (Andr.) Focke (Rosaceae).

Distribution. Guizhou, Yunnan.

Diagnosis. *Chaetocnema deqinensis* resembles *C. yulongensis*. It can be separated from the latter by the following characters: maximal curvature of median lobe in lateral view situated close to apex; apical end of median lobe broadly rounded; suprafrontal sulcus absent in middle. In *C. yulongensis*, maximal curvature of median lobe in lateral view situated medially; apical end of median lobe narrowly rounded; suprafrontal sulcus obtuse in middle.

Description. Body length: 1.80–2.15 mm, without head: 1.60–1.95 mm. Body width: 0.90–1.10 mm. Length of antenna to length of body: 0.64–0.65 mm. Elytron length (along suture) to width (maximum): 2.40–2.60. Pronotum width (at base) to length: 1.60–1.60. Length of elytron to length of pronotum (along middle): 2.95–2.97. Width of elytra at base (in middle of humeral calli) to width of pronotum at base: 1.14–1.15. Maximum width of elytra to maximum width of pronotum: 1.46–1.48.

Color of elytron bronzy, similar to color of pronotum and head. Antennomere 1 partly dark brown. Antennomeres 2–4 completely yellow. Antennomere 5 partly brown. The remaining antennomeres brown. Tibia partly brown. Profemora and mesofemora light brown. Metafemora brown.

Head hypognathous. Frontal ridge between antennal sockets narrow and convex. Frontolateral sulcus present. Suprafrontal sulcus deep laterally, absent in middle. Orbital sulcus deep. Ratio of width of frontal ridge (excluding margin) to width of antennal socket (excluding margin): 1.04–1.07. Width of orbital sulcus to width of frontolateral sulcus: 0.88–0.90. Numbers of punctures on vertex: 8–10. Numbers of punctures on orbit: 4. Numbers of hairs along frontolateral sulcus: 9–10. Numbers of

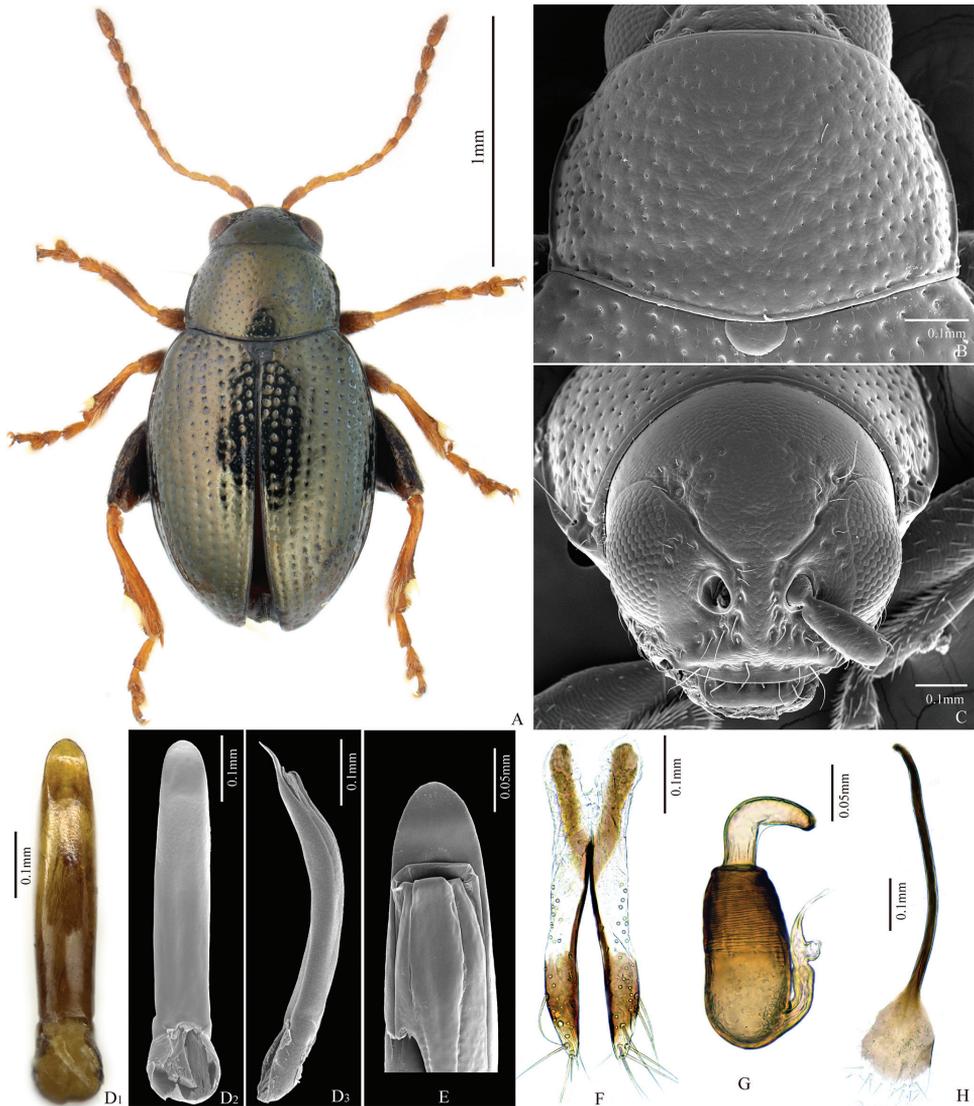


Figure 5. *Chaetocnema deginensis*. **A** Male habitus **B** Prothorax, dorsal view **C** Head, frontal view **D1–D2** Adeagus, ventral view **D3** Adeagus, lateral view **E** Apical part of Adeagus, dorsal view **F** Vaginal palpus **G** Spermatheca **H** Tignum.

hairs on front (triangle area surrounded by frontolateral sulcus and clypeus): 0. Numbers of hairs on clypeus: 9. Numbers of hairs on labrum: 6. Anterior margin of labrum slightly concave in middle.

Base of pronotum with two obscure longitudinal impressions visible only near basal margin. Deep row of large punctures at base of pronotum present on sides, lacking in middle. Pronotal base evenly convex. Lateral sides of pronotum slightly convex with maximum width near base. Anterolateral prothoracic callosity protruding laterally,

forming a round angle frontolaterally. Posterolateral prothoracic callosity poorly developed. Diameter of pronotal punctures 2 to 4 times smaller than distance between them.

Elytra with convex sides. All rows of punctures on elytron regular and single. Interspaces between stria of punctures smooth and glabrous. Numbers of lines of minute punctures on each interspace: 2. Elytral humeral callus well developed.

First male protarsomere slightly larger than second. First male protarsomere, length to width ratio: 1.80–1.86. First and second male protarsomeres, length to length ratio: 1.51–1.57. First and second male protarsomeres, width to width ratio: 0.90–0.92. First male protarsomere, width at apex to width at base: 1.60–1.90. Length of metatibia to distance between denticle and metatibial apex: 2.30–2.80. Large lateral denticle on metatibia sharp. Metatibial serration proximal to large lateral denticle present, obtuse. First male metatarsomere, length to width ratio: 2.68. First and second male metatarsomeres, length to length ratio: 1.60–1.70. First and second male metatarsomeres, width to width ratio: 0.83–0.85. Third and fourth male metatarsomeres, length to length ratio: 1.45–1.60.

Apical part of median lobe in ventral view narrowing abruptly with obscure polygonal line on sides. Ventral surface of apical fourth of median lobe deeply concave. Ventral longitudinal groove absent. Apical denticle in ventral view absent. Minute transverse wrinkles on ventral side absent. Median lobe in lateral view unevenly curved, sinusoidal near apex. Maximum curvature in lateral view situated apically.

Spermathecal receptacle pear-shaped. Basal part of spermathecal duct straight. Spermathecal pump much shorter than receptacle. Apex of spermathecal pump cylindrical. Spermathecal pump attached to middle of receptacle top. Basal part of receptacle wider than apical. Posterior sclerotization of tignum spoon-shaped, wider than mid section. Mid section of tignum nearly straight or slightly curved. Anterior sclerotization of tignum about as wide as mid section. Apex of vaginal palpus subdeltoid, with lateral side slightly arching. Sides of mid part of vaginal palpus (before apex) narrowing from base, slightly widening towards apex. Anterior sclerotization of vaginal palpus nearly parallel. Anterior end of anterior sclerotization narrowly rounded. Length of posterior sclerotization greater than width. Width of posterior sclerotization greater than width of anterior sclerotization.

Type material. Holotype: 1♂, China, east slope of Baiman snow mountain, Deqin, **Yunnan**, Alt.3300m, 28.VIII.1981, Leg. Shuyong Wang, host: *Duchesnea indica*. "*Chaetocnema deqinensis* sp. n., Des. Ruan et al. 2014".

Paratypes (all in IZCAS, except those that are indicated as USNM): 8♂23♀, Baiman snow mountain, Deqin, **Yunnan**, Alt.3300m, 28.VIII.1981, Leg. Shuyong Wang, host: *Duchesnea indica*, 1♀ (USNM); 1♂, Liuku, **Yunnan**, Alt.900m, 13.VI.1981, Leg. Shuyong Wang; 1♂, Zhiben Mountain, Yunlong, **Yunnan**, Alt.2250m, 21.VI.1981, Leg. Shuyong Wang; 1♂1♀, Xinzhu, Ludian, Lijiang, **Yunnan**, Alt.2800m, 29.VII.1981, Leg. Shuyong Wang; 1♀, Baoshan, **Yunnan**, Alt.1500m, 18.VI.1981, Leg. Shuyong Wang; 1♂, Heilongtang, Kunming, **Yunnan**, Alt.2000m, 14.V.1981, Leg. Shuyong Wang (USNM); 1♂4♀, Tsengyih, Meitan, **Guizhou**, 15.VII.1940, Leg. Gressitt (SYSU).

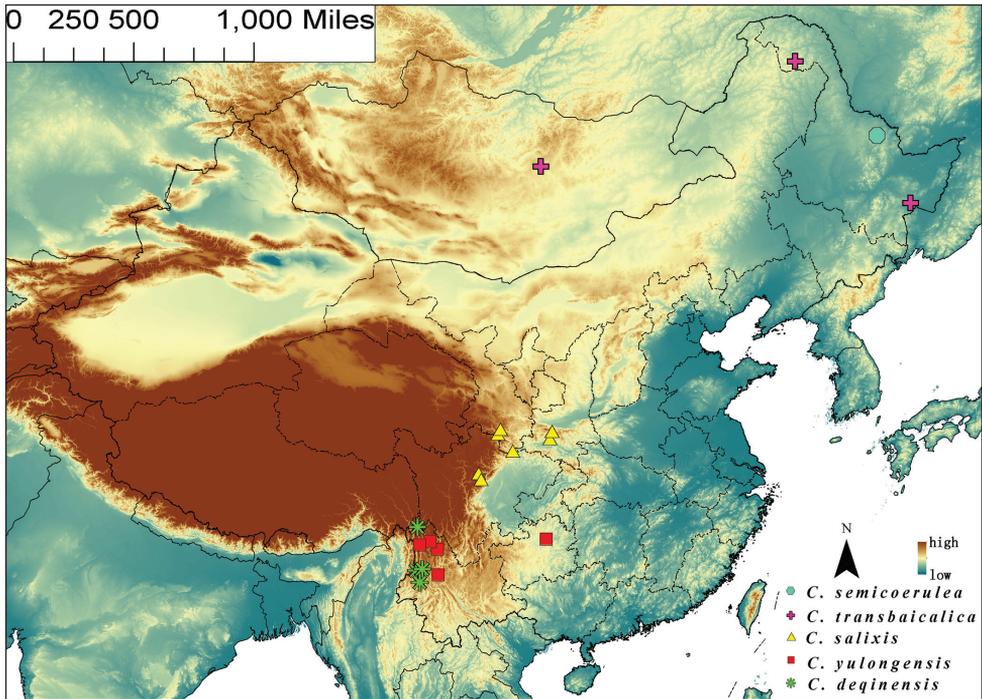


Figure 6. Map of mainland China, illustrating species distribution; *C. semicoerulea* = blue octagon; *C. transbaicalica* = purple crosses; *C. salix* = yellow triangles; *C. yulongensis* = red squares; *C. deqinensis* = green stars.

Acknowledgement

This research was supported by grants from the National Science Foundation of China to Xingke Yang (PI, Grant No. 3010300101 and Grant No. 31372239); the National Science Fund for Fostering Talents in Basic Research (Special Subjects in Animal Taxonomy, NSFC-J1210002).

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***Bembidion* (?*Nipponobembidion*) *ruruy* sp. n., a new brachypterous ground beetle (Coleoptera, Carabidae) from Kunashir Island, Kuriles, Russia**

Kirill V. Makarov¹, Yuri N. Sundukov²

1 Department of Zoology and Ecology, Moscow State Pedagogical University, 129164 Moscow, Russia **2** State Nature Reserve “Kurilskiy”, 694500 Yuzhno-Kurilsk, Sakhalinskaya oblast’, Russia

Corresponding author: Kirill V. Makarov (kvmac@inbox.ru)

Academic editor: *Achille Casale* | Received 27 August 2014 | Accepted 18 November 2014 | Published 12 December 2014

<http://zoobank.org/3A621F02-484B-4943-BA6B-800A565428E5>

Citation: Makarov KV, Sundukov YN (2014) *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n., a new brachypterous ground beetle (Coleoptera, Carabidae) from Kunashir Island, Kuriles, Russia. ZooKeys 463: 75–93. doi: 10.3897/zookeys.463.8504

Abstract

A new species, *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n., is described from the foot of Ruruy Volcano, Kunashir Island, Kuril Archipelago, Russia. It is only the second consubgener, being characterized by the reduced wings, the rounded elytral shoulders, and the backward position of the posterior supra-orbital pore. In this connection, the subgenus *Nipponobembidion* Habu & Baba, 1968 is rediagnosed and both of its species are keyed. It might have originated from *Plataphodes* Ganglbauer, 1891, possibly in relation to volcanic activities in the region.

Keywords

Bembidion, Bembidiini, Trechitae, morphology, taxonomy, relict, Kuril Archipelago, volcano, faunogenesis

Introduction

The carabid fauna of Kunashir Island, Kuriles, Russia, can be considered as well-known (see review by Lafer 2002), comprising, according to our data, at least 150 species. Despite the small size of the island and the narrow straits separating it from the neighbouring islands, there are several subendemic taxa. The genus *Bembidion* Latreille, 1802 alone, based on our data, is represented on Kunashir by 23 species, none of which has hitherto been regarded as endemic.

In the summer of 2013, a small series of a remarkable brachypterous *Bembidion* were collected in the northern part of Kunashir Island, and description is provided below.

Materials and methods

Standard methods were applied for treating the material. Genitalia were mounted on permanent slides using the Faure-Berlese medium. External characters were studied with the help of MBS-1 and Leica M165C stereoscopes, the genitalia examined under MBR-15 and Micromed 2, version 2–20 compound microscopes. Pictures were taken using a Canon EOS 5D Mark III camera with a Canon MP-E 65 mm objective lens and a Canon PowerShot A640, while the extended focus images by means of the Zerene Stacker software.

The abbreviations used in text are as follows:

EL	greatest length of elytra;
EW	greatest width of elytra;
HL	length of head, measured along the median line from fore margin of clypeus to rear edge of the temples;
HW	greatest width of head;
L	body length from fore margin of clypeus to elytral apex;
Ls	sum of HL, Pl(t) and EL;
PA	width of pronotal apex;
PB	width of pronotal base;
PL(m)	length of pronotum, measured along the median line;
PL(t)	greatest length of pronotum;
PW	greatest width of pronotum;
M	arithmetic mean.

Designations of the sclerotized parts of the aedeagus are given after Maddison (1985). Female reproductive tract characters follow the terminology of Liebherr and Will (1998). Abbreviations given in the illustrations are the following:

AG	apical gonocoxite;
BC	bursa copulatrix;
BS	brush sclerite;
DP	dorsal plate;
FL	flagellum;
FS	flagellar sheath;
LD	latero-distal sclerite;
OP	ostial microtrichial patch;
RL	right lobe of central sclerite complex;
SD	spermathecal duct;

SG spermathecal gland;
SP spermatheca;
VSP ventral sclerite patch.

The material has been shared between the collections of the Zoological Institute, Russian Academy of Sciences, St. Petersburg (ZISP) and the Moscow State Pedagogical University (MSPU), as well as in the private collection of the second author, kept in Lazo, Maritime Province, Russia (CSLR).

Taxonomy

Bembidion (?*Nipponobembidion*) *ruruy* sp. n.

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Figs 1–5

Holotype ♂ with labels: “Northern Kunashir, 2.5 km NW of Cape Nelyudimiyi, N44°29.433', E146°11.783', 4.VIII.2013, leg. K. Makarov & Y. Sundukov” and “HOLOTYPE *Bembidion* (*Nipponobembidion*) *ruruy* Makarov & Sundukov 2014 [printed on red paper]”.

The specimen is deposited in ZISP, the genitalia mounted on a slide in Faure-Berlese medium are pinned beneath.

Paratypes. 4 ♂, 3 ♀ from northern Kunashir, 2.5 km NW of Cape Nelyudimiyi, N44°29.433', E146°11.783', 4.VIII.2013, leg. K. Makarov & Y. Sundukov; [1 ♀ — ZISP, 1 ♂, 1 ♀ — MPSU, 3 ♂, 1 ♀ — CSRL]; 1 ♂ from northern Kunashir, mouth of Dokuchaev River, N44° 30.317', E146°10.800', 30.VII.2013, leg. Y. Sundukov [CSLR].

Type locality. RUSSIA: Kuril Archipelago: Kunashir Island, at the foot of Ruruy Volcano.

Etymology. The species epithet is a Latinized noun in apposition to reflect the name of the volcano at the foot of which the new species was found.

Description. Body faintly convex. Length 4.1–5.1 mm, width 1.4–2.1 mm.

Head and pronotum black, elytra black- or dark brown, entire upperside with a faint bronze or bluish lustre. Head appendages: antennae black-brown with lighter bases of antennomeres 2–4; palpi black with yellowish apical palpomeres; mandibles entirely brown or with lighter apices; labrum dark brown. Underside black or dark brown. Legs black or black-brown with lighter pro- and mesotrochantera, as well apical parts of metatarsi; all tibiae and tarsi brown (Fig. 1).

Upperside devoid of punctuation, only basal pits of pronotum with a few small punctures at bottom. Dorsal microsculpture of head, including clypeus and labrum, with rough isodiametric meshes especially rough inside frontal furrows. Disc of pronotum finely microsculptured, with transverse meshes growing isodiametric and rougher like on head towards margins (Fig. 2A, B). Elytra with a very delicate, transverse microsculpture; the latter near basal elytral margin isodiametric and rougher. Head appendages and

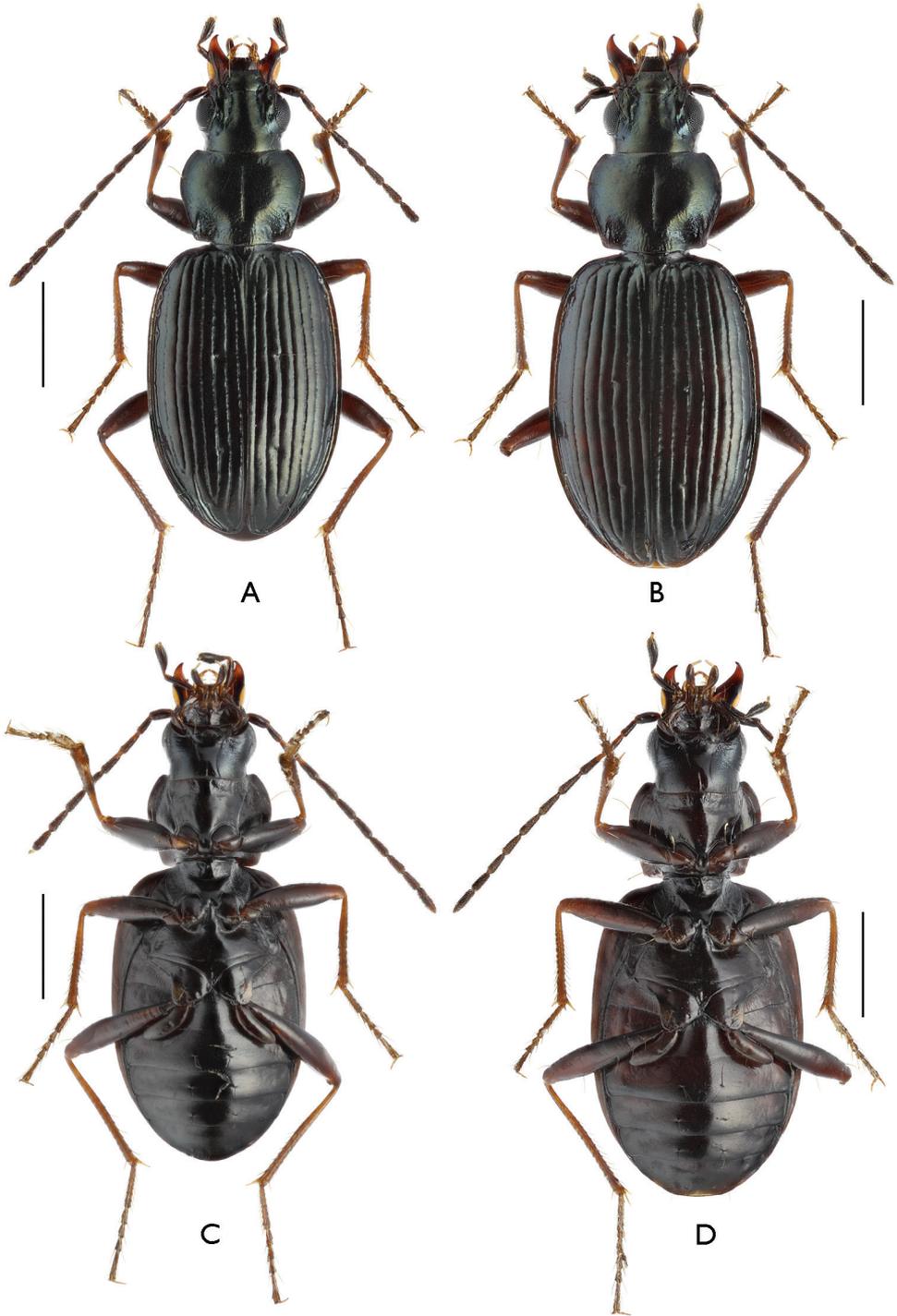


Figure 1. Habitus of *Bembidion* (?*Nipponobembidion*) *rury* sp. n., dorsal (A, B) and ventral (C, D) views. Scale bars 1.0 mm. A, C male, holotype B, D female, paratype.

extremities with a distinct microsculpture of broad meshes. Microsculpture of pleurites and sternites isodiametric, strongly obliterated at edges of abdominal sternites.

Standard dimensions (mm): HW 0.78–0.95 (M 0.87); HL 0.58–0.74 (M 0.62); PA 0.75–0.94 (M 0.84); PW 1.03–1.30 (M 1.16); PB 0.80–0.95 (M 0.89); PL(t) 0.88–0.99 (M 0.92); PL(m) 0.83–0.95 (M 0.87); EW 1.60–2.05 (M 1.86); EL 2.38–3.05 (M 2.64); Ls 3.84–4.90 (M 4.18); L 4.10–5.10 (M 4.6).

Head not flattened, together with eyes 1.29–1.42 times as broad as long. Eyes moderately convex. Antennae long, in ♂ as long as elytra, in ♀ 0.90–0.95 their length. Mandibles small, with pointed apices. Labrum trapeziform, with six setae along fore margin. Clypeus trapeziform, with two long setae in fore angles. Tooth of mentum large, edged, broadly rounded at apex; mentum with two setae at base. Submentum with two pairs of large setae, external ones being shorter. Gula in basal 1/3 with a deep, thin, longitudinal sulcus (Fig. 2C, D). Temples short, about 1/3 as long as eye diameter. Two supra-ocular setae: one near the middle of eye, the other behind its caudal margin. Frontal furrows non-diverging, parallel, broad, groove-like, expressed from caudal eye margin nearly up to setae on clypeus. Space between frontal furrow and lateral edge of frons convex, not keel-shaped.

Pronotum (Fig. 2A, B) moderately convex, faintly cordiform, transverse (PW/PL(t) = 1.24–1.33 (M 1.29), PW/PL(m) = 1.28–1.37 (M 1.31), broader than head (PW/HW = 1.31–1.37 (M 1.34), broadest at 3/5 off base. Front margin slightly concave, its fine edging broadly interrupted in the middle. Fore angles faintly produced forward, their apices narrowly rounded. Base faintly convex, at basal pits slightly concave and vaguely edged, a little broader than fore margin (PB/PA = 1.01–1.10, M 1.06). Hind angles not produced, obtuse, slightly skewed forward, rounded at apices. Lateral sides in anterior half moderately convex and regularly rounded, in posterior half rectilinearly narrowed towards hind angles. Lateral margins narrowly edged. Two lateral setae on each side: one in front of maximal breadth, the other at caudal angle. Transverse impressions faint. Basal fovea rather large, roundly triangular, flattened and moderately rugose inside, delimited outside by a faint keel.

Elytra oblong-oval, rather large, broad (EL/EW = 1.39–1.69 (M 1.42), EL/PL(t) = 2.70–3.11 (M 2.91), EW/PW = 1.55–1.67 (M 1.59), slightly convex, broadest at 2/3 of elytral length. Shoulder not protruding, broadly rounded. Basal margin reaching apex of 4th (4 specimens) or 5th (5 specimens) stria, near shoulder arcuated and gradually turning into lateral margin. Lateral margin flattened and narrow. External apical angle broadly rounded. Striae complete, moderately deep, non-punctate, interspaces faintly convex; stria 7 either well-developed or superficial and faint in anterior half, but evident throughout; stria 8 fused to 9th about midway of series umbilicata (Fig. 3A, B). Subscutellar stria rather short, placed inside interspace 1. Subscutellar pore placed at junction of striae 1 and 2. Interval 3 with two well-expressed discal pores lying at stria 3: frontal at ca 2/5, caudal at ca 2/7, off base. Apical stria deep, cariniform, uninterrupted, fused to 5th stria, carrying two setigerous pores: one at apex, the other opposite stria 4. Series umbilicata consisting of eight setae: four in humeral group, and two each in the middle and at apex (Figure 3A, B).



Figure 2. Head and pronotum of *Bembidion* (?*Nipponobembidion*) *rury* sp. n., dorsal (A, B) and ventral (C, D) view. Scale bars 0.5 mm. A, C male, holotype B, D female, paratype.

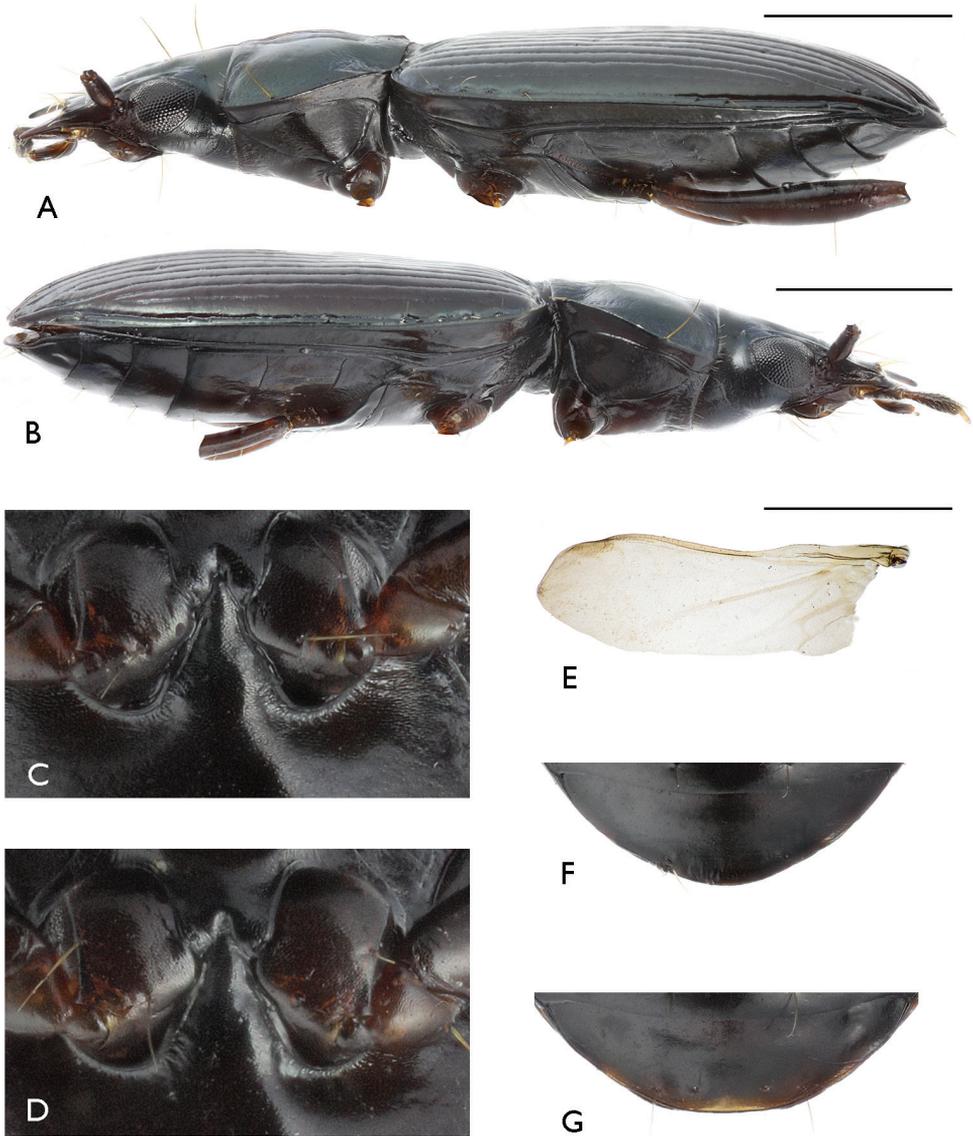


Figure 3. *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n. Scale bars 1.0 mm. **A, C, E, F** male, holotype **B, D, G** female, paratype **A, B** body, lateral view (extremities not shown) **C, D** metacoxae and metepisternal process, ventral view **E** hindwing **F, G** anal sternite, ventral view.

Hindwings (Fig. 3E) shortened, 0.65–0.54 times as long as elytra. Among longitudinal veins only larger ones retained, basal parts of *R*, *CuA*, *CuP*, *AA*₃ and *AP*₁₊₂ being well-expressed while *MP* poorly visible. Transverse veins represented by *r*₁ and *r*₂, both only incompletely delimiting an *rc* cell (designations after Fedorenko 2009).

Legs moderately long, slender; metatarsus subequal in length to metatibia. All tibiae and meso- and metatarsomeres 1 with distinct longitudinal furrows. Meso- and

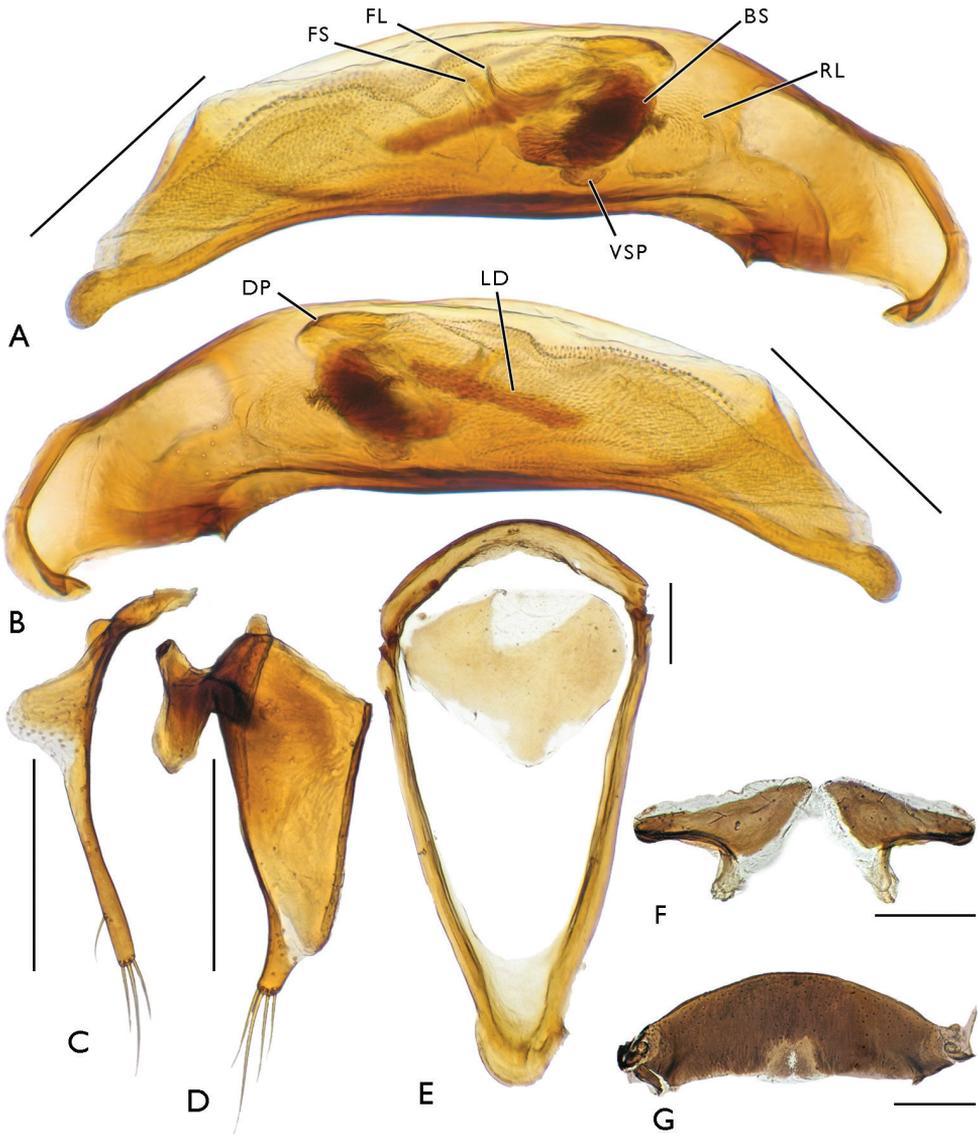


Figure 4. Male genital apparatus of *Bembidion* (?*Nipponobembidion*) *rury* sp. n., holotype. Scale bars 0.25 mm. **A** aedeagus, right side **B** aedeagus, left side **C** right paramere **D** left paramere **E** sternite 9, ventral view **F** sternite 8 **G** tergite 8.

metatarsomeres 3 and 4 with short dorsal keels. Claws thin, about 0.6 times as long as last tarsomere. Meso- and metafemora with 4 setae near caudal margin. Ventro-apical setae of penultimate tarsomere long, reaching beyond 2/3 of claw length.

Underside non-punctate (Fig. 1C, D). Metasternal process narrowly bordered only on sides (Fig. 3C, D). Metepisterna shortened: external margin 1.5 times as long as breadth along fore margin (1 ♂ and 1 ♀ measured). Metacoxae with three setae.

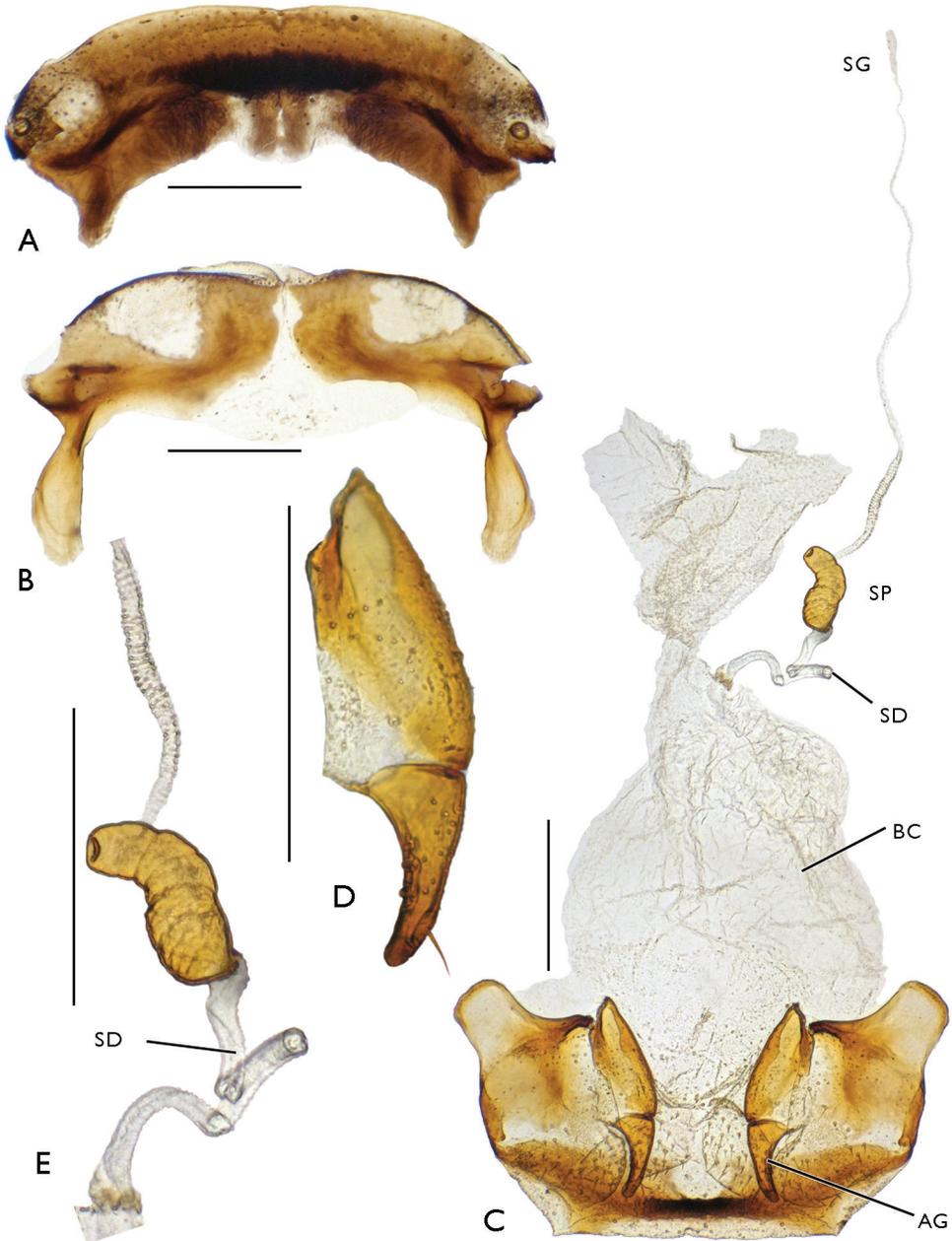


Figure 5. Female genital apparatus of *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n., paratype. Scale bars 0.25 mm. **A** tergite 8 **B** sternite 8. **C** genital apparatus **D** left gonocoxite **E** spermatheca.

Metatrochantera with one seta midway. Abdominal sternites simple, with neither pubescence nor additional setae; apical sternite at apex with two setae in ♂, four setae in ♀ (Fig. 3F, G).



Figure 6. Habitat of *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n., northern Kunashir, 2.5 km NW of Cape Nelyudimyi (N44°29.433', E146°11.783').

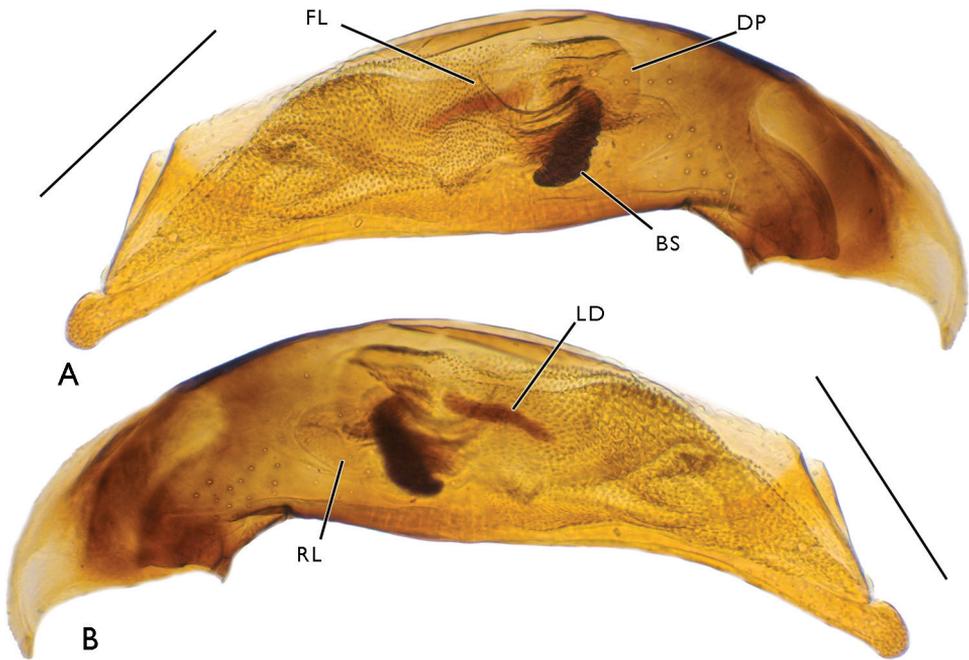


Figure 7. Aedeagus of *Bembidion* (*Plataphodes*) *tetraporum* Bates, 1883. Scale bars 0.25 mm. **A** right side **B** left side.

Aedeagus rather slender, its ventral margin faintly curved, apex moderately broad, rounded. Central sclerite complex (CSC) of endophallus with a large brush sclerite and a rather short, S-shaped flagellum with an adjacent flagellar sheath. Right lobe of CSC poorly sclerotized, distinctly microsculptured, reaching down to basal notch of aedeagus. Left lobe small, sclerotized, devoid of a marked sculpture. Ventral sclerite patch small, lying beneath bush sclerite. Ostial microtrichial patch well-developed. Left part of endophallus with two additional structures: a short row of spinicles located level to brush sclerite and a rather long laterodistal sclerite formed by fused cuticular scales (Fig. 4A, B). Left paramere broad (Fig. 4D), with four (one long in the middle and three short) setae at apex; right paramere (Fig. 4C) narrow, with three (one long in the middle and two short) apical setae and one short subapical seta on ventral side.

Female genital apparatus as in Fig. 5. Apical segment of gonocoxite with 1–2 long, subapical, external setae and 2–3 ensiform setae in basal half of external margin (Fig. 5D). Copulatory bursa oval, without additional sclerites, about 1.5 times as long as broad. Duct of spermatheca long, fluted, terminating inside copulatory bursa ventrolaterally. Spermatheca (Fig. 5E) well-sclerotized, elongated and clearly curved, 1.5–2.0 times as broad as duct. Glandular duct long, entering inside distal part of spermatheca.

Distribution. Kunashir Island, southern Kuriles, Russia; known only from the island's northern part at the foot of Ruruy Volcano.

Habitats. Much of the type series was taken inside a water-logged gravel-clay mixture and in crevices of a wet rocky cliff at the bank of a mountain stream running through a narrow mudslide-formed canyon (Fig. 6). The same places yielded abundant *B. (Plataphodes) tetraporum* Bates, 1883, *B. (Ocydromus) dolorosum* (Motschulsky, 1850) and *Nebria (Nakanebria) shibanaii* Uéno, 1955.

Comparative notes. The shape of the head and pronotum, the elytral chaetotaxy pattern, and the complex of characters related to flight loss (shortened elytra, obliterated elytral shoulder, short metepisterna) allow for *B. ruruy* sp. n. to be assigned to the hitherto monobasic Japanese subgenus *Nipponobembidion* Habu & Baba, 1968. However, the new taxon differs significantly from *Bembidion ainu* Habu & Baba, 1968, the type species of that subgenus, by its habitus, endophallus armament, and perhaps also its paramere chaetotaxy, the left paramere in the sole male *B. ainu* known to date carrying only one apical seta. The following key can be proposed.

Key to the species of *Nipponobembidion* Habu & Baba, 1968

- 1 Larger (4–5 mm), upperside monochromous, black or brown with metallic lustre; legs and antennae monochromous, dark brown. Metepisterna elongated, external margin 1.5 times as long as breadth along fore margin. Metasternal process not edged at apex. Kunashir, Ruruy Volcano ***B. ruruy* sp. n.**
- Smaller (3–3.5 mm), head and pronotum black, elytra brown to red-brown; antennomere 1 and legs light, reddish. Metepisterna very short, external margin only 1.12 times as long as breadth along fore margin. Metasternal process entirely edged. Hokkaido, Daisetsu Volcano..... ***B. ainu* Habu & Baba**

Discussion

In spite of the considerable similarity between *B. ainu* and *B. ruruy* sp. n. related to wing reduction, as well as the chaetotaxy pattern peculiarities, these species differ by a number of significant characters. Furthermore, the metasternal process in *B. ainu* is entirely edged, the basal edging of the elytra only reaching the 4th stria while the endophallus armament is different.

The presence or absence of an edging on the anterior process of the metathorax is traditionally significant when taxonomically sorting out the *Plataphus*-complex (*Plataphus* Motschulsky, 1864, *Plataphodes* Ganglbauer, 1891, *Trichoplataphus* Netolitzky, 1914, *Blepharoplataphus* Netolitzky, 1920) and the *Ocydromus*-complex (*Ocydromus* Clairville, 1806, *Peryphus* Dejean, 1821, *Asioperiphus* Vysoký, 1986 and allied groups). Based on the above distinctions, *B. ainu* and *B. ruruy* sp. n. could be treated as belonging to different species groups of *Bembidion*, suggesting parallel developments related to wing reduction.

It is noteworthy, however, that the significance of that character has repeatedly been questioned. Thus, in the recent review of the phylogeny of *Bembidion* by Maddison (2012), the subgenera *Plataphus* and *Plataphodes*, as well as the “*simplex*” and “*kuprianovi*” species groups (in the sense of Lindroth 1963) are united within the larger *Plataphus*-complex, even though in the latter two groups the anterior process of the metathorax is completely edged through a sharp arcuate impression in front of the apex, like the condition observed in numerous species from the *Ocydromus*-complex.

The basal edging of the elytra in *B. ruruy* sp. n. appears to vary: in approximately half of the specimens from the type series it reaches the 4th stria, versus the 5th in the remaining individuals.

The differences in endophallus armament seem to be considerable when comparing *B. ruruy* sp. n. to the description of *B. ainu*. Regrettably, since the aedeagus sketch contained in the original description (Habu and Baba 1968: 146) fails to show a number of important details, it appears impossible to provide a thorough comparison between these two species, based on endophallus characters. Even though we are inclined to assign *B. ruruy* sp. n. to the subgenus *Nipponobembidion* Habu & Baba, 1968, we prefer to question this placement now, because the diagnosis of that subgenus as formulated by Habu and Baba (1968) would otherwise require several amendments.

When describing *B. ainu*, Habu and Baba (1968) noted that the length of the basal edging of the elytra, coupled with several other structural details, bring it closer to species of the subgenus *Plataphodes*. Based on a number of habitus features, as well as several other taxonomically important characteristics, the new species from Kunashir likewise seems to be similar to representatives of the subgenera *Plataphus* and *Plataphodes* in the sense of many authors (Netolitzky 1943, Habu 1973, Kryzhanovskij 1983, Kryzhanovskij et al. 1995, Marggi et al. 2003, Toledano 2008, 2009, Toledano and Nakládal 2011). The resemblance is particularly striking as regards the endophallus structure which *B. ruruy* sp. n. shares with the syntopic *B. tetraporum*: the central

sclerite complex is nearly identical, a considerable difference being only observed in the length of the left laterodistal sclerite (Fig. 7).

Inasmuch as the main differences between *Nipponobembidion* and *Plataphodes* are related to the former's wing reduction (and, consequently, shortened metepisterna and obliterated elytral humeri), also lying in body shape, *Nipponobembidion* seems best to be considered as a rather local and highly specialized derivative of *Plataphodes*. In assigning *B. ruruy* sp. n. to *Nipponobembidion*, one must also consider its geographical proximity to *B. ainu*, let alone the same geological and palaeogeographical background.

According to many authors (Velizhanin 1970, Briggs 1974, Korotkii et al. 1977, Korotkii 1985, Ota and Machida 1987, Levina and Grachev 1998, Bezverkhii et al. 2002, Pietsch et al. 2003, Bogatov et al. 2006, Vasilevskii 2008), during nearly the entire Pleistocene the Kunashir Island was connected to Hokkaido. Towards the Early Pleistocene (2.6 My), Sakhalin, Hokkaido and the southern Kuriles formed a large peninsula. The coastline of the Sea of Okhotsk in the Early Pleistocene (1.8 My) was close to the present-day one, all following changes in land area depending on climatic fluctuations.

A considerable sea transgression which was due to climate warming in the Late Pleistocene (130,000–70,000 y) separated Kunashir from Hokkaido, but the following two waves of cold (60,000–40,000 and 22,000–11,000 y) divided by a moderately warm climate resulted in a restored land connection of these two islands. In the Late Würm (15,000–13,000 y), another, rapid climate warming occurred, during which the rates of ice melting and sea-level rise dragged far behind climate change. The most intense interchanges of thermophilous biotic elements, especially those from Hokkaido to Kunashir, are believed to have taken place then, of course until the rising sea restored their isolation towards the mid-Holocene.

Pietsch et al. (2003), giving a biogeographical evaluation of the southern Kurile biota, noted that the modern flora and fauna of the islands are characterized by a high level of species diversity and a low degree of endemism. These authors considered this as an example of a “non-relict” genesis of the biome. The main roles in the formation of southern Kuriles' biodiversity might have been played by migrations from Hokkaido. Even though during the entire Late Pleistocene no traces of a cover glaciation have been revealed, to a considerable degree the modern taxonomic composition of each of the island's biota could have depended on the pioneer volcanic landscapes and on the presence of refugia on the volcanoes' slopes in the form of thermal waters and fumarola fields (Razzhigaeva and Ganzei 2004). As a good example is the beetle *Bembidion* (*Ocydromus*) *negrei* Habu, 1958, known from several localities in Hokkaido and Honshu, but recorded on Kunashir Island only in thermal habitats in the caldera of Golovnin Volcano (Morita 2010, Ogawa 2014).

The above information concerning the morphological structure and geographical distribution of *Nipponobembidion*, coupled with the background geological and palaeoclimatic chronologies, suggests that this subgenus could have had a common ancestor with *Plataphodes*. Both currently known species of *Nipponobembidion* are only known from slopes of active volcanoes (Kimoto and Yasuda 1995, Masumoto 1980) showing fumarola and other thermal activities. Yet both differ considerably from each other,

also suggesting their relict statuses. One may surmise that initially the ancestral form or forms could have been distributed over a single land mass composed of Sakhalin, Hokkaido and the southern Kuriles, with following cold climate phases reducing their ranges to one or a few fragments still confined to active volcanoes. It is remarkable that no *Nipponobembidion* has been found south of Hokkaido, albeit of Japan is fairly well known carabid fauna. This only supports our suggestion that thermal refugia may have played key roles in the formation of that subgenus. It seems as though, along with shrinking distributions, the ancestral populations could have switched to dwelling inside rocky and gravelly grounds on warmed patches near fumarola fields and thermal water outlets. This might have been followed by wing reduction, shortened metepisterna, and rounded humeral angles of the elytra. The relatively small eyes developed as the result of a semi-endogean lifestyle might have led to a caudad shift of the posterior supra-ocular setae while flattened elytral striae to a reduced size of discal pores. To summarize, *B. rurus* sp. n. can be regarded as a relict element in the Kunashir fauna, most probably Late Pleistocene in age.

Acknowledgements

The authors are most grateful to the administration and staff of the Kurile State Nature Reserve, due to whose help a very interesting material could be obtained in the northern part of Kunashir Island. We are obliged to S. Morita for interesting data on the distribution of *Bembidion* on Hokkaido, as well as to two anonymous reviewers for their important suggestions to improve our paper. Special thanks go to I. A. Belousov (St. Petersburg) and O. L. Makarova (Moscow) who provided most useful reviews of advanced drafts. S. I. Golovatch (Moscow) kindly helped us edit the English.

This work was financially supported by the Ministry of Education and Science of the Russian Federation (project 6.632.2014 / K).

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Supplementary material I

Habitus of *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n. female paratype, dorsal

Authors: Kirill V. Makarov, Yuri N. Sundukov

Data type: Image file.

Explanation note: This image correspond to Fig. 1B in article.

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Supplementary material 2

Habitus of *Bembidion* (?*Nipponobembidion*) ruruy sp. n. female paratype, ventral

Authors: Kirill V. Makarov, Yuri N. Sundukov

Data type: Image file.

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Supplementary material 3

Habitus of *Bembidion* (?*Nipponobembidion*) ruruy sp. n. female paratype, lateral

Authors: Kirill V. Makarov, Yuri N. Sundukov

Data type: Image file.

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Supplementary material 4

Habitus of *Bembidion* (?*Nipponobembidion*) ruruy sp. n. male holotype, dorsal

Authors: Kirill V. Makarov, Yuri N. Sundukov

Data type: Image file.

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Supplementary material 5

Habitus of *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n. male holotype, ventral

Authors: Kirill V. Makarov, Yuri N. Sundukov

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Supplementary material 6

Habitus of *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n. male holotype, lateral

Authors: Kirill V. Makarov, Yuri N. Sundukov

Data type: Image file.

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Supplementary material 7

Male genital apparatus of *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n., holotype: aedeagus, left side

Authors: Kirill V. Makarov, Yuri N. Sundukov

Data type: Image file.

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Supplementary material 8

Male genital apparatus of *Bembidion* (?*Nipponobembidion*) *ruruy* sp. n., holotype: aedeagus, right side

Authors: Kirill V. Makarov, Yuri N. Sundukov

Data type: Image file.

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When DNA barcoding and morphology mesh: Ceratopogonidae diversity in Finnmark, Norway

Elisabeth Stur¹, Art Borkent²

1 Norwegian University of Science and Technology, NTNU University Museum, Department of Natural History, NO-7491 Trondheim, Norway **2** Art Borkent, Research Associate of the Royal British Columbia Museum, the American Museum of Natural History, and Instituto Nacional de Biodiversidad, 691-8th Ave. SE, Salmon Arm, British Columbia, V1E 2C2, Canada

Corresponding author: *Elisabeth Stur* (elisabeth.stur@ntnu.no)

Academic editor: *V. Blagoderov* | Received 28 May 2014 | Accepted 12 November 2014 | Published 12 December 2014

<http://zoobank.org/D464F276-E99E-4157-94F8-BF5DBE0E6898>

Citation: Stur E, Borkent A (2014) When DNA barcoding and morphology mesh: Ceratopogonidae diversity in Finnmark, Norway. ZooKeys 463: 95–131. doi: 10.3897/zookeys.463.7964

Abstract

DNA barcoding in Ceratopogonidae has been restricted to interpreting the medically and veterinary important members of *Culicoides* Latreille. Here the technique is utilised, together with morphological study, to interpret all members of the family in a select area. Limited sampling from the county of Finnmark in northernmost Norway indicated the presence of 54 species, including 14 likely new to science, 16 new to Norway, and one new to Europe. No species were previously recorded from this county. Only 93 species were known for all of Norway before this survey, indicating how poorly studied the group is. We evaluate and discuss morphological characters commonly used in identification of biting midges and relate species diagnoses to released DNA barcode data from 223 specimens forming 58 barcode clusters in our dataset. DNA barcodes and morphology were congruent for all species, except in three morphological species where highly divergent barcode clusters indicate the possible presence of cryptic species.

Keywords

Atrichopogon, *Forcipomyia*, *Dasyhelea*, *Culicoides*, *Brachypogon*, *Ceratopogon*, *Serromyia*, *Probezzia*, *Bezzia*, *Palpomyia*

Introduction

The Ceratopogonidae (biting midges) are generally small flies with a nearly worldwide distribution; the family includes 6,180 extant species in 111 genera (Borkent 2014a) but undoubtedly, many more undescribed species await discovery. Immatures are found in a wide array of aquatic, semiaquatic and moist terrestrial habitats. Female adults of many species in early lineages of the family suck blood from vertebrates or are ectoparasites on larger insects (e.g. wings of Odonata and Lepidoptera, caterpillars, phasmids). More derived lineages are predators of primarily nematoceros Diptera (e.g. Chironomidae) (Downes and Wirth 1981). Adults of both sexes imbibe nectar and/or honey dew and some are important pollinators of plants such as cocoa (Glendinning 1972). Numerous species of *Leptoconops* Skuse, *Forcipomyia* Meigen and *Culicoides* Latreille are pests of humans and livestock, having irritating bites and transmitting a wide array of viruses, protozoa and nematodes, including some important diseases (Borkent 2005).

Although Ceratopogonidae are common in almost all aquatic and semi-aquatic habitats, many species are small and members of some genera can be notoriously difficult to identify. The family is particularly poorly known taxonomically in Norway, in part due to very limited collecting and a general lack of experts over many years. Presently in Europe, the family has approximately half as many species as the Chironomidae, while in Norway this percentage is considerably lower (15%), as only 93 species of ceratopogonids have been recorded (Soot-Ryen 1943, Mehl 1996, Hagan et al. 2000, Thunes et al. 2004 and Szadziewski et al. 2012). Worldwide, however, there are about as many species of Ceratopogonidae (6,180) known as of Chironomidae (6235) (Borkent 2014a, Patrick Ashe pers. comm.). As this limited study of the ceratopogonid fauna of the far north shows, there are many more species of Ceratopogonidae actually present in Norway, with the strong expectation of further species both there and in more southerly habitats once these are systematically collected. Further to this, and particularly pertinent to studies of northern faunas, there have been only a few taxonomic studies comparing Old and New World Ceratopogonidae (Borkent and Bissett 1990; Borkent and Grogan 1995) and we therefore are uncertain about the true identity of some of these. There is an especially strong need to compare species of *Forcipomyia*, *Atrichopogon* Kieffer, *Dasyhelea* Kieffer, *Culicoides*, and *Brachypogon* Kieffer, all genera with numbers of species in the far north and which likely are more broadly distributed in the Holarctic than presently recognized.

Of all biting flies, the immatures of Ceratopogonidae are by far the most poorly known, with only limited regional keys to some larvae and pupae of some genera. To a distressing degree, the larvae of the subfamily Ceratopogoninae are morphologically similar and difficult to identify. The pupae are rich in characters and have been recently revised by Borkent (2014b).

DNA barcoding is defined as the use of short standardized sequences to identify specimens to species (Hebert et al. 2003). As a natural consequence, DNA barcodes can also be used to analyze species boundaries through genetic comparisons between

similar taxa and provide an objective dataset to be used in the definition of species in addition to morphology, ecology and other species specific characteristics. The 5' end of the mitochondrial gene cytochrome c oxidase subunit one (COI) is, since Hebert et al. (2003), regarded as the standard barcode region for animals and has been fairly widely used in Diptera (e.g. Ekrem et al. 2010; Renaud et al. 2012, Meiklejohn et al. 2012, Nagy et al. 2013). This marker is also used in the establishment of the Barcode Index Number (BIN) System, a DNA based registry for all animal species using operational taxonomic units as presumptive species (Ratnasingham and Hebert 2013). The use of COI-barcodes (or other molecular markers) to interpret species of *Ceratopogonidae* has barely begun and has focused on distinguishing those species of *Culicoides* implicated in the spread of diseases of domestic animals (e.g. Ander et al. 2013; Augot et al. 2013) as well as their hosts and parasites (Santiago-Alarcon et al. 2012). Our broader use here is the first to examine all the species of *Ceratopogonidae* at a given locality. Being a study of a high latitude fauna, the work provides ample opportunities to make future comparisons with the ceratopogonid fauna from elsewhere and especially from other localities in the northern Holarctic Region.

Neither Mehl (1996) in his overview of Norwegian *Culicoides* nor The Norwegian Biodiversity Information Centre (NBIC)'s "Artsobservasjoner" and "Artskart") have registered any *Ceratopogonidae* species from the county of Finnmark previous to our work.

Material and methods

Specimens were collected through a survey focusing on selected aquatic insect groups in Finnmark, the northernmost county of mainland Norway. More than 100 different sites were visited in three main trips during the season from June 11 to September 9, 2010 (Ekrem et al. 2012). Since the *Ceratopogonidae* were not a target group during the sampling, it is likely only a fraction of the existing species have been collected. The majority of *Ceratopogonidae* were retrieved from eight Malaise traps and only seven additional sites were sampled with sweep nets, dip nets or light trap (Fig. 1). All sample sites are described in Ekrem et al. (2012).

DNA barcodes were initially used to explore the unknown diversity of *Ceratopogonidae* from Finnmark. Several specimens of each morphotype were selected under a stereomicroscope and sampled for DNA analysis, typically by removing 1-3 legs. Tissues were shipped to the Biodiversity Institute of Ontario (BIO), Canada for sequencing of partial COI gene sequences. Mainly adult flies of both sexes were sequenced, but two larvae and one pupa were also included. COI amplification and sequencing followed standard protocols at the Canadian Centre for DNA Barcoding, BIO, including bi-directional Sanger sequencing. A list of barcoded material and all reference numbers are given in the Appendix; protocols, sequences, metadata and photographs of all specimens are available through the public project "Ceratopogonidae of Finnmark" [FICER] in the Barcode of Life Data Systems 3.0 (BOLD), (www.boldsystems.org, Ratnasingham and Hebert 2007).

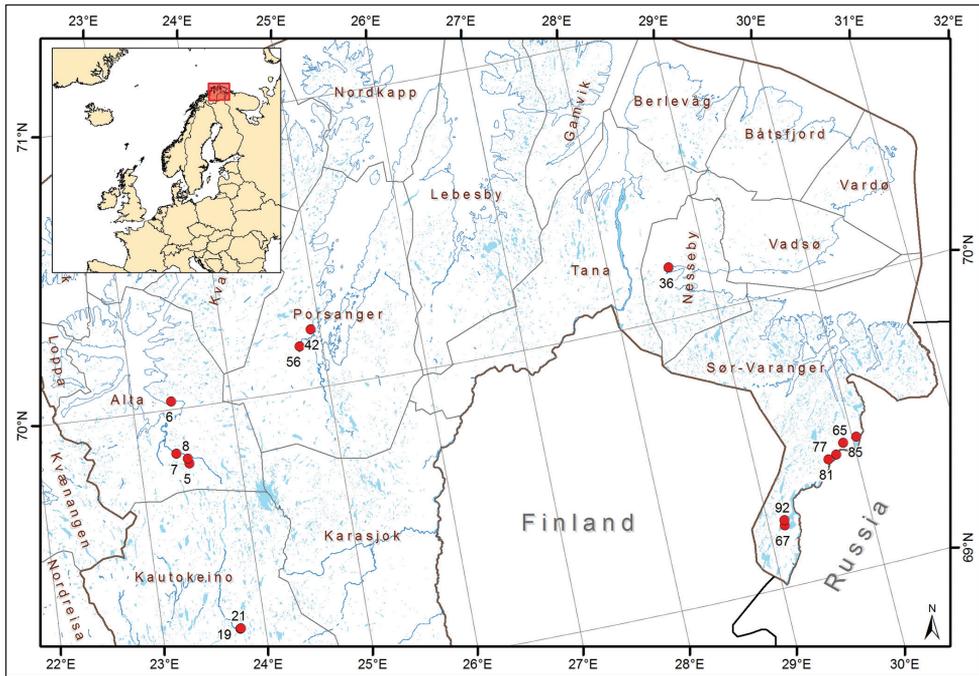


Figure 1. Sample sites for Ceratopogonidae in Finnmark, Norway, in 2010. Modified after Fig. 2 in Ekrem et al. (2012). Map by Marc Daverdin, NTNU University Museum.

Since slide mounting is generally needed for morphological species identification of biting midges, selected specimens (representing both sexes when available) from each cluster were slide mounted in Euparal®. The remaining un-mounted midges are preserved in 96% ethanol and stored in a -20 °C freezer. All specimens are deposited in the collection of the NTNU University Museum in Trondheim, Norway.

DNA barcodes from each genetic cluster (produced by the neighbor joining algorithm on Kimura 2-parameter genetic distances in BOLD) were compared with all COI sequences in BOLD and GenBank through the BOLD identification engine and GenBank's MegaBLAST-algorithm (Morgulis et al. 2008) respectively. All instances which produced an identification different from our morphological identification are discussed in the taxonomic treatments below. We used MEGA 5.2 (Tamura et al. 2011) to generate the taxon ID-tree based on the neighbor joining algorithm from aligned COI sequences using partial deletion for areas with gaps and 1000 bootstrap replicates. The taxon ID-tree is not a phylogenetic hypothesis of the included taxa, but a graphic representation of barcode clusters based on genetic Kimura 2-parameter distances. Alignment was performed on protein sequences and was trivial as there were no observed indels and very high similarity on the amino acids level. Tools present in BOLD were used to produce a genetic distance summary and to perform a barcode gap analysis. All analyses were done using Kimura 2-parameter genetic distances (Kimura 1980).

Species were identified using taxonomic literature as referenced below (under each genus or species). Sources for *Ceratopogonidae* records in Norway were Soot-Ryen (1943), Mehl (1996), Hagan et al. (2000), Thunes et al. (2004), and Szadziewski et al. (2012). Comments on European distribution of *Ceratopogonidae* are based on data published in Fauna Europea (Szadziewski et al. 2012), for North America we relied on the summary distributions given by Borkent and Grogan (2009) and kept updated by the second author.

Results

DNA barcodes were obtained from 223 specimens representing 54 morphological species (Table 1, Fig. 2). Thirty-eight species were represented by more than one specimen from Finnmark and showed a mean intraspecific Kimura 2-parameter distance of 1.6%. Maximum observed intraspecific distance for the complete dataset was considerably higher (11.9%) than the minimum observed interspecific divergence (5.8%). However, at least three morphological species contained multiple BINs (well separated barcode clusters) where cryptic species-level diversity may be present. *Dasyhelea (Dicryptoscena) modesta* (Winnertz, 1852) contains two BINs with mean intraspecific distance 4.9%, maximum intraspecific distance 11.9% and distance to nearest neighbor of a different morphospecies 16.9%. *Dasyhelea (Dasyhelea) malleola* Remm, 1962 contains four BINs with mean intraspecific distance 2.2%, maximum intraspecific distance 5.1% and distance to nearest neighbor of a different morphospecies 15.1%. *Brachypogon (Isohelea) nitidulus* (Edwards, 1921) contains two BINs with mean intraspecific distance 3.2%, maximum intraspecific distance 6.0% and distance to nearest neighbor of a different morphospecies 17.2%. Treating the multiple clusters of these three morphospecies as presumptive (cryptic) species, the maximum intraspecific distance for the whole dataset is 4.0% compared to 5.8% minimum interspecific distance, giving an overall barcode-gap of almost 2%.

There are two additional morphospecies where the Refined Single Linkage (RESL) analysis in BOLD (Ratnasingham and Hebert 2013) produces multiple BINs but where we suspect no more than one species: *Brachypogon (Isohelea) sociabilis* (Goetghebuer, 1920) has four BINs, a mean intraspecific distance of 1.71%, maximum intraspecific distance of 4.0% and distance to nearest neighbor 13.5%. *Bezzia rhynchostylata* Remm, 1974 has three BINs, a mean intraspecific distance of 2.4%, maximum intraspecific distance 3.8% and distance to nearest neighbor 17.2%. Both morphology and comparatively low intraspecific distance in these species suggest that the RESL algorithm overestimates presumptive species (as BINs) for these taxa.

We also compared our DNA barcodes with the partial COI gene sequences Ander et al. (2013) provided for 37 named *Culicoides* species from Sweden. All *Culicoides* species we collected in Finnmark, except for *C. minutissimus* (Zetterstedt, 1855), are

Table 1. Distribution of Ceratopogonidae in Finnmark based on the revised Strand-system (Økland 1981). Species marked with an asterisk (*) are also known from North America (Borkent and Grogan 2009). Division of Finnmark in four regions according to the revised “Strand-system” (Økland 1981): FV = western Finnmark, FI = inner Finnmark, FN = northern Finnmark and FØ = eastern Finnmark.

	FV	FI	FN	FØ	previously recorded in Norway
Forcipomyiinae					
<i>Atrichopogon (Atrichopogon) hirtidorsum</i> Remm, 1961	x			x	
<i>Atrichopogon (Atrichopogon) infuscus</i> Goetghebuer, 1929	x				
<i>Atrichopogon (Atrichopogon) minutus</i> (Meigen, 1830) *	x				X
<i>Atrichopogon (Lophomyidium) fuscus</i> (Coquillett, 1901) *				x	
<i>Atrichopogon (Melochelea) oedemerarum</i> Storå, 1939 *				x	
<i>Forcipomyia (Euprojoannisia) alacris</i> (Winnertz, 1852)				x	
<i>Forcipomyia (Euprojoannisia) palustris</i> (Meigen, 1804) *	x			x	X
<i>Forcipomyia (Euprojoannisia) sp. 6ES nr. palustris</i>				x	
<i>Forcipomyia (Forcipomyia) bipunctata</i> (Linneus, 1767) *				x	
<i>Forcipomyia (Forcipomyia) squamigera</i> Kieffer, 1916				x	X
<i>Forcipomyia (Forcipomyia) sp. 2ES “bipunctata group”</i>	x				
<i>Forcipomyia (Forcipomyia) sp. 3ES “bipunctata group”</i>	x				
<i>Forcipomyia (Forcipomyia) hygrophila</i> Kieffer, 1925 *				x	X
<i>Forcipomyia (Forcipomyia) nigra</i> (Winnertz, 1852)	x			x	X
<i>Forcipomyia (Forcipomyia) nigrans</i> Remm, 1962	x	x	x	x	X
<i>Forcipomyia (Forcipomyia) tenuis</i> (Winnertz, 1852)	x			x	
<i>Forcipomyia (Forcipomyia) sp. 1ES</i>				x	
<i>Forcipomyia (Synthyridomyia) acidicola</i> (Tokunaga, 1937) *				x	X
<i>Forcipomyia (Synthyridomyia) knockensis</i> Goetghebuer, 1938				x	
<i>Forcipomyia (Thyridomyia) monilicornis</i> (Coquillett, 1905) *				x	X
<i>Forcipomyia (Thyridomyia) sp. 4ES</i>				x	
<i>Forcipomyia (Thyridomyia) sp. 5ES</i>				x	
<i>Forcipomyia (Trichohelea) chaetoptera</i> Remm, 1962				x	
Dasyheleinae					
<i>Dasyhelea (Dasyhelea) bensoni</i> Edwards, 1933				x	X
<i>Dasyhelea (Dasyhelea) malleola</i> Remm, 1962 (2 cluster)				x	X
<i>Dasyhelea (Dasyhelea) sp. 4ES nr. bilineatal pallidiventris</i>	x			x	
<i>Dasyhelea (Dicryptoscena) modesta</i> (Winnertz, 1852)	x			x	X
<i>Dasyhelea (Prokempia) sp. 1ES</i>	x			x	
<i>Dasyhelea (Pseudoculicoides) bifida</i> Zilahi-Sebess, 1936 *				x	
<i>Dasyhelea (Pseudoculicoides) sp. 2ES mutabilis group</i>				x	
<i>Dasyhelea (Pseudoculicoides) sp. 3ES mutabilis group</i>				x	
Ceratopogoninae					
Culicoidini					

	FV	FI	FN	FØ	previously recorded in Norway
<i>Culicoides (Beltramyia) sphagnumensis</i> Williams, 1955 *				x	X
<i>Culicoides (Beltramyia) salinarius</i> Kieffer, 1914			x	x	
<i>Culicoides (Culicoides) griseus</i> Edwards, 1939	x		x	x	X
<i>Culicoides (Oecacta) albicans</i> Winnertz, 1852				x	X
<i>Culicoides (Silvaticulicoides) fascipennis</i> (Stæger, 1839)				x	X
<i>Culicoides (Wirthomyia) minutissimus</i> (Zetterstedt, 1855)				x	
<i>Culicoides (Wirthomyia) reconditus</i> Campbell & Pelham-Clinton, 1960	x				X
Ceratopogonini					
<i>Brachypogon (Isohelea) nitidulus</i> (Edwards, 1921)			x	x	X
<i>Brachypogon (Isohelea) sociabilis</i> (Goetghebuer, 1920)				x	X
<i>Brachypogon (Isohelea)</i> sp.1ES				x	
<i>Brachypogon (Isohelea)</i> sp. 2ES nr. <i>norvegicus</i> (sp.n.?)				x	
<i>Ceratopogon abstrusus</i> Borkent & Grogan, 1995 *				x	
<i>Ceratopogon grandiforceps</i> (Kieffer, 1913)			x		
<i>Ceratopogon lacteipennis</i> Zetterstedt, 1838				x	X
<i>Serromyia femorata</i> (Meigen, 1804)	x			x	X
Johannsenomyiini					
<i>Probezzia</i> sp. (pupa)				x	
Palpomyiini					
<i>Bezzia annulipes</i> (Meigen, 1830) *				x	
<i>Bezzia circumdata</i> (Stæger, 1839) *				x	X
<i>Bezzia rhynchostylata</i> Remm, 1974				x	X
<i>Palpomyia puberula</i> Remm, 1976	x				
<i>Palpomyia remmi</i> Havelka, 1974	x				X
<i>Palpomyia serripes</i> (Meigen, 1818)				x	X
Ceratopogonidae gen. sp. 1ES (larvae) (<i>Bezzia</i> or <i>Palpomyia</i>)	x			x	

represented in their study and our DNA barcodes match 98–100% with the sequences Ander et al. (2013) deposited in GenBank. Identification of *Culicoides salinarius* Kieffer, 1914 based on morphology is consistent to Ander et al.'s (2013) and not to Wenk et al.'s (2012) interpretation of the species. Voucher material for the COI-sequences published by Wenk et al. (2012) and Ander et al. (2013) was requested from the respective authors, but unfortunately not made available for examination. Thus, we were unable to confirm if the identifications correspond to our morphological interpretation of *C. salinarius*.

Five of the sample sites collected 92% of the investigated specimens and all but one species were found at the five sites FinLoc65, FinLoc05, FinLoc08, FinLoc85, and FinLoc42 (Fig. 1, Ekrem et al. 2012). The most productive location in terms of Cerat-

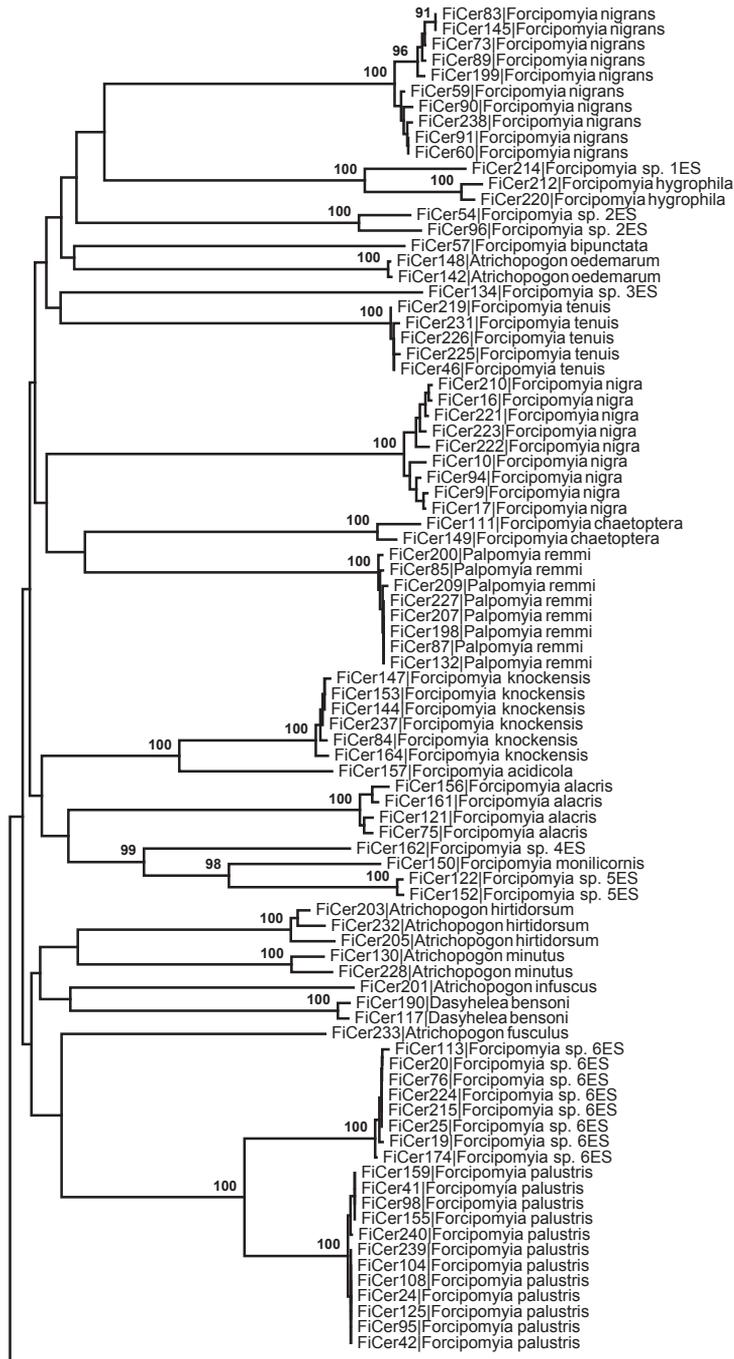


Figure 2. Taxon-ID tree of the studied Ceratopogonidae specimens based on the neighbor joining algorithm from aligned COI sequences using partial deletion for areas with gaps and 1000 bootstrap replicates in MEGA 5.2. All included sequences were longer than 500 bp. Bootstrap values shown on branches supported by more than 90% of the bootstrap replicates.

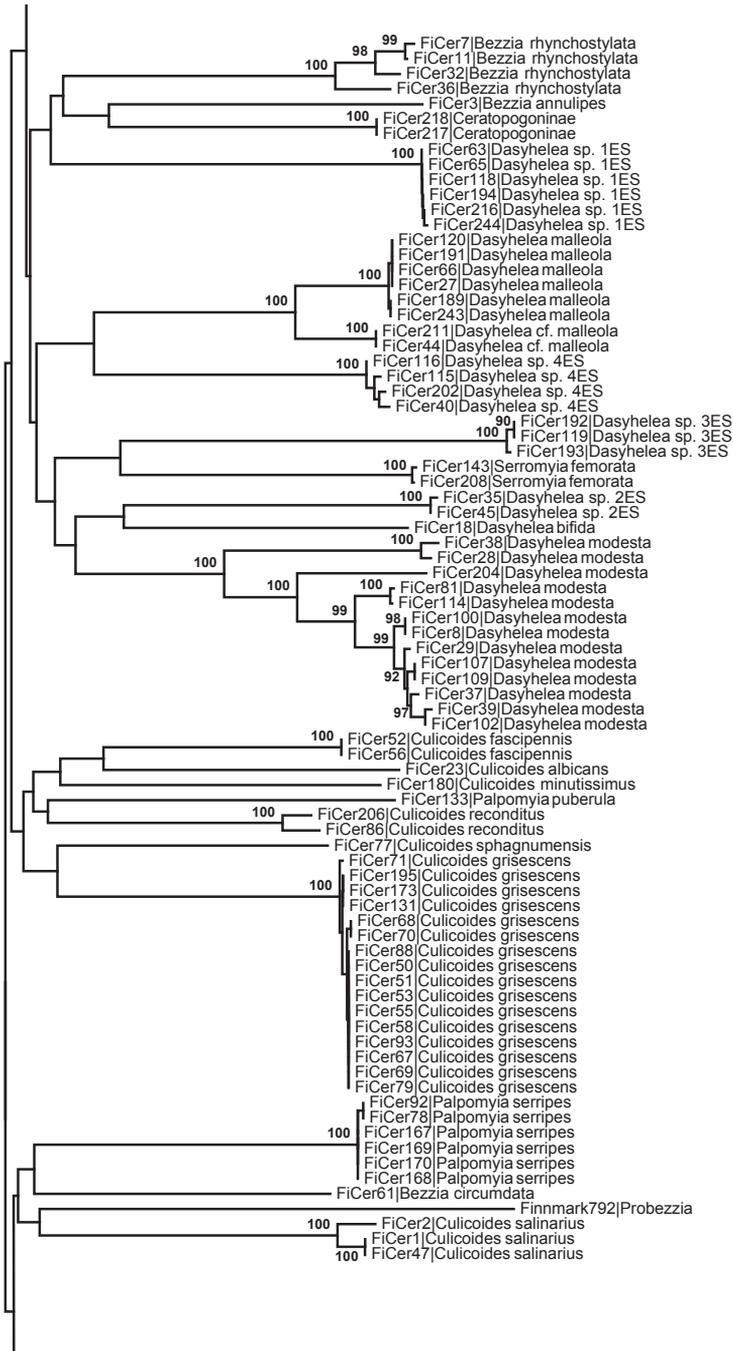


Figure 2. Continued.

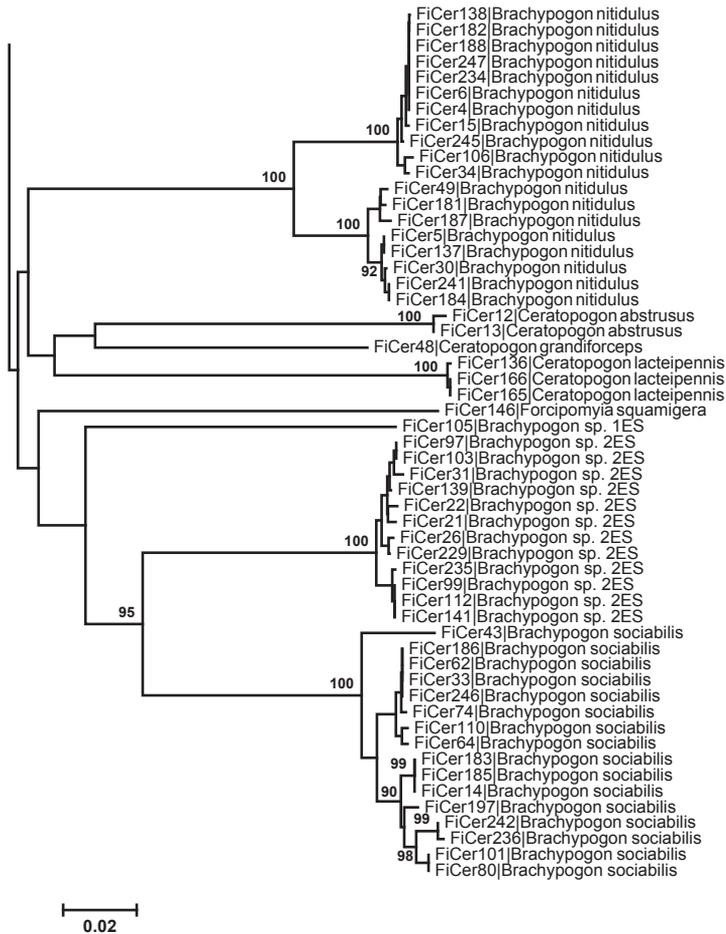


Figure 2. Continued.

opogonidae material was one locality in the eastern part of the county (FinLoc65, Malaise 7) in which 72% of all specimens treated were sampled and 41 of 55 species were found. The other Malaise traps collected from 1.4% to 8.4% of the specimens and 3–13 species, while the light trap at the research station (FinLoc85) collected 4.7% of the specimens and four species, including three species not collected elsewhere.

Taxonomic discussion

The “ID” referred to below is the individual DNA barcode specimen ID and serves as a link between the DNA barcode in BOLD and the voucher specimen. The “FinLoc” number denotes the specific collecting sites shown in Figure 1.

Forcipomyiinae

Atrichopogon

We collected adults of five species of *Atrichopogon* representing three subgenera.

Atrichopogon (Atrichopogon) hirtidorsum Remm, 1961

All three females of *A. (Atrichopogon) hirtidorsum* key to *A. fossicola* in Goetghebuer (1934) (*A. fossicola* is listed as a synonym of *A. fuscus*) and to *A. hirtidorsum* in Remm (1961) based on the length of the scutal bristles.

Material examined. 3♀ (ID: FiCer203, FiCer205, FiCer232), 23 July–07 August 2010, FinLoc08, Malaise trap.

Atrichopogon (Atrichopogon) infuscus Goetghebuer, 1929

The single male of *A. (Atrichopogon) infuscus* keys to *A. infuscus* both in Goetghebuer (1934) and Remm (1961). The available descriptions of *A. infuscus* and *A. hirtidorsum* are very basic and we have not examined types of these species. Thus, more detailed taxonomic revision of these species may change the identity of our examined specimens.

Material examined. 1♂ (ID: FiCer201) 23 July–07 August 2010, FinLoc08, Malaise trap.

Atrichopogon (Atrichopogon) minutus (Meigen, 1830)

Of the five *Atrichopogon* species we collected, only *A. (Atrichopogon) minutus* has been previously recorded in Norway. The species is easily recognizable both as males and females using Remm's (1961) and Havelka's (1976) descriptions.

Material examined. 1♂ (ID: FiCer228) 10–23 July 2010, FinLoc08, Malaise trap, 1♀ (ID: FiCer130) 23 July–07 August 2010, FinLoc05, Malaise trap.

Atrichopogon (Lophomyidium) fuscus (Coquillett, 1901)

The female of *A. (Lophomyidium) fuscus* fits the description in Szadsziewski et al. (1996) and is the first species record in the subgenus *A. (Lophomyidium)* Cordero in Norway.

Material examined. 1♀ (ID: FiCer233) 30 July–10 August 2010, FinLoc65, Malaise trap.

***Atrichopogon (Meloebelea) oedemerarum* Storå, 1939**

The two males of *A. (Meloebelea) oedemerarum* closely match Szadziewski et al.'s (1995) description of the species.

Material examined. 2♂♂ (ID: FiCer142, FiCer148) 24 June–20 July 2010, FinLoc65, Malaise trap.

Forcipomyia

Within the genus *Forcipomyia* we found 18 species distributed in five subgenera (Table 1). For identifying the subgenera we used the key and definitions in Wirth and Ratanaworabhan (1978), Debenham (1987), and a key to the subgenera restricted to Fennoscandia and northern Europe (Borkent unpublished). Alwin and Szadziewski (2013) recently published a key to the subgenera present in Poland and confirms subgeneric identifications here. Identification of *Forcipomyia* at the species level are mostly based on the key and figures in Remm (1962), however, additional literature is used in individual cases (see below).

***Forcipomyia (Euprojoannisia) alacris* (Winnertz, 1852)**

Forcipomyia (Euprojoannisia) alacris has been previously recorded in Norway.

Material examined. 3♂♂ (ID: FiCer121, FiCer156, FiCer161) 24 June–20 July 2010; 1♂ (ID: FiCer75) 30 July–10 August 2010, all FinLoc65, Malaise trap.

***Forcipomyia (Euprojoannisia) palustris* (Meigen, 1804)**

Forcipomyia palustris has been previously recorded in Norway. The males match the description of Szadziewski (1986).

Material examined. 3♂♂ (ID: FiCer24, FiCer104, FiCer108), and 3♀♀ (ID: FiCer41, FiCer42, FiCer98), 19–24 June 2010, 4♀♀ (ID: FiCer95, FiCer125, FiCer155, FiCer159) 24 June–20 July 2010, 2♀♀ (ID: FiCer239, FiCer240) 30 July–10 August 2010, all FinLoc65, Malaise trap.

Forcipomyia (Euprojoannisia) sp. 6ES nr. palustris

Forcipomyia sp. 6ES nr. *palustris* is a species morphologically similar to *F. palustris* but differs in subtle differences in the male genitalia: The gonocoxal apodemes are narrower apically and with very short lateral projections and posteriorly the ventral prong is more slender and elongate.

Material examined. 4♂♂ (ID: FiCer19, FiCer20, FiCer25, FiCer113) 19–24 June 2010, 1♀ (ID: FiCer76) 30 July–10 August 2010, 1♀ (ID: FiCer174) 24 June–20 July 2010, all FinLoc65, Malaise trap, 1♀ (ID: FiCer215) 11–26 June 2010, FinLoc05, Malaise trap, 1♂ (ID: FiCer224) 19 June 2010, netting.

***Forcipomyia (Forcipomyia) bipunctata* (Linnaeus, 1767)**

The single male was identified as *F. bipunctata* following the description of this species by Szadziewski et al. (2007). Additionally, the key and figures in Remm (1962) were consulted. Szadziewski et al. (2007) revised the European *bipunctata* species group of the subgenus *F. (Forcipomyia)* and included *F. bipunctata*, *F. squamigera*, *F. ciliata* (Winnertz, 1852), and *F. pulchrithorax* Edwards, 1924.

Material examined. 1♂ (ID: FiCer57) 08 September 2010, FinLoc85, light trap.

***Forcipomyia (Forcipomyia) squamigera* Kieffer, 1916**

The single male was identified as *F. (Forcipomyia) squamigera* based on the description of the species in Szadziewski et al. (2007).

Material examined. 1♂ (ID: FiCer146) 24 June–20 July 2010, FinLoc65, Malaise trap.

***Forcipomyia (Forcipomyia) sp. 2ES bipunctata* group**

The females of *F. sp. 2ES* have lanceolate setae on all tibiae and elongated seminal capsules. They seem to belong within the *bipunctata* group (Szadziewski et al. 2007). For species determination an association with male specimens is necessary. Whether these two specimens belong to one or two species is not clear. More material and associations are necessary for accurate determination.

Material examined. 2♀♀ (ID: FiCer54, FiCer96) 07 and 08 September 2010, FinLoc85, light trap.

***Forcipomyia (Forcipomyia) sp. 3ES bipunctata* group**

The single female, *F. sp. 3ES*, with lanceolate setae on mid and hind tibia, fits within the *bipunctata* group (Szadziewski et al. 2007). The larger setae on fore tibia are missing (broken) and could be lanceolate or not. This specimen has a wing length of 1.7 mm, like the largest species of this group, *F. (Forcipomyia) ciliata* (Winnertz, 1852).

Material examined. 1♀ (ID: FiCer134) 23 July–07 August 2010, FinLoc05, Malaise trap.

***Forcipomyia (Forcipomyia) hygrophila* Kieffer, 1925**

Forcipomyia hygrophila has been previously recorded in Norway.

Material examined. 1♂ (ID: FiCer220) 19 June 2010, FinLoc77, netting, 1♀ (ID: FiCer212) 11–26 June 2010, FinLoc05, Malaise trap.

Forcipomyia (Forcipomyia) sp. 1ES

The single female specimen of *F. sp. 1ES*, is genetically relatively close to *F. hygrophila* but easy to distinguish morphologically (e.g. by the shape of the palpus) (Fig. 3).

Material examined. 1♀ (ID: FiCer214) 11–26 June 2010, FinLoc05, Malaise trap.

***Forcipomyia (Forcipomyia) nigra* (Winnertz, 1852)**

Forcipomyia nigra has been previously recorded in Norway.

Material examined. 4 ♂♂ (ID: FiCer9, FiCer10, FiCer16, FiCer17) 19–24 June 2010, 1♂ (ID: FiCer94) 24 June–20 July 2010, all FinLoc65, Malaise trap. 1♀ (ID: FiCer210) 11–26 June 2010, FinLoc05, Malaise trap, 2♂♂ (ID: FiCer221, FiCer222) 19 June 2010, FinLoc67, netting, 1♂ (ID: FiCer223) 19 June 2010, FinLoc81, netting.

***Forcipomyia (Forcipomyia) nigrans* Remm, 1962**

Forcipomyia nigrans has been previously recorded in Norway.

Material examined. 1♂ (ID: FiCer59), 1♀ (ID: FiCer60) both 24 July–06 August 2010, FinLoc19, 1♂ (ID: FiCer90) and 1♀ (ID: FiCer91) both 24 July–06 August 2010, FinLoc21, 1♀ (ID: FiCer145) 24 June–20 July 2010, 1♀ (ID: FiCer83) 20–30 July 2010, 2♀♀ (ID: FiCer73, FiCer238) 30 July–10 August 2010, all four specimens FinLoc65, 1♀ (ID: FiCer89) 25 August–09 September 2010, FinLoc56, 1♀ (ID: FiCer199) 23 July–07 August 2010 FinLoc05, all Malaise trap.

***Forcipomyia (Forcipomyia) tenuis* (Winnertz, 1852)**

Forcipomyia tenuis has not been recorded from Scandinavia before, but is known from many other European countries.

Material examined. 1♂ (ID: FiCer46) 17 June 2010, FinLoc36, 1♂ (ID: FiCer219) 19 June 2010, FinLoc77, 2♂♂ (ID: FiCer225, FiCer226) 13 June 2010, FinLoc06, all netting, 1♂ (ID: FiCer231) 20–30 July 2010, FinLoc65, Malaise trap.

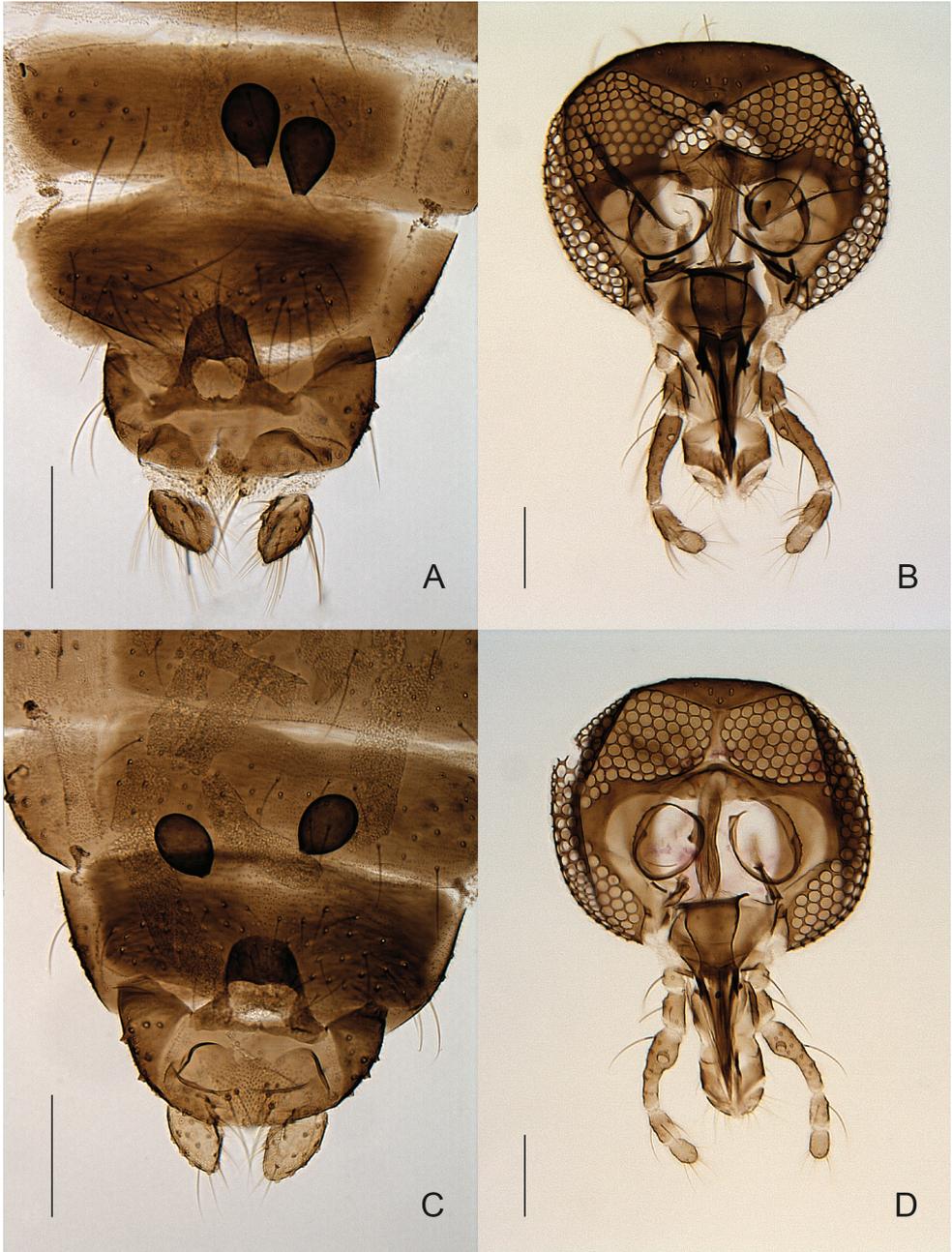


Figure 3. **A, B** *Forcipomyia hygrophila* female **A** terminalia, in ventral view **B** head, in anterior view **C, D** *Forcipomyia* sp. 1 female **C** terminalia, in ventral view **D** head, in anterior view.

***Forcipomyia (Synthyridomyia) acidicola* (Tokunaga, 1937)**

Three species of the subgenus *F.* (*Synthyridomyia*) are known from Europe. The single female specimen from Finnmark fits the diagnosis of the subgenus (Wirth and Ratanaworabhan 1978) and Tokunaga's (1937) description of the species. *Forcipomyia acidicola* has been previously recorded in Norway (Thunes et al. 2004).

Material examined. 1♀ (ID: FiCer157) 24 June–20 July 2010, FinLoc65, Malaise trap.

***Forcipomyia (Synthyridomyia) knockensis* Goetghebuer, 1938**

The identification of this species is based on the key of Remm (1962) and the redescription by Szadziewski (1983).

Material examined. 1♂ (ID: FiCer84) 20.–30. June 2010, 2♂♂ (ID: FiCer144, FiCer153) & 2♀♀ (ID: FiCer147, FiCer164) 24 June–20 July 2010, 1♀ (ID: FiCer237) 30 July–10 August 2010, all FinLoc65, Malaise trap.

***Forcipomyia (Thyridomyia) monilicornis* (Coquillett, 1905)**

The species has been previously recorded in Norway.

Material examined. 1♂ (ID: FiCer150) 24 June–20 July 2010, FinLoc65, Malaise trap.

Forcipomyia (Thyridomyia) sp. 4ES

Three species within the subgenus *F.* (*Thyridomyia*) could be distinguished: *F.* (*Thyridomyia*) *monilicornis*, as well as two unnamed species *F.* (*Thyridomyia*) sp. 4ES, and *F.* (*Thyridomyia*) sp. 5ES. The two latter have only been collected as females (Fig. 4).

Material examined. 1♀ (ID: FiCer162) 24 June–20 July 2010, FinLoc65, Malaise trap.

Forcipomyia (Thyridomyia) sp. 5ES

Material examined. 2♀♀ (ID: FiCer122, FiCer152) 24 June–20 July 2010, FinLoc65, Malaise trap.

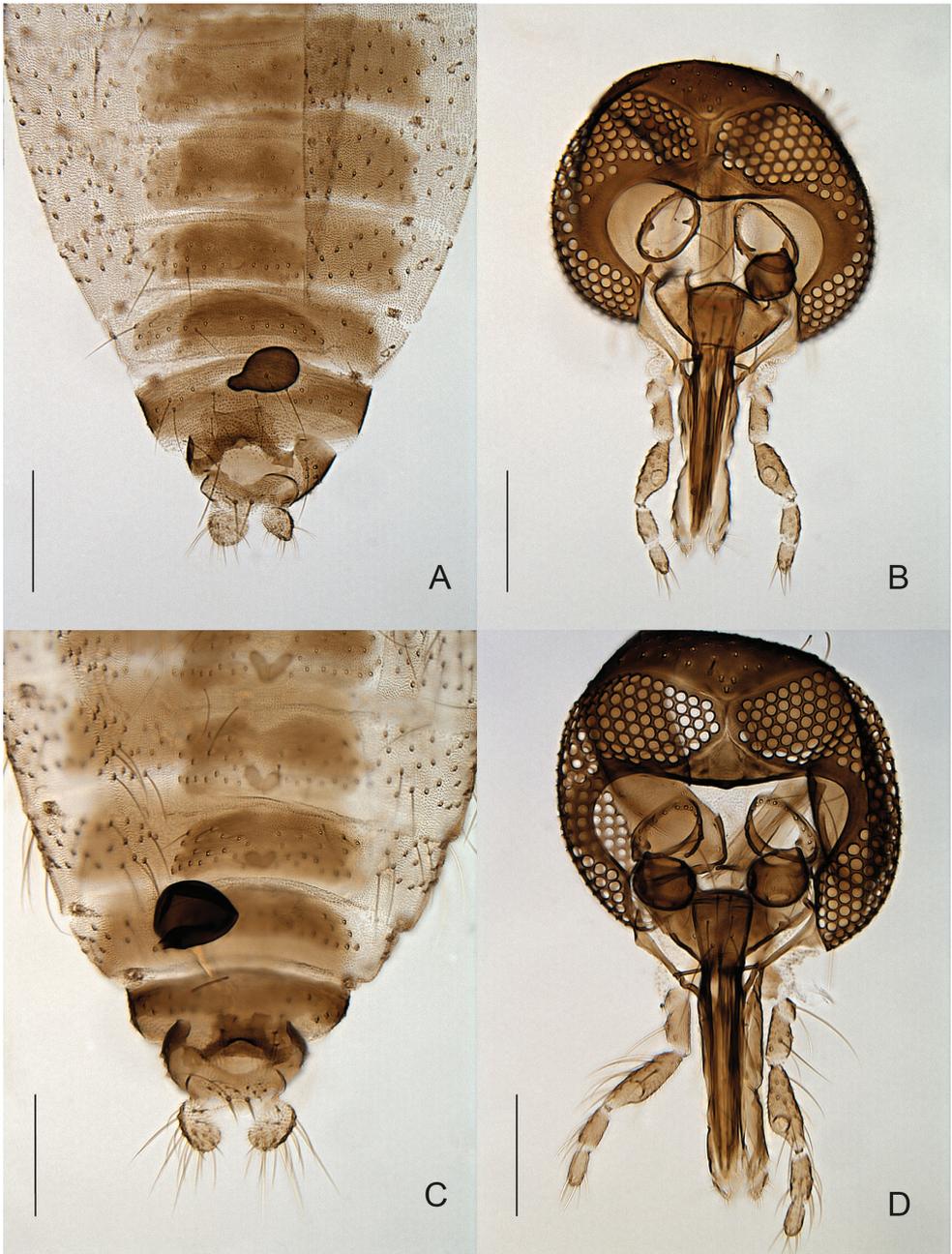


Figure 4. **A, B** *Forcipomyia* sp. 5 female **A** terminalia, in ventral view **B** head, in anterior view **C, D** *Forcipomyia* sp. 4 female **C** terminalia, in ventral view **D** head, in anterior view.

***Forcipomyia (Trichobelea) chaetoptera* Remm, 1962**

The male and female key to *F. (Trichobelea) chaetoptera* using Remm (1962).

Material examined. 1♂ (ID: FiCer111) 19–24 June 2010 & 1♀ (ID: FiCer149) 24 June–20 July 2010, both FinLoc65, Malaise trap.

Dasyheleinae***Dasyhelea***

The Polish species of this genus have recently been revised by Dominiak (2012) which included 30 of the 63 (Dominiak and Szadziewski 2010) known European species.

***Dasyhelea (Dasyhelea) bensoni* Edwards, 1933**

Dasyhelea bensoni is not included in Dominiak's (2012) key but the species is discussed within the description of *D. pallidiventris* (Goetghebuer, 1931) in her work. An allocation of the two Finnmark females to the species is not definite since the palpal setae are missing on both specimens and no associated males have been collected. *Dasyhelea (Dasyhelea) bensoni* has been previously recorded in Norway.

Material examined. 2♀♀ (ID: FiCer117, FiCer190) 24 June–20 July 2010, FinLoc65, Malaise trap.

***Dasyhelea (Dasyhelea) malleola* Remm, 1962 (2 cluster)**

There are two clusters of *D. (Dasyhelea)* specimens, both including males and females, which key out to *D. (Dasyhelea) malleola* and fit within the description for the species provided by Dominiak (2012). Whether or not these specimens are members of one or two species requires more material and a Holarctic revision of the genus. *Dasyhelea malleola* has been previously recorded in Norway. Between the males, no significant differences could be observed. The females however, differ in the shape of the posterior portion of sternite 9 (projecting anteriorly): subgenital plate elongate and vase shape in FiCer44 (Fig. 5) and widened in FiCer66, FiCer120, FiCer191 and FiCer243 (Fig. 5 and figure 39 in Dominiak (2012)). The spermatheca of specimen FiCer44 lacked pores and the extension was narrow; spermathecae of specimens FiCer191, FiCer120, FiCer243, and FiCer66 were with pores and the extension thicker). Since we only have one single male and female in the cluster of *D. cf. malleola* it has to be confirmed with more material if the differences are consistent between the two forms.

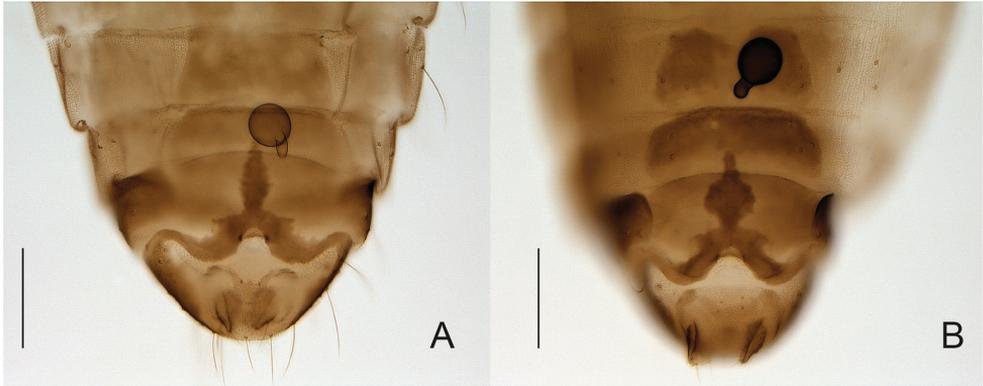


Figure 5. Female terminalia, in ventral view **A** *Dasyhelea cf. malleola* **B** *Dasyhelea malleola*.

Material examined. 1♂ (ID: FiCer27) and 1♀ (ID: FiCer44) 19–24 June 2010, 1♂ (ID: FiCer189) and 2♀♀ (ID: FiCer120, FiCer191) 24 June–20 July 2010, 1♀ (ID: FiCer243) 20–30 July 2010, 1♀ (ID: FiCer66), 30 July–08 August 2010, all FinLoc65, Malaise trap, 1♂ (ID: FiCer211) 11–26 June 2010, FinLoc05, Malaise trap.

Dasyhelea (Dasyhelea) sp. 4ES nr. bilineata/pallidiventris

The male and females of *Dasyhelea* sp. 4ES do not key to any of the species included in Dominiak's (2012) key. Comparing the specimens with the provided species descriptions puts the species close to *D. bilineata* Goetghebuer, 1920 and *D. pallidiventris*.

Material examined. 1♀ (ID: FiCer40) 19–24 June 2010, 2♀♀ (ID: FiCer115, FiCer116) 24 June–20 July 2010, all FinLoc65, Malaise trap. 1♂ (ID: FiCer202) 23 July–07 August 2010, FiLoc08, Malaise trap.

***Dasyhelea (Dicryptoscena) modesta* (Winnertz, 1852)**

Several specimens, both males and females, could be assigned to *D. modesta* (Winnertz, 1852). They fit Dominiak's (2012) interpretation of the species. The genetic distances for CO1 within the species cluster, however, can be as much as 10%, indicating the possibility of more than one species under this name.

Material examined. 8♂♂ (ID: FiCer8, FiCer28, FiCer29, FiCer100, FiCer102, FiCer107, FiCer109, FiCer114) and 3♀♀ (ID: FiCer37, FiCer38, FiCer39) 19–24 June 2010, 1♂ (ID: FiCer81) 20–30 July 2010 all FinLoc65, Malaise trap, 1♀ (ID: FiCer204) 23 July–07 August 2010, FiLoc08, Malaise trap.

Dasyhelea (Prokempia) sp. 1ES

All sampled *Dasyhelea* sp. 1ES specimens are females of the subgenus *D. (Prokempia)*. Species identification is only presently possible with males.

Material examined. 1♀ (ID: FiCer118) 19–24 June 2010, 1♀ (ID: FiCer194) 24 June–20 July 2010, 1♀ (ID: FiCer244) 20–30 July 2010, 2♀♀ (ID: FiCer63, FiCer65) 30 July–08 August 2010, all FinLoc65, Malaise trap, 1♀ (ID: FiCer216) 11–26 June 2010 FinLoc05, Malaise trap.

***Dasyhelea (Pseudoculicoides) bifida* Zilahi-Sebess, 1936**

Of the three *D. (Pseudoculicoides)* species collected, only *D. bifida* could be named. *Dasyhelea (Pseudoculicoides) sp. 2ES* and *D. (Pseudoculicoides) sp. 3ES* are members of the *mutabilis* group sensu Waugh and Wirth (1976). Associations to males are presently necessary to determine the nominal species.

Material examined. 1♂ (ID: FiCer18) 19–24 June 2010 FinLoc65, Malaise trap.

Dasyhelea (Pseudoculicoides) sp. 2ES

Material examined. 2♀♀ (ID: FiCer35, FiCer45) 19–24 June 2010 FinLoc65, Malaise trap.

Dasyhelea (Pseudoculicoides) sp. 3ES

Material examined. 3♀♀ (ID: FiCer119, FiCer) 24 June–20 July 2010 FinLoc65, Malaise trap.

Ceratopogoninae**Culicoidini*****Culicoides***

Within the genus *Culicoides* we found seven species representing five subgenera. For identification, the keys and descriptions of Glukhova (2005) were used and, in addition, the key and descriptions in Campbell and Pelham-Clinton (1959) and Delécolle (1985) were consulted.

***Culicoides (Beltramyia) sphagnumensis* Williams, 1955**

Material examined. 1 ♀ (FiCer77) 30 July–10 August 2010, FinLoc65, Malaise trap.

***Culicoides (Beltramyia) salinarius* Kieffer, 1914**

The males of this species key to *C. salinarius* in Delécolle (1985). The wings of these specimens have a single pale spot over r-m and CuA₂ is dark, also features of females of this species.

Material examined. 2 ♂♂ (FiCer1, FiCer2) 19–24 June 2010, FinLoc65, Malaise trap.
1 ♂ (FiCer47) 15 June–02 July 2010, FinLoc42, Malaise trap.

***Culicoides (Culicoides) grisescens* Edwards, 1939**

Material examined. 2 ♂♂ (FiCer93, FiCer173) 24 June–20 July 2010, 1 ♂ (FiCer79) 20–30 July 2010, 2 ♂♂ (FiCer68, FiCer70) and 3 ♀♀ (FiCer67, FiCer69, FiCer71) 30 July–08 August 2010, all FinLoc65, Malaise trap, 1 ♂ (FiCer195) and 1 ♀ (FiCer131) 23 July–07 August 2010, FinLoc05, Malaise trap, 1 ♂ (FiCer88) 25 August–09 September 2010, FinLoc56, Malaise trap, 3 ♂♂ (FiCer50, FiCer55, FiCer58) and 2 ♀♀ (FiCer51, FiCer53) 08 September 2010, FinLoc85, light trap.

***Culicoides (Oecacta) albicans* Winnertz, 1852**

Material examined. 1 ♂ (FiCer23) 19–24 June 2010, FinLoc65, Malaise trap.

***Culicoides (Silvaticulicoides) fascipennis* (Stæger, 1839)**

Material examined. 2 ♀♀ (FiCer52, FiCer56) 08 September 2010, FinLoc85, light trap.

***Culicoides (Wirthomyia) minutissimus* (Zetterstedt, 1855)**

Material examined. 1 ♀ (FiCer180) 24 June–20 July 2010, FinLoc65, Malaise trap.

***Culicoides (Wirthomyia) reconditus* Campbell & Pelham-Clinton, 1960**

Material examined. 1 ♂ (FiCer86) 10 - 23 July 2010, FinLoc05, Malaise trap, 1 ♀ (FiCer206) 23 July–07 August 2010, FinLoc08, Malaise trap.

Ceratopogonini

Genus *Brachypogon*

The *Brachypogon* species collected in Finnmark all belong to the subgenus *B. (Isohelea)*.

Brachypogon (Isohelea) nitidulus (Edwards, 1921)

As mentioned above, there are two clearly divergent clusters of DNA barcodes from specimens identified as *B. nitidulus*, with a maximum Kimura 2-parameter distance of 5.98% (Figure 2). Specimens from the two clusters were collected at the same time and place and no morphological distinction is observed. We suspect that the fairly large observed COI divergence indicates possible cryptic species in this group. *Brachypogon nitidulus* has been previously recorded in Norway.

The male specimens of the cluster with FiCer04 have a relatively stout palpal segment 3, the males of cluster with FiCer05 have a more slender palpal segment 3.

Material examined. 7♂♂ (ID: FiCer4, FiCer5, FiCer6, FiCer15, FiCer30, FiCer106, FiCer245) and 2♀♀ (ID: FiCer34, FiCer247) 19–24 June 2010, 3♂♂ (ID: FiCer137, FiCer138, FiCer187) and 4♀♀ (ID: FiCer182, FiCer184, FiCer188) 24 June–20 July 2010, 1♀ (ID: FiCer241) 20–30 July 2010, 1♀ (ID: FiCer234) 30 July–10 August 2010, all FinLoc65, Malaise trap, 1♀ (ID: FiCer49) 15 June–02 July 2010, FinLoc42, Malaise trap.

Brachypogon (Isohelea) sociabilis (Goetghebuer, 1920)

Brachypogon sociabilis has been previously recorded in Norway.

Material examined. 3♂♂ (ID: FiCer14, FiCer101, FiCer110) and 3♀♀ (ID: FiCer33, FiCer43, FiCer246) 19–24 June 2010, 2♂♂ (ID: FiCer183, FiCer185) and 1♀ (ID: FiCer186) 24 June–20 July 2010, 1♂ (ID: FiCer80) and 1♀ (ID: FiCer242) 20–30 July 2010, 2♂♂ (ID: FiCer62, FiCer64) and 2♀♀ (ID: FiCer74, FiCer236) 30 July–10 August 2010, all FinLoc65, Malaise trap, 1♂ (ID: FiCer197) 23 July–07 August 2010, FinLoc05, Malaise trap.

Brachypogon (Isohelea) sp. 1ES

Brachypogon sp.1ES keys to *B. (Isohelea) incompletus* (Kieffer, 1925) in Szadziewski et al. (1994), but does not entirely fit their species description (e.g. differently shaped aedeagus).

Material examined. 1♂ (FiCer105) 19–24 June 2010, FinLoc65, Malaise trap.

Brachypogon (Isohelea) sp. 2ES

Brachypogon sp. **2ES** is a species similar to *B. (Isohelea) norvegicus* Szadziewski & Hagan, 2000 but with a differently shaped aedeagus. The species is possibly new to science.

Material examined. ♂♂ (FiCer21, FiCer22, FiCer26, FiCer31, FiCer99, FiCer112) 19–24 June 2010, ♂ (FiCer141) 24 June–20 July 2010, ♂ (FiCer229) 20–30 July 2010, 1♀ (FiCer235) 30 July–10 August 2010, all FinLoc65, Malaise trap.

Genus *Ceratopogon*

All identifications are based on the generic revision by Borkent and Grogan (1995).

***Ceratopogon abstrusus* Borkent & Grogan, 1995**

Ceratopogon abstrusus was described by Borkent and Grogan (1995) from the Nearctic with a wide range from Alaska to northern Greenland and has been referred by them as “the most broadly distributed of all *Ceratopogon* species”. The record from Finnmark is the first for the Palearctic (other than northern Greenland).

Material examined. 2♂♂ (FiCer12, FiCer13) 19–24 June 2010, FinLoc65, Malaise trap.

***Ceratopogon grandiforceps* (Kieffer, 1913)**

Ceratopogon grandiforceps from Finnmark is the first record for Fennoscandia.

Material examined. 1♂ (FiCer48) 15 June–02 July 2010, FinLoc42, Malaise trap.

***Ceratopogon lacteipennis* Zetterstedt, 1838**

Ceratopogon lacteipennis has been previously recorded in northern Norway (Senja) and other localities in Norway (Thunes et al. 2004, Hagan et al. 2000).

Material examined. 3♂♂ (FiCer136, FiCer165, FiCer166) 24 June–20 July 2010, FinLoc65, Malaise trap.

Genus *Serromyia*

Serromyia femorata (Meigen, 1804)

This species has been previously recorded in Norway and was redescribed by Borkent and Bissett (1990).

Material examined. 1♂ (FiCer208) 10–23 July 2010, FinLoc08, Malaise trap, 1♀ (ID: FiCer143) 24 June–20 July 2010, FinLoc65, Malaise trap.

Johannsenomyiini

Genus *Probezzia*

Probezzia sp.

A single pupa was collected in a drift sample (see Fig. 9 in Ekrem et al. 2012).

The pupa from Finnmark is the first record of this genus for Norway. Three European species of *Probezzia* are Holarctic in distribution (Wirth 1971). The specimen was identified to genus using the key to genera by Borkent (2014b).

Material examined. 1 pupa (Finnmark792) 19 June 2010, FinLoc92, drift.

Palpomyiini

Genus *Bezzia*

Bezzia annulipes (Meigen, 1830)

The specimen from Finnmark fits the description in Remm (1974a) and Wirth et al. (1984) for this Holarctic species. This is the first record of the species in Norway.

Material examined. 1♂ (FiCer3) 19–24 June 2010, FinLoc65, Malaise trap.

Bezzia circumdata (Staeger, 1839)

The species keys to *B. solstitialis* (Winnertz, 1852) in Remm 1974a which is currently considered a synonym of *B. circumdata*.

Material examined. 1♀ (FiCer61) 30 July–08 August 2010, FinLoc65, Malaise trap.

Bezzia rhynchostylata Remm, 1974

The species keys to *B. rhynchostylata* in Remm 1974b.

Material examined. 2♂♂ (FiCer7, FiCer11) and 2♀♀ (FiCer32, FiCer36) 19–24 June 2010, FinLoc65, Malaise trap.

Genus *Palpomyia*

Palpomyia puberula Remm, 1976

The examined female keys to and fits the description of *Palpomyia puberula* in Remm (1976).

Material examined. 1♀ (FiCer133) 23 July–07 August 2010, FinLoc05, Malaise trap.

Palpomyia remmi Havelka, 1974

The Finnmark specimens fit the description by Havelka (1974). Krzywinski (1997) records the species for the first time in Norway and mentions that the species could be conspecific to the North American *P. canadensis* Grogan & Wirth, 1979. If the two species are conspecific, *P. remmi* would have a Holarctic distribution.

Material examined. 1♂ (FiCer227) 10–23 July 2010 and 3♂♂ (FiCer200, FiCer207, FiCer209) 23 July–07 August 2010, FinLoc08, Malaise trap, 2♀♀ (FiCer85, FiCer87) 10–23 July 2010 and 1♀ (FiCer132, FiCer198) 23 July–07 August 2010, FinLoc05, Malaise trap.

Palpomyia serripes (Meigen, 1818)

The examined males and females key to and fit the description of *P. serripes* in Remm (1976). The species seems to have a “north-south” rather than a circumpolar distribution.

Material examined. 1♂ (FiCer92) and 4♀♀ (FiCer167, FiCer168, FiCer169, FiCer170) 24 June–20 July 2010, 1♀ (FiCer78) 20–30 July 2010, all FinLoc65, Malaise trap.

Ceratopogonidae gen. sp. 1ES

The larvae belong to either *Bezzia* or *Palpomyia*. For further identification association with the adult is required.

Material examined. 2 larvae (FiCer217, FiCer218) 14 June 2010, FinLoc07, benthos.

Discussion

Our relatively cursory sampling of *Ceratopogonidae* revealed a startling 54 species within nine genera. Of these, 40 could be identified to previously named species, and 14 are apparently either undescribed or are close to previously known species. Considering that no *Ceratopogonidae* have been previously recorded from Finnmark, this is

a substantial increase in numbers and reflects the poorly sampled and interpreted state of this diverse and common family in northern Norway. There are several impediments to our understanding this group in Finnmark. For example, much of our collecting, especially with hand nets, was not focused on Ceratopogonidae, which often require a less delicate sweeping mode than is best for Chironomidae. Most of our specimens were collected with Malaise traps, especially with the trap at locality FinLoc65. Even with these considerable limitations, we uncovered a substantial diversity. Certainly, with further concerted sampling in Finnmark, we would expect to find a significantly more diverse fauna than reported here.

A second impediment to understanding Ceratopogonidae in Finnmark, Norway and Europe in general is the major gaps in taxonomic revisions. For most genera, there are no inclusive European keys, based on examination of types and comparative material and most current revisions are regional or country specific. Even the continent-wide threat of Bluetongue and the Schmallenberg virus, resulting in millions of Euros in losses to livestock, has failed as an incentive to produce a comprehensive taxonomic analysis of the species of *Culicoides*, some of which act as vectors of these diseases. Further to this, very few revisions have compared Palaearctic and Nearctic species, especially important for northern taxa, and this has made an understanding of the distributions of many species uncertain. In some instances, it is very likely that some Palaearctic and Nearctic species, presently with different names, are actually conspecific.

To complete comprehensive revisions, authors should check all available types. This too is an impediment to our understanding of a number of genera. Many species names are floating because no one has examined the types since they were first described (in some cases over 150 years ago!).

Much of this reflects the general state of support for taxonomy, which is generally poor to non-existent. In the meantime, the Ceratopogonidae are a case in point for the value of future studies. Many species live in peripheral aquatic habitats (edges of streams, ponds and marshes) or in very small water bodies (springs, small pools), habitats that are often under extreme threat on our planet. A better understanding of the fauna of these habitats would reinforce the concept that they need to be protected.

One advantage of the present study, despite the lack of some species names, is that every investigated specimen is DNA barcoded and kept as a voucher in a public collection. This makes it possible to include them in further taxonomic studies, and to associate other life stages at a later point in time when obtained. For morphological species that are represented by more than one barcode cluster (such as *Dasyhelea modesta* or *Brachypogon nitidulus*), detailed reexamination of vouchers will be required to discover possible morphological traits that may distinguish new taxa. Moreover, as Anderson et al. (2013) found for the chironomid genus *Micropsectra*, detailed comparison of multiple life stages, ecology and nuclear molecular markers should clarify whether some of the highly divergent barcode clusters obtained in our study actually represent different biological species.

Acknowledgements

We are grateful for the help and comments provided by Professor Ryszard Szadziowski on various taxa. We extend our thanks to Torbjørn Ekrem for assistance on the genetic analyses. We thank Torbjørn Ekrem, William Grogan and Jonas Strandberg for comments to the manuscript, Linn Hagenlund for sorting Malaise trap samples and Marc Daverin for producing the map in Figure 1. The second author extends his deep appreciation to his wife Annette Borkent for continued financial support (and otherwise) of his taxonomic studies. This study was partially funded through a grant from the Norwegian Taxonomy Initiative run by the Norwegian Biodiversity Information Centre.

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Appendix

Overview of sequenced Ceratopogonidae specimens and species from Finnmark.

Sample ID	Species	Life Stage	Locality	Collection Date	Collectors	GenBank Accession
FiCer203	<i>A. (Atrichopogon) hirtidorsum</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ767865
FiCer205	<i>A. (Atrichopogon) hirtidorsum</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ767866
FiCer232	<i>A. (Atrichopogon) hirtidorsum</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ767867
FiCer201	<i>A. (Atrichopogon) infuscus</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ767868
FiCer130	<i>A. (Atrichopogon) minutus</i>	adult	FinLoc05	27-Aug-2010	Ekrem et al.	KJ767869
FiCer228	<i>A. (Atrichopogon) minutus</i>	adult	FinLoc08	23-Jul-2010	Ekrem et al.	KJ767870
FiCer233	<i>A. (Lophomyidium) fuscus</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ767864
FiCer148	<i>A. (Meleohela) oedemarus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767871
FiCer142	<i>A. (Meleohela) oedemarus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767872
FiCer156	<i>F. (Euprojoannisia) alacris</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768001
FiCer121	<i>F. (Euprojoannisia) alacris</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768002
FiCer75	<i>F. (Euprojoannisia) alacris</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ768003
FiCer161	<i>F. (Euprojoannisia) alacris</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768004
FiCer239	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ768036
FiCer104	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768037
FiCer108	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768038

Sample ID	Species	Life Stage	Locality	Collection Date	Collectors	GenBank Accession
FiCer24	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768039
FiCer155	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768040
FiCer125	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768041
FiCer95	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768042
FiCer98	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768043
FiCer240	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ768044
FiCer159	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768045
FiCer41	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768046
FiCer42	<i>F. (Euprojoannisia) palustris</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768047
FiCer25	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768055
FiCer215	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc05	26-Jun-2010	Ekrem et al.	KJ768056
FiCer174	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768057
FiCer224	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc81	19-Jun-2010	T. Ekrem, E. Stur	KJ768058
FiCer113	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768059
FiCer76	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ768060
FiCer19	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768061
FiCer20	<i>F. (Euprojoannisia) sp. 6ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768062
FiCer57	<i>F. (Forcipomyia) bipunctata</i>	adult	FinLoc65	08-Sep-2010	T. Andersen	KJ768005
FiCer146	<i>F. (Forcipomyia) squamigera</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768063
FiCer54	<i>F. (Forcipomyia) sp. 2ES</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ768049
FiCer96	<i>F. (Forcipomyia) sp. 2ES</i>	adult	FinLoc85	07-Sep-2010	T. Andersen	KJ768050
FiCer134	<i>F. (Forcipomyia) sp. 3ES</i>	adult	FinLoc05	27-Aug-2010	Ekrem et al.	KJ768051
FiCer212	<i>F. (Forcipomyia) hygrophila</i>	adult	FinLoc05	26-Jun-2010	Ekrem et al.	KJ768008
FiCer220	<i>F. (Forcipomyia) hygrophila</i>	adult	FinLoc77	19-Jun-2010	T. Ekrem, E. Stur	KJ768009
FiCer9	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768017
FiCer222	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc67	19-Jun-2010	T. Ekrem, E. Stur	KJ768018
FiCer221	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc67	19-Jun-2010	T. Ekrem, E. Stur	KJ768019
FiCer210	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc05	26-Jun-2010	Ekrem et al.	KJ768020
FiCer17	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768021
FiCer16	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768022
FiCer94	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768023
FiCer10	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768024
FiCer223	<i>F. (Forcipomyia) nigra</i>	adult	FinLoc81	19-Jun-2010	T. Ekrem, E. Stur	KJ768025
FiCer83	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ768026
FiCer145	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768027
FiCer91	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc21	06-Aug-2010	Ekrem et al.	KJ768028
FiCer90	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc21	06-Aug-2010	Ekrem et al.	KJ768029
FiCer89	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc56	09-Sep-2010	Ekrem et al.	KJ768030
FiCer238	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ768031
FiCer199	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc05	07-Aug-2010	Ekrem et al.	KJ768032
FiCer73	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ768033
FiCer60	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc19	06-Aug-2010	Ekrem et al.	KJ768034
FiCer59	<i>F. (Forcipomyia) nigrans</i>	adult	FinLoc19	06-Aug-2010	Ekrem et al.	KJ768035
FiCer231	<i>F. (Forcipomyia) tenuis</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ768064
FiCer226	<i>F. (Forcipomyia) tenuis</i>	adult	FinLoc06	13-Jun-2010	T. Ekrem, E. Stur	KJ768065
FiCer225	<i>F. (Forcipomyia) tenuis</i>	adult	FinLoc06	13-Jun-2010	T. Ekrem, E. Stur	KJ768066

Sample ID	Species	Life Stage	Locality	Collection Date	Collectors	GenBank Accession
FiCer219	<i>F. (Forcipomyia) tenuis</i>	adult	FinLoc77	19-Jun-2010	T. Ekrem, E. Stur	KJ768067
FiCer46	<i>F. (Forcipomyia) tenuis</i>	adult	FinLoc36	17-Jun-2010	E. Stur	KJ768068
FiCer214	<i>F. (Forcipomyia) sp. 1ES</i>	adult	FinLoc05	26-Jun-2010	Ekrem et al.	KJ768048
FiCer157	<i>F. (Synthyridomyia) acidicola</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768000
FiCer237	<i>F. (Synthyridomyia) knockensis</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ768010
FiCer84	<i>F. (Synthyridomyia) knockensis</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ768011
FiCer147	<i>F. (Synthyridomyia) knockensis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768012
FiCer144	<i>F. (Synthyridomyia) knockensis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768013
FiCer153	<i>F. (Synthyridomyia) knockensis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768014
FiCer164	<i>F. (Synthyridomyia) knockensis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768015
FiCer150	<i>F. (Thyridomyia) monilicornis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768016
FiCer162	<i>F. (Thyridomyia) sp. 4ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768052
FiCer122	<i>F. (Thyridomyia) sp. 5ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768053
FiCer152	<i>F. (Thyridomyia) sp. 5ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768054
FiCer111	<i>F. (Trichobelea) chaetoptera</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ768006
FiCer149	<i>F. (Trichobelea) chaetoptera</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768007
FiCer190	<i>D. (Dasyhelea) bensoni</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767961
FiCer117	<i>D. (Dasyhelea) bensoni</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767962
FiCer211	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc05	26-Jun-2010	Ekrem et al.	KJ767964
FiCer44	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767965
FiCer27	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767966
FiCer66	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767967
FiCer120	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767968
FiCer191	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767969
FiCer189	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767970
FiCer243	<i>D. (Dasyhelea) malleola</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767971
FiCer202	<i>D. (Dasyhelea) sp. 4ES</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ767996
FiCer40	<i>D. (Dasyhelea) sp. 4ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767997
FiCer116	<i>D. (Dasyhelea) sp. 4ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767998
FiCer115	<i>D. (Dasyhelea) sp. 4ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767999
FiCer107	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767972
FiCer81	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767973
FiCer204	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ767974
FiCer39	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767975
FiCer38	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767976
FiCer37	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767977
FiCer100	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767978
FiCer29	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767979
FiCer102	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767980
FiCer28	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767981
FiCer8	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767982
FiCer114	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767983
FiCer109	<i>D. (Dicryptoscena) modesta</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767984
FiCer63	<i>D. (Prokempia) sp. 1ES</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767985
FiCer65	<i>D. (Prokempia) sp. 1ES</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767986
FiCer118	<i>D. (Prokempia) sp. 1ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767987

Sample ID	Species	Life Stage	Locality	Collection Date	Collectors	GenBank Accession
FiCer194	<i>D. (Prokempia)</i> sp. 1ES	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767988
FiCer216	<i>D. (Prokempia)</i> sp. 1ES	adult	FinLoc05	26-Jun-2010	Ekrem et al.	KJ767989
FiCer244	<i>D. (Prokempia)</i> sp. 1ES	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767990
FiCer18	<i>D. (Pseudoculicoides) bifida</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767963
FiCer35	<i>D. (Pseudoculicoides)</i> sp. 2ES	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767991
FiCer45	<i>D. (Pseudoculicoides)</i> sp. 2ES	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767992
FiCer193	<i>D. (Pseudoculicoides)</i> sp. 3ES	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767993
FiCer192	<i>D. (Pseudoculicoides)</i> sp. 3ES	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767994
FiCer119	<i>D. (Pseudoculicoides)</i> sp. 3ES	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767995
FiCer1	<i>C. (Beltramymia) salinarius</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767957
FiCer2	<i>C. (Beltramymia) salinarius</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767958
FiCer47	<i>C. (Beltramymia) salinarius</i>	adult	FinLoc42	02-Jul-2010	Ekrem et al.	KJ767959
FiCer77	<i>C. (Beltramymia) sphagnumensis</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767960
FiCer88	<i>C. (Culicoides) griseus</i>	adult	FinLoc56	09-Sep-2010	Ekrem et al.	KJ767938
FiCer131	<i>C. (Culicoides) griseus</i>	adult	FinLoc05	27-Aug-2010	Ekrem et al.	KJ767939
FiCer195	<i>C. (Culicoides) griseus</i>	adult	FinLoc05	07-Aug-2010	Ekrem et al.	KJ767940
FiCer50	<i>C. (Culicoides) griseus</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ767941
FiCer51	<i>C. (Culicoides) griseus</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ767942
FiCer53	<i>C. (Culicoides) griseus</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ767943
FiCer55	<i>C. (Culicoides) griseus</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ767944
FiCer58	<i>C. (Culicoides) griseus</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ767945
FiCer93	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767946
FiCer67	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767947
FiCer68	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767948
FiCer69	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767949
FiCer70	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767950
FiCer71	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767951
FiCer173	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767952
FiCer79	<i>C. (Culicoides) griseus</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767953
FiCer23	<i>C. (Oecacta) albicans</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767935
FiCer52	<i>C. (Silvaticulicoides) fascipennis</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ767936
FiCer56	<i>C. (Silvaticulicoides) fascipennis</i>	adult	FinLoc85	08-Sep-2010	T. Andersen	KJ767937
FiCer180	<i>C. (Wirthomyia) minutissimus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767954
FiCer206	<i>C. (Wirthomyia) reconditus</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ767955
FiCer86	<i>C. (Wirthomyia) reconditus</i>	adult	FinLoc05	23-Jul-2010	Ekrem et al.	KJ767956
FiCer4	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767879
FiCer5	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767880
FiCer6	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767881
FiCer106	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767882
FiCer137	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767883
FiCer241	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767884
FiCer138	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767885
FiCer30	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767886
FiCer234	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ767887
FiCer15	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767888
FiCer247	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767889

Sample ID	Species	Life Stage	Locality	Collection Date	Collectors	GenBank Accession
FiCer188	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767890
FiCer187	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767891
FiCer49	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc42	02-Jul-2010	Ekrem et al.	KJ767892
FiCer245	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767893
FiCer184	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767894
FiCer181	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767895
FiCer182	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767896
FiCer34	<i>B. (Isohelea) nitidulus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767897
FiCer110	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767898
FiCer246	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767899
FiCer242	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767900
FiCer14	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767901
FiCer236	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ767902
FiCer183	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767903
FiCer101	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767904
FiCer33	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767905
FiCer185	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767906
FiCer43	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767907
FiCer186	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767908
FiCer62	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767909
FiCer64	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767910
FiCer74	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767911
FiCer80	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767912
FiCer197	<i>B. (Isohelea) sociabilis</i>	adult	FinLoc05	07-Aug-2010	Ekrem et al.	KJ767913
FiCer105	<i>B. (Isohelea) sp. 1ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767914
FiCer97	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767915
FiCer99	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767916
FiCer103	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767917
FiCer26	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767918
FiCer112	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767919
FiCer22	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767920
FiCer229	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ767921
FiCer21	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767922
FiCer141	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767923
FiCer235	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	10-Aug-2010	Ekrem et al.	KJ767924
FiCer139	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767925
FiCer31	<i>B. (Isohelea) sp. 2ES</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767926
FiCer12	<i>Ceratopogon abstrusus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767927
FiCer13	<i>Ceratopogon abstrusus</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767928
FiCer48	<i>Ceratopogon grandiforceps</i>	adult	FinLoc42	02-Jul-2010	Ekrem et al.	KJ767929
FiCer166	<i>Ceratopogon lacteipennis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767932
FiCer136	<i>Ceratopogon lacteipennis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767933
FiCer165	<i>Ceratopogon lacteipennis</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ767934
FiCer143	<i>Serromyia femorata</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768085
FiCer208	<i>Serromyia femorata</i>	adult	FinLoc08	23-Jul-2010	Ekrem et al.	KJ768086
Finnmark792	<i>Probezzia</i>	pupa	FinLoc92	19-Jun-2010	G.A. Halvorsen	KJ768084

Sample ID	Species	Life Stage	Locality	Collection Date	Collectors	GenBank Accession
FiCer3	<i>Bezzia annulipes</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767873
FiCer61	<i>Bezzia circumdata</i>	adult	FinLoc65	08-Jul-2010	Ekrem et al.	KJ767874
FiCer7	<i>Bezzia rhynchostylata</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767875
FiCer36	<i>Bezzia rhynchostylata</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767876
FiCer11	<i>Bezzia rhynchostylata</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767877
FiCer32	<i>Bezzia rhynchostylata</i>	adult	FinLoc65	24-Jun-2010	Ekrem et al.	KJ767878
FiCer133	<i>Palpomyia puberula</i>	adult	FinLoc05	27-Aug-2010	Ekrem et al.	KJ768069
FiCer85	<i>Palpomyia remmi</i>	adult	FinLoc05	23-Jul-2010	Ekrem et al.	KJ768070
FiCer227	<i>Palpomyia remmi</i>	adult	FinLoc08	23-Jul-2010	Ekrem et al.	KJ768071
FiCer209	<i>Palpomyia remmi</i>	adult	FinLoc08	23-Jul-2010	Ekrem et al.	KJ768072
FiCer207	<i>Palpomyia remmi</i>	adult	FinLoc08	23-Jul-2010	Ekrem et al.	KJ768073
FiCer200	<i>Palpomyia remmi</i>	adult	FinLoc08	07-Aug-2010	Ekrem et al.	KJ768074
FiCer198	<i>Palpomyia remmi</i>	adult	FinLoc05	07-Aug-2010	Ekrem et al.	KJ768075
FiCer87	<i>Palpomyia remmi</i>	adult	FinLoc05	23-Jul-2010	Ekrem et al.	KJ768076
FiCer132	<i>Palpomyia remmi</i>	adult	FinLoc05	27-Aug-2010	Ekrem et al.	KJ768077
FiCer168	<i>Palpomyia serripes</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768078
FiCer92	<i>Palpomyia serripes</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768079
FiCer170	<i>Palpomyia serripes</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768080
FiCer78	<i>Palpomyia serripes</i>	adult	FinLoc65	30-Jul-2010	Ekrem et al.	KJ768081
FiCer169	<i>Palpomyia serripes</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768082
FiCer167	<i>Palpomyia serripes</i>	adult	FinLoc65	20-Jul-2010	Ekrem et al.	KJ768083
FiCer218	Ceratopogonidae gen. sp. 1ES	larva	FinLoc07	14-Jun-2011	T. Ekrem, E. Stur	KJ767930
FiCer217	Ceratopogonidae gen. sp. 1ES	larva	FinLoc07	14-Jun-2010	T. Ekrem, E. Stur	KJ767931

The LifeWatch approach to the exploration of distributed species information

Daniel Fuentes¹, Nicola Fiore²

1 Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas (CSIC), Spain. **2** Ecology Unit, University of Salento, Italy

Corresponding author: *Daniel Fuentes* (dfuentes@ebd.csic.es)

Academic editor: *L. Penev* | Received 7 August 2014 | Accepted 28 November 2014 | Published 12 December 2014

<http://zoobank.org/5A51DF9E-1BE4-45F2-A5E9-9DF74E37EEF9>

Citation: Fuentes D, Fiore N (2014) The LifeWatch approach to the exploration of distributed species information. ZooKeys 463: 133–148. doi: 10.3897/zookeys.463.8397

Abstract

This paper introduces a new method of automatically extracting, integrating and presenting information regarding species from the most relevant online taxonomic resources. First, the information is extracted and joined using data wrappers and integration solutions. Then, an analytical tool is used to provide a visual representation of the data. The information is then integrated into a user friendly content management system. The proposal has been implemented using data from the Global Biodiversity Information Facility (GBIF), the Catalogue of Life (CoL), the World Register of Marine Species (WoRMS), the Integrated Taxonomic Information System (ITIS) and the Global Names Index (GNI). The approach improves data quality, avoiding taxonomic and nomenclature errors whilst increasing the availability and accessibility of the information.

Keywords

Online taxonomic resources, interoperable web services, information retrieval, taxonomy

Introduction

Detailed information of species can be queried by the scientific community through multiple online taxonomic resources which are accessible on the Web. An online taxonomic resource is a megascience platform that harvests, processes and provides biodiversity data of animals, plants, fungi and micro-organisms. The information included

in these portals describes taxonomies, synonyms, references, images and distributions, etc. The online taxonomic resources are a aggregation (or mash-up) designed to collate the data of all organisms set in the context of a taxonomic hierarchy and of their distribution.

In general, a comprehensive online taxonomic resource cover information on all kinds of organisms like in Catalogue of Life (CoL, <http://www.catalogueoflife.org>), Discover Life (<http://www.discoverlife.org/>), Encyclopedia of Life (EoL, <http://eol.org>), Global Biodiversity Information Facility (GBIF, <http://www.gbif.org>), Biodiversity Heritage Library (BHL, <http://www.biodiversitylibrary.org>), the Integrated Taxonomic Information System (ITIS, <http://www.itis.gov>) and the Global Names Index (GNI, <http://gni.globalnames.org>). However, it can also focuses on a limited area of biodiversity, such as World Register of Marine Species (WoRMS, <http://www.marinespecies.org>), International Nucleotide Sequence Database Collaboration (INSDC, <http://www.insdc.org>) and JSTOR Plant Science (<http://plants.jstor.org>).

It is estimated that the number of species on the planet that have been documented by scientists has risen to 1.9 million (Chapman 2009). Taxonomists have been tasked with cataloguing and quantifying the Earth's biodiversity. Their progress is measured in code-compliant descriptions that include text, images, type material and molecular sequences (Hardisty et al. 2013). These experts often disagree about the best classification for a given group of organisms, and there is no universal taxonomy (Patterson et al. 2014, David et al. 2012). However, the taxonomic name has remained as the most commonly shared identifier that spans sequences, specimens, and publications despite the wealth of possible connections between biodiversity data objects (Patterson et al. 2010).

As we move towards a digital data world, we are increasingly reliant on the internet as a source of information (Thessen et al. 2011, Patterson 2014). Unfortunately, at present it is often tedious, even with the help of new technologies, to obtain information on a taxonomic name, either to track its origins and subsequent use, or to verify that it has been correctly used. Taxonomists have to consult primary literature because they consider that online resources are incomplete (Thessen et al. 2012, Franz et al. 2008).

Nowadays, species identification errors come from diverse causes: the variation in data quality and cross-linkages between databases, an inadequate updating of information and the lack of a single authoritative world taxonomic resource for the definition of the taxa cause. Moreover, the taxonomy itself is subject to continuous evolution, since the elements that it classifies continue to evolve. Hence, taxonomic resources will differ in their composition even if they claim to be comprehensive. They will change as new knowledge develops due to scientific and technological advances in the field of software development and evolution (Franz and Thau 2011, Franz et al. 2008).

Online taxonomic resources reflect these differences by supporting several scientific classifications resulting in mismatched records and inflated species numbers. Divergences in names and taxonomies are frequently found due to consulted databases are fed from disparate sources. The consequence of misspelled names and bad taxonomy is erroneous to scientific conclusions (De Broyer et al. 2011, Katsanevakis et al. 2013, Parr et al. 2012).

Contextually, the maintenance and management of information uploaded, error avoidance and the resolution of inconsistencies combined with the data control of treatments, make species list management a great effort (Zachos 2013). Thus, a strong case is presented, for the integration and harmonization of the existing information distributed regarding species classifications. The lack of tools facilitating this task becomes a fundamental obstacle.

The LifeWatch research e-infrastructure (<http://www.lifewatch.eu>) does not try to compose its own taxonomy from different sources. LifeWatch has come to an agreement with the different sources of taxonomic backbone information so as to be able to offer their usage in the LifeWatch framework, for example, in order to disambiguate the species names in queries. In addition, LifeWatch is working closely with all initiatives in the domain including GBIF, the Global Names Architecture (GNA, <http://www.globalnames.org>), EoL, CoL, Pan-European Species directories Infrastructure (PESI, <http://www.eu-nomen.eu>), and national authorities, to provide the taxonomic capabilities needed for its purposes (Giddy et al. 2009).

This paper presents a method that facilitates the exploration of existing species information from distributed sources, through a set of interoperable web services. It enables links to the most important on-line biodiversity databases to retrieve information about taxonomy, synonyms, common names, etc. The rest of this paper is structured as follows: In section 2 a brief description of the infrastructure where the presented service is placed. Section 3 outlines the most widely used online taxonomic resources and software tools. The design and implementation of our proposal are presented in Section 4 and the last section contains some concluding remarks.

LifeWatch in a nutshell

LifeWatch is a European research e-infrastructure (ESFRI, http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri) project for biodiversity science and ecosystems research (now entering its construction phase) that collaborates with scientists and engineers from across the European Union. Figure 1 shows the LifeWatch architecture divided in layers, including a range of new services and tools to help researchers communicate, share data, analyze results, create models, manage projects and organize training.

Services can be put together in three main groups:

- *Core ICT support*: The LifeWatch ICT Infrastructure is a system of distributed nodes distribution system that provides access to and processing of biodiversity data from a variety of sources through common open interfaces (Giddy et al. 2009). In this context, flexible and durable solutions for storage, computing, networking and hosting are included providing services with the technology support required.
- *Virtual Laboratories*: To provide researchers with a common point of access and share the data, the LifeWatch infrastructure includes a set of virtual labs. A virtual lab is an interoperable computing environment that allows researchers to update

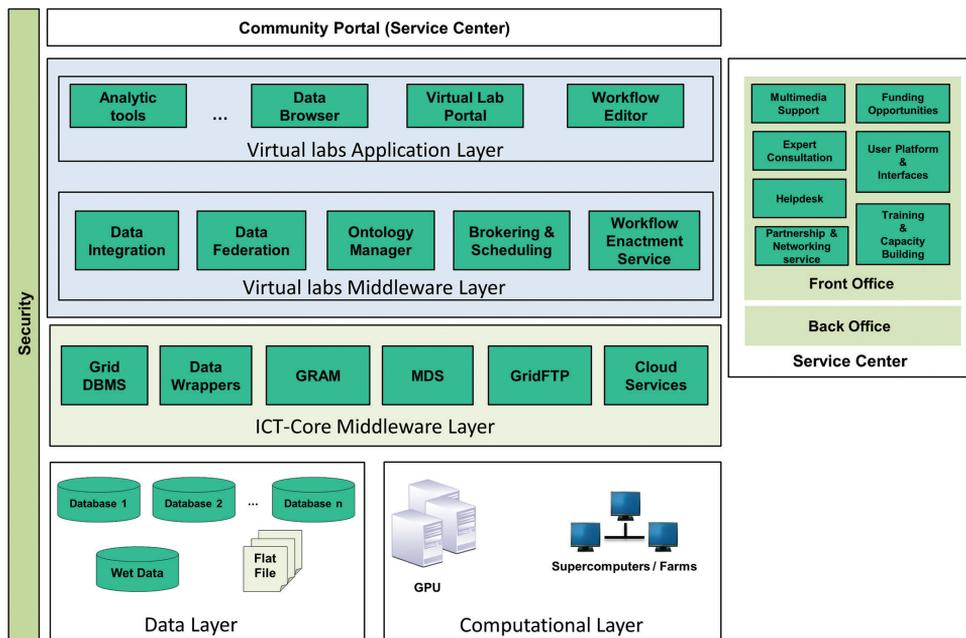


Figure 1. LifeWatch architecture in layers.

the database and to use analytical tools to extract specific information from the data. Furthermore, it supports multidisciplinary international collaboration between researchers working in different time zones.

- *Community support*: Due to the diverse range of available tools, the community support element of the platform brings people and expertise together. Thus, providing access to all services, and assisting participating organizations and scientists with training programmes, technical advice, grant information and other resources.

The LifeWatch functional requirements concern the types of operations that the users need in order to find, access, process and view data. They include:

- Searching and browsing mechanisms for distributed data and services.
- Uniform identity framework for data and services.
- Access to existing data and services, distributed among multiple organisations. Data and service providers continue to manage their data (and services) independently as now, including control of the creation and modification of data/services. However, data can be accessed by authorised users located anywhere through a generic mechanism defined by LifeWatch.
- Mechanisms for source data preservation, such as the access to past versions of data sets that have been used to produce secondary information.
- Capture data from users and lightweight devices, including field sensors and networks providing continuous streams of new data, and portable computing devices, often with intermittent connectivity.

- Mechanisms for data analysis as well as mapping and modelling tools, using standard ways to manipulate and view data.
- Mechanisms for data fusion, integrating different sources (such as sensor data, biodiversity parameters, geographic data, primary data, workflow execution), to allow fast retrieval at different levels of detail, for example, in analysis and visualisation.
- Support the understanding of results by the user, by providing tools and mechanisms to enhance knowledge extraction from discovery as well as from analysis results.

State of art

In the rest of the paper, we will consider the following concepts related to taxonomy taking into account the list of terms used in GBIF (Hawksworth 2010):

Species: A taxon at the rank.

Classification. Hierarchical system in which items may be grouped, with little or no ancillary data.

Checklist. List of names within a limited context.

Treatment. Description of a taxon

Aggregation. The drawing together of digital biodiversity data from multiple sources.

Scientific name. The scientific name of a taxon at any rank above the species group consists of one name, that of a species of two names (binomen), and that of a subspecies three names (a trinomen).

Accepted name. the designation adopted by an author as the correct name for a taxon under consideration.

Valid name. of an available name, one acceptable under the provisions of the taxonomic resource and which is the correct name for a taxon in an author's taxonomic judgement.

Synonym. Each of two or more names of the same rank used to denote the same taxon.

The scope of megascience platforms processing biodiversity information

Online taxonomic resources provide information about the taxonomic status of a taxon as well as synonymous relations, they facilitate the taxonomic data capture, help input data control processes and integrate information in other databases and infrastructures (Triebel et al. 2012). Despite almost all these taxonomic resources containing information about all living things, each has its own data domains, providers, scope of contents and user communities. For instance: occurrences and records in GBIF, taxonomic checklists and classifications in CoL, names in the Global Names Usage Bank (GNUB, <http://www.globalnames.org/GNUB>), taxonomy in marine species in WoRMS, zoological publications and nomenclatures in The Official Registry of Zoological Nomenclature (ZooBank, <http://zoobank.org>), knowledge data and multimedia objects in EoL, DNA barcoding sequences in International Barcode of Life (iBOL, <http://ibol.org>), etc.

Scientific names and taxonomies are of essential interest in major biodiversity platforms (Boyle et al. 2013, Metzger et al. 2013, Patterson et al. 2010) and are typically fed by individual scientists and institutions researching data. However, they may alternatively be supplied by primary data collected from other databases (Nozères et al. 2012) which creates a graph, in which taxonomic resources are the nodes and data flows the connectors, creating dependences between them. For example, EoL contains information from several taxonomic hierarchies like GBIF, GNA, iBOL, International Nucleotide Sequence Database Collaboration (INSDC), JSTOR Plant Science and Biodiversity Heritage Library (BHL), The International Plant Names Index (IPNI, <http://www.ipni.org>), etc.

In the future, data flows will be even more complicated due to the growth in the number of initiatives, infrastructures and collaborations that cover taxonomy and classification challenges. The new biology based on the big data world is envisaged as a discipline with a strong data-centric character and a growing role for informatics. The responsibility for managing data from many sources will probably be carried out by modules or nodes that serve specified subdisciplines. The nodes will aggregate heterogeneous content within a particular subdomain, making it discoverable and available to end users (Patterson 2014, Thesen and Patterson 2011). An example that follows this model is the Global Names Architecture, which indexes, organizes and interconnects on-line information about organisms and their names.

Interoperability solutions

Today, one of the main challenges in bioinformatics is the implementation of the interoperability in an environment where interdisciplinary cooperation is key to scientific understanding (Berendsohn et al. 2011, Fielding 2000, Remsen et al. 2006). Data sharing is essential to fostering the collaboration and large-scale analysis needed for the successful treatment of the initiatives connected with biodiversity (Costello et al. 2013, Hine et al. 2003). Currently, there are two main proposals to achieve the interoperability desired across such systems and data; federating and brokering. In the federating solution (Heimbigner et al. 1985), the interoperability is achieved by a set of service buses based on the SOA architecture binding the user and the provider. Initiatives that follow this solution are based on federal specifications, covering data and metadata models, predefined vocabularies and ontologies, service interfaces and binding protocols. The Infrastructure for Spatial Information in the Europe (INSPIRE, <http://inspire.ec.europa.eu>) directive or the National Spatial Data Infrastructure (<http://www.fgdc.gov/nsdi/nsdi.html>) are two examples of such a federated approach.

However, in the brokering approach (Nativi et al. 2011) the heterogeneity is addressed by focusing on mediation rather than standardization. It proposes a User-Broker-Producer model by which the Broker consists of multiple support components facilitating the discovery of, semantic and natural language mediation, data access services, workflow process, and publishing. The brokering model has been adopted by the European approach to Global Earth Observation System of Systems (EuroGEOSS,

<http://www.eurogeoss.eu>) project. Following the functional requirements, the brokering option is selected as all data providers use a different specification to interoperate. Therefore, a middleware (composed of brokers) interconnect clients and online taxonomic resources in a common infrastructure.

Tools

In the last years, some tools have already been developed for the exploration of distributed information about taxonomies. New advances in taxonomic publication processes are designed to speed information automatically to diverse users. One method dealt with a solution for special citation of taxonomic work when used in wiki pages by combining both the original non-wiki source and the respective wiki page (Penev et al. 2011). However, another approach sets out a workflow that describes the assembly of elements from a Scratchpad taxon page (<http://scratchpads.eu>) to export a structured XML file (Blagoderov et al. 2010). Methods of semantic tagging and semantic enhancements, text and data processing, publishing and dissemination in taxonomy have provided an increase in open access literature and journals aiming at rapid publication of taxonomic treatments, including new publication models such as semantically enhanced information (Penev et al. 2010). Also, the software package DELTA includes a data-basing program which stores morphological data for export in different forms and acts as a manager of taxonomic research (Coleman et al. 2010).

Recently, many organizations have developed different software tools to harvest, publish and share data (Katsanevakis et al. 2012, Kennedy et al. 2006, Wu et al. 2009). GBIF offers community tools to enable the integration of biodiversity data from heterogeneous sources using standards and protocols; an example is the Integrated Publishing Toolkit (IPT, <http://ipt.gbif.org>) which enables the publication of content in databases or text files using open standards Darwin Core (DwC, <http://rs.tdwg.org/dwc>) and the Ecological Metadata Language (EML, <http://knb.ecoinformatics.org/software/eml/>). The GBIF Spreadsheet Processor is a similar tool intended for smaller occurrence datasets stored in excel files. The limited number of concepts in Darwin Core offer a strength in usability but is weak for observational descriptions (Hill et al. 2010). The Biological Collection Access Service for Europe (BioCASE, <http://www.biocase.org>) has developed BioCASE Provider Software (BPS, http://www.biocase.org/products/provider_software), a middleware that facilitates the connection and mapping of data into XML schemes such as the Access to Biological Collections Data standard (ABCD, http://www.tdwg.org/standards/115/download/ABCD_v206.html). The main advantage of ABCD is the large set of concepts available relative to a species observation. This however, can be challenging to use owing to concept ambiguity. Biodiversity Information Standards (TDWG) is the organisation that works on defining standards in the field of biodiversity informatics. The most widely deployed formats for occurrence data are DwC and ABCD. The TCS (Taxonomic Concept Transfer Schema) was also developed for exchange taxonomic data but it defines only the taxonomic backbone.

Taxonomic information retrieval tool

This section presents a tool that explores taxonomic information from online taxonomic resources. Given the name of one species, this approach links to different sources to showing taxonomic information and other related data. The design has followed the LifeWatch data requirements described in Section 2 for the data access and visualization.

Design

A graphical representation of the design of the method is presented in Figure 2. It can be noticed that follows the steps of the brokering approach. Layers and modules are shown, which are necessary for the access, extraction, integration, analysis and representation of the data devolving from online taxonomic resources of the LifeWatch architecture (illustrated in Figure 1).

The information is retrieved from data providers and flows through the system from one layer to another. In each layer the information is filtered, selected and formatted to finally facilitate scientists in the analysis of specific species information.

The Data layer contains the distributed taxonomic resources that feed the application with their information. Each resource contains a specification of interoperable services which describe how to access the data.

The ICT-Core Middleware layer includes the Data Wrapper module which accesses the taxonomic resource, queries the information about the requested taxon and extracts the specific fields that the interface shows. Features such as the specification, metadata, request and response are in different resources. Thus, when a new taxonomic resource is added to the system, the module is modified and new ETL (Extract, Transform and Load) solutions are created to obtain the required information.

The Virtual Labs Middleware layer contains two modules. First, once the data from all online taxonomic resources is obtained, the information is joined together in the Data Integration module. This information facilitates the data management and data representation by the broker and the analytic tools respectively.

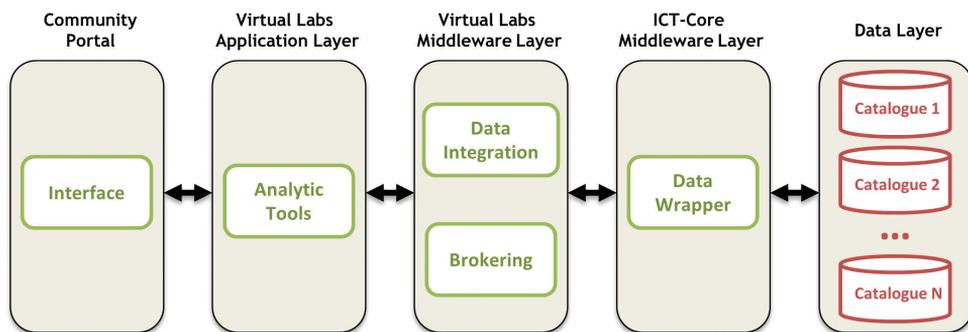


Figure 2. General structure of the service in correspondence with the LifeWatch infrastructure layers.

Second, the Brokering module manages all the data flow in the application using a broker, defining species concepts which are shown to the user. The broker converges disparate vocabularies and enables uniformity of search and access in divergent online taxonomic resources. It receives the name of a taxon from the user interface and calls the Data Integration module to query the taxon in all the taxonomic resources. Subsequently, the result is passed to the next layer for analytical purposes. Finally, the species information generated is sent to the graphical user interface.

The Virtual Labs Application layer includes all the analytical tools to support the visualization of the extracted data from online taxonomic resources using reports, graphs, tabs, rows, colors, etc., improving the exploration and the information driven-decisions.

Lastly, a graphical user interface shows the results with different options to analyze and download the information. The management of the taxonomic resources in the system is flexible, which means that the addition or deletion of a taxonomic resource only supposes the modification of the Data Wrapper module. To incorporate a new online taxonomic resource it is necessary to map the information retrieval from the resource to the specific concepts that the system manages (taxonomies, synonyms, valid and accepted names, etc.). Hence, there is an abstraction layer between the ICT-Core Middleware layer and the Virtual Labs Middleware layer where the implementation details of the taxonomic resources are not relevant to the rest of the design.

Implementation

Following the previous design a taxonomic tool has been implemented to facilitate the exploration of taxonomies, accepted names and synonyms, using the information from five online taxonomic services; GBIF, CoL and WoRMS, ITIS and GNI. The last resource, GNI, is a compilation of all the various namestrings that have been used as scientific names, whether correctly or not, with variant spellings and mis-spellings. In this sense, GNI cannot be considered a source of taxonomic information as CoL or WoRMS.

The structure of the solution is represented in Figure 3, where three main elements are distinguished: the online taxonomic resources, the server containing the application that access and shows the information and the user who provides inputting species names.

The server is the principal element in the figure as it provides fundamental infrastructure services. It accommodates the services implemented according to the LifeWatch requirements described in Section 2. These services are listed in four categories: Core Basic Services, Supporting Basic Services, Supporting Thematic Services and Specific Thematic Services. A more detailed list of services and its descriptions can be found in the LifeWatch Reference Model (Giddy et al. 2009). The presented tool is an approximation of the Taxonomy Access Service placed in the Supporting Thematic Services category. An example of such an application is Liferay web portal that contains the infrastructure website which is the service access point. In Liferay, applications are deployed in the form of portlets. We have developed a portlet that implements the

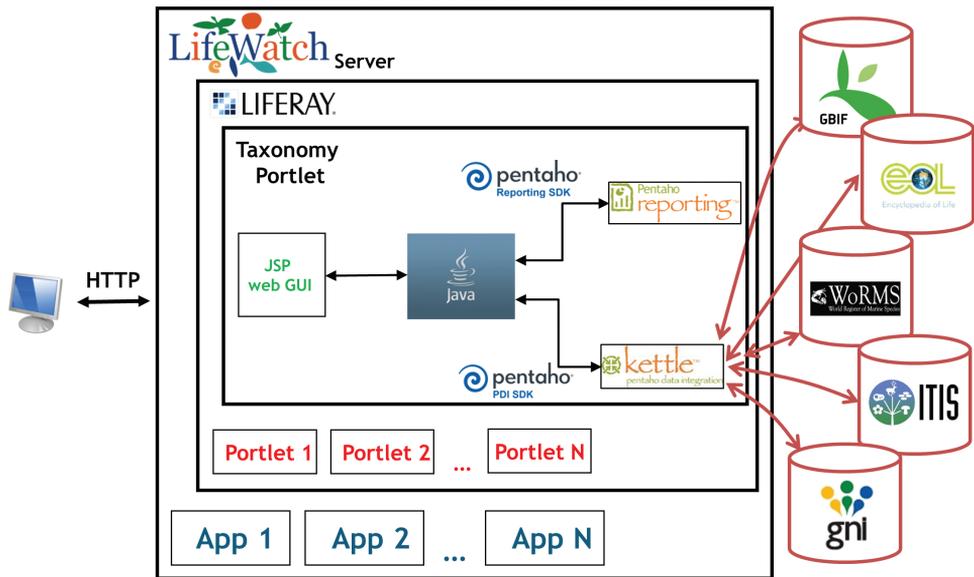


Figure 3. Implementation of the service with the used technologies.

search of taxonomic information using the previous design and a business intelligence solution called Pentaho (<http://www.pentaho.com>).

The three online taxonomic resources make up the current Data layer. They offer interoperable web services and interfaces that facilitate data queries from external applications and integrate such information into other systems. Due to the web services' specification in any taxonomic resource differs, a new wrapper solution has to be designed to consult each of them. In the portlet, the Data Wrapper module is implemented by the Pentaho Data Integration tool (also known as Kettle). This tool permits the design of transformations, enabling ETL capabilities to form requests, process responses and locate information in each taxonomic resource. Three separate transformations are defined because both ways to query data and the XML structure in responses are different in these taxonomic resources.

The modules contained in the Virtual Labs Middleware Layer are implemented using different software tools. First, the Pentaho Data Integration is again used for the development of the Data Integration module. Once the information of each taxonomic resource is available separately, a new transformation is designed using this tool to join them together in a common XML file.

In the Brokering module, a Java program implements the broker using libraries. The program provides the link between the Analytic tool, the Data Integration, and the Data wrapper modules. When a user introduces the name of a species in the application, the broker sends the request to the Data wrapper module. To do this, it uses the libraries contained in the Pentaho Data Integration SDK to call the transformations which in turn implements the wrappers from the Java program. Subsequently,

the Broker sends the information to the Data Integration module. As a result, a XML file contains the data from the three taxonomic resources using common labels.

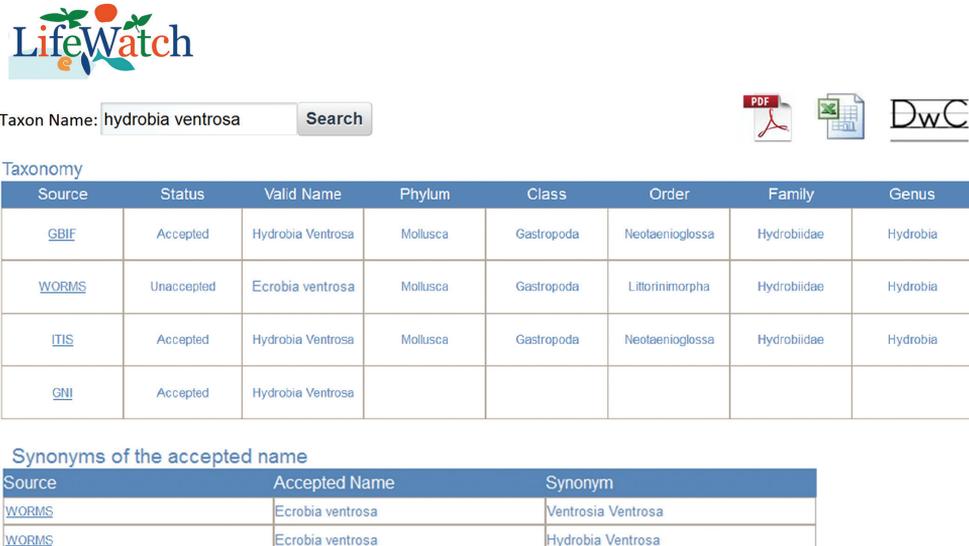
Finally, the broker sends this file to the Analytic tool, through the libraries defined by the the Pentaho Reporting SDK, which consequently generates a report with the information.

The Analytic tool module is implemented using a report template designed by the tool Pentaho Report Design Wizard. This template produces a report in which the information is organized using dynamic tables (available in pdf, html and xls). The report is progressed to the graphical interface that illustrating the final results and available for download.

The application also has a data exportation option in compliance with the Darwin Core standard. Darwin Core is an internationally recognized standard for biodiversity data exchange, used by GBIF and other organizations to encode data related to organism names, taxonomies, references, etc. This option provides sufficient flexibility to support specific tasks, allowing advanced users to build custom applications tailored to particular needs (Chapman 2005).

Results

Figure 4 shows an example using the proposed implementation. The taxon name introduced by the user is *Hydrobia Ventrosa*, a small brackish water snail. This taxon can be found in GBIF, WoRMS, ITIS and GNI but not in CoL, consequently there are no results for CoL in the application. The web service offered by GNI only permits checking if the provided taxon is a valid name, but the taxonomic information cannot be obtained.



The screenshot shows the LifeWatch web application interface. At the top left is the LifeWatch logo. Below it is a search bar with the text "Taxon Name: hydrobia ventrosa" and a "Search" button. To the right of the search bar are icons for PDF, Excel, and Dwc (Darwin Core) export options. Below the search bar is a "Taxonomy" section with a table showing search results from four sources: GBIF, WoRMS, ITIS, and GNI. The table has columns for Source, Status, Valid Name, Phylum, Class, Order, Family, and Genus. Below the taxonomy table is a section titled "Synonyms of the accepted name" with a table showing synonyms from WoRMS.

Source	Status	Valid Name	Phylum	Class	Order	Family	Genus
GBIF	Accepted	Hydrobia Ventrosa	Mollusca	Gastropoda	Neolaenioglossa	Hydrobiidae	Hydrobia
WoRMS	Unaccepted	Ecrobia ventrosa	Mollusca	Gastropoda	Littorinimorpha	Hydrobiidae	Hydrobia
ITIS	Accepted	Hydrobia Ventrosa	Mollusca	Gastropoda	Neolaenioglossa	Hydrobiidae	Hydrobia
GNI	Accepted	Hydrobia Ventrosa					

Synonyms of the accepted name		
Source	Accepted Name	Synonym
WoRMS	Ecrobia ventrosa	Ventrosia Ventrosa
WoRMS	Ecrobia ventrosa	Hydrobia Ventrosa

Figure 4. Result of searching *Hydrobia Ventrosa* using our proposal.



Species: **Hydrobia ventrosa (Montagu, 1803)**
Swollen Spire Shell

»Kingdom: Animalia »Phylum: Mollusca »Class: Gastropoda »Order: Neotaenioglossa »Family: Hydrobiidae
»Genus: Hydrobia »Species: Hydrobia ventrosa

Hydrobia ventrosa (Montagu, 1803)
AphiaID: 140127

Classification: Biota > Animalia (Kingdom) > Mollusca (Phylum) > Gastropoda (Class) > Caenogastropoda (Subclass) > Littorinimorpha (Order) > Truncatelloidea (Superfamily) > Hydrobiidae (Family) > Hydrobia (Genus)

Status ✘ **unaccepted** (currently placed in genus *Ventrosia*)

Accepted name Ventrosia ventrosa (Montagu, 1803) accepted as Ecrobia ventrosa (Montagu, 1803)

Rank Species

Parent Hydrobia Hartmann, 1821

Figure 5. Some details about the results of searching *Hydrobia Ventrosa* in GBIF and WoRMS online taxonomic resources.

It is evident that GBIF and ITIS show the same taxonomy. However, *Hydrobia Ventrosa* is an accepted name for GBIF, ITIS and GNI but not for WoRMS and the order in WoRMS (*Littorinimorpha*) is also different from the other taxonomic resources (*Neotaenioglossa*). Moreover, given that the accepted name in WoRMS is *Ecrobia Ventrosa*, this taxonomic resource indicates two synonymous names for the same species: *Ventrosia Ventrosa* and (the introduced) *Hydrobia Ventrosa*. Classifications and synonyms of both taxonomic resources appear together in two separated tables which can be downloaded in different formats including, an XML file following the Darwin Core standard. In the first column, the name of the resource shows a direct link to the website in order to obtain more details about the found taxon such as citations, environment, taxonomic history, etc.

Part of the results of a species query in GBIF and WoRMS are represented in Figure 5. From comparisons drawn in both figures, it is clear that our proposal facilitates the visualization of the data in combination with a time effective search that increases availability and accessibility whilst reducing errors in names and classifications.

Experimentation in a real context

The application is used by some researchers based in the Ecology Unit at the University of Salento (Lecce, Italy). The work is focused on experimental research in aquatic ecosystems. The implemented system has many benefits and enables the reconciliation of species information in different online taxonomic resources.

Firstly, the time that scientists spend researching a taxon has been drastically reduced. Currently, CoL, GBIF, WoRMS, ITIS and GNI all have different websites, interfaces and tools (which the researcher would need to use). With the proposed system, users don't need to consider the range of research methods as the search is combined including all online taxonomic resources. Furthermore, the application permits users to introduce a list of taxa showing the results in a crosstab report.

Secondly, we noticed that almost all the scientists base their research on two or more online taxonomic resources. The same taxon cannot appear in a taxonomic resource but can be classified with various synonyms in another. In some cases, especially in old species lists, the same taxon appears with various synonyms provoking confusion. This application permits the resolution of names and synonyms, consequently reducing the size of the lists and avoiding false results and conclusions.

Finally, the method is useful to scientists who work with new or recently-discovered species. In these cases, accepted names and synonyms change frequently. The application helps to find divergences in taxonomies and accepted names between online taxonomic resources.

Conclusion

A method has been presented to obtain taxonomic information from the main online taxonomic resources. A solution divided in modules has been designed to automatically extract and represent information about taxonomies, synonyms and accepted names. The proposed solution has been used in a real context and a very promising and competitive performance for avoiding errors and false results has been achieved.

Acknowledgements

This research is supported by the LifeWatch Service Centre (Italy) and the project EIC-LW-2011-0034 of the Spanish Ministry of Economy and Competitiveness.

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Internet resources

- Access to Biological Collections Data (ABCD) – http://www.tdwg.org/standards/115/download/ABCD_v206.html
- BioCASE – <http://www.biocase.org>
- BioCASE Provider Software (BPS) – http://www.biocase.org/products/provider_software
- Biodiversity Heritage Library (BHL) – <http://www.biodiversitylibrary.org>
- Catalogue of Life (COL) – <http://www.catalogueoflife.org>
- Darwin Core – <http://rs.tdwg.org/dwc>
- Discover Life – <http://www.discoverlife.org>
- Ecological Metadata Language (EML) – <http://knbc.ecoinformatics.org/software/eml>
- Encyclopedia of Life (EOL) – <http://eol.org>
- EuroGEOSS – <http://www.eurogeoss.eu>
- European Strategy Forum on Research Infrastructures (ESFRI) – http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri
- Global Biodiversity Information Facility (GBIF) – <http://www.gbif.org>
- Global Names Architecture (GNA) – <http://www.globalnames.org>
- Global Names Index (GNI) – <http://gni.globalnames.org>
- Global Names Usage Bank (GNUB) – <http://www.globalnames.org/GNUB>
- Infrastructure for Spatial Information in the Europe (INSPIRE) – <http://inspire.ec.europa.eu>
- Integrated Taxonomic Information System (ITIS) – <http://www.itis.gov>
- International Barcode of Life (iBOL) – <http://ibol.org>
- International Nucleotide Sequence Database Collaboration (INSDC) – <http://www.insdc.org>
- International Plant Names Index (IPNI) – <http://www.ipni.org>
- Integrated Publishing Toolkit (IPT) – <http://ipt.gbif.org>
- JSTOR Plant Science – <http://plants.jstor.org>
- Liferay – <http://www.liferay.com>
- LifeWatch – <http://www.lifewatch.eu>
- National Spatial Data Infrastructure (NSDI) – <http://www.fgdc.gov/nsdi/nsdi.html>
- Pan-European Species directories Infrastructure (PESI) – <http://www.eu-nomen.eu>
- Pentaho – <http://www.pentaho.com>
- World Register of Marine Species (WoRMS) – <http://www.marinespecies.org>
- Zoological Nomenclature (ZooBank) – <http://zoobank.org>

Corrigenda: Two new species of *Mediomastus* (Annelida, Capitellidae) from Tokyo Bay, Japan. ZooKeys 422: 115–126.

Shinri Tomioka¹, Eijiroh Nishi², Hiroshi Kajihara³

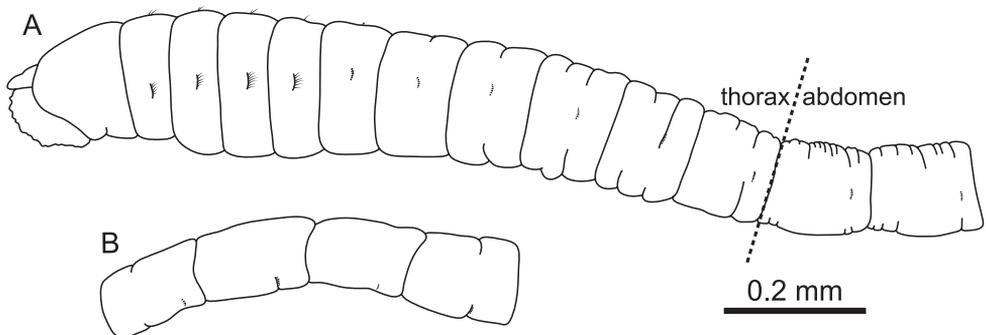
1 Department of Natural History Sciences, Graduate School of Science, Hokkaido University, N10 W8, Sapporo 060-0810, Japan **2** College of Education and Human Sciences, Yokohama National University, Hodogaya, Yokohama 240-8501, Japan

Corresponding author: *Shinri Tomioka* (shinri.tomioka@mail.sci.hokudai.ac.jp)

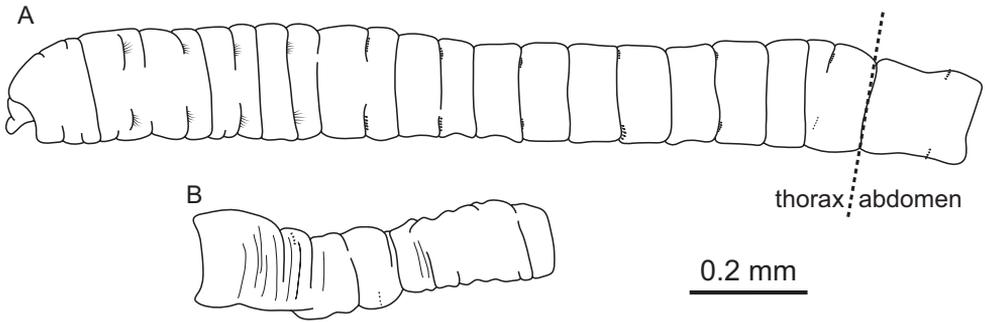
Academic editor: *C. Glasby* | Received 7 November 2014 | Accepted 20 November 2014 | Published 12 December 2014

Citation: Tomioka S, Nishi E, Kajihara H (2014) Corrigenda: Corrigenda: Two new species of *Mediomastus* (Annelida, Capitellidae) from Tokyo Bay, Japan. *ZooKeys* 422: 115–126. *ZooKeys* 463: 149–150. doi: 10.3897/zookeys.463.8913

It has come to our attention that in the work referenced above Figure 7A, B is INCORRECT:



The CORRECT one is as follows:



References

Tomioka S, Nishi E, Kajihara H (2014) Two new species of *Mediomastus* (Annelida, Capitellidae) from Tokyo Bay, Japan. *ZooKeys* 422: 115–126. doi: 10.3897/zookeys.422.7501