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A new species of *Odaginiceps* Fiers, 1995 (Copepoda, Harpacticoida, Tetragonicipitidae) from the Mediterranean coast of Turkey

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Abstract

Male and female of *Odaginiceps korykosensis* **sp. n.** (Copepoda, Harpacticoida, Tetragonicipitidae), collected in the intertidal zone of Kızkalesi beach along the Mediterranean coast of Turkey (Mersin Province), are described. The new species is the fifth member of the genus and can easily be distinguished from the other species by the presence of four setae/spines on the second endopodal segment of P4 and by the structure of the caudal rami. Previously, representatives of the genus *Odaginiceps* have been reported from Gulf of Mexico, off Bermuda and Kenya. *O. korykosensis* **sp. n.** is the first record of the genus in the Mediterranean Sea.

Keywords

Harpacticoida, Tetragonicipitidae, *Odaginiceps*, taxonomy, new species

Introduction

The genus *Odaginiceps* Fiers, 1995 is one of the 12 genera currently recognized in the family Tetragonicipitidae and now comprises four species (Wells 2007). The genus was first created by Fiers (1995) in one of his comprehensive and excellent papers on the

Tetragonicipitidae from the Yucatecan continental shelf (Mexico). In this paper, Fiers (1995) described *O. clarkae* Fiers, 1995 from the West Central Atlantic (Quintana Roo State, Nichupte Lagoon, Cancun, Mexico) and designated it as the type species of the genus. In the same paper Fiers (1995) also described *O. xamaneki* Fiers, 1995 from the Western Central Atlantic (western region of Yucatecan continental shelf, Mexico). The third species (*O. elegantissima* Fiers, 1995) was also described and allocated to the genus by Fiers (1995) after reexamining the material previously identified by Coull (1970) as *Diagoniceps laevis* Willey, 1930 from Castle Harbour (Bermuda). Fiers and De Troch (2000) later described the fourth species, *O. immanis* Fiers and De Troch, 2000, from the Indo-Pacific (Gazi Bay, Kenya). No other report of *Odaginiceps* has appeared in the literature since then. But the intensive investigation (carried out between 2000–2010) of over 500 phytal and interstitial harpacticoid samples taken from nearly 200 different stations along the mediolittoral zone of rocky shores and sandy beaches of almost all Turkish coasts (unpublished data) revealed a new species of *Odaginiceps* which was found only in a single locality. Both sexes of this new species were described in detail below.

Material and methods

Samples were collected using the Karaman-Chappuis method (Delamare Deboutteville 1953) from the type locality on three different dates (Table 1) but only one male and one female were obtained at the first sampling (April 09, 2007). Prior to dissection, the habitus was drawn from whole specimens temporarily mounted in lactophenol. Specimens were dissected in lactic acid and the dissected parts were mounted in lactophenol mounting medium. Broken glass fibres were added to prevent the animal and appendages from being compressed by the coverslip and to facilitate rotation and manipulation, allowing observation from all angles. Preparations were subsequently sealed with Entellan® (Merck). All drawings were prepared using a camera lucida on Olympus BX-51 differential interference contrast microscope. Total body length was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami. Measurements were made with an ocular micrometer. Scale bars in illustrations are in μm. The descriptive terminology is adopted from Huys et al. (1996). Abbreviations used in the text are: ae, aesthetasc; P1–P6, for swimming legs 1–6; exp

Table 1. Some physical and chemical parameters of interstitial water on different sampling dates at the type locality.

Date	09 April 2007	27 July 2007	26 November 2007
pH	8,16	7,29	8,14
Temperature (°C)	18,3	29,8	19,1
Conductivity (ms)	45,7	57,1	54,0
Salinity (ppt)	34,5	37,8	35,5
Oxygen (mg/L)	2,78	1,11	1,71

(enp)-1 (-2, -3) to denote the proximal (middle, distal) segment of a ramus. Material was deposited in the Mersin University Zoology Museum (MUZM) at Mersin, Turkey. Physical and chemical parameters of the interstitial water in the sampling pit are summarized in Table 1. Parameters were measured with an YSI 85 Handheld Dissolved Oxygen and Conductivity Instrument (YSI Inc.), with the exception of the pH which was measured with an Orion 3-star (Thermo Fisher Scientific Inc.) Portable pH Meter.

Results

Order Harpacticoida Sars, 1903
Family Tetragonicipitidae Lang, 1944
Genus *Odaginiceps* Fiers, 1995

***Odaginiceps korykosensis* sp. n.**
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Figs 1–6

Type locality. Turkey, Mediterranean coast, Mersin Province; intertidal zone of Kızkalesi beach (36°27.473'N, 34°08.647'E). The type locality is fine sand beach.

Material examined: Holotype ♀ dissected on seven slides. Allotype ♂ dissected on six slides. Legs. S. Karaytuğ, S. Sak, A. Alper and S. Sönmez.

Description. Female (Fig. 1A, B). Total body length 770 µm, with largest width measured at cephalothorax. Integument of cephalic shield smooth, of all other somites ornamented with irregular pattern of hardly visible spinules. Body surface with sensilla pattern as figured. Posterior margin of the body somites with serrate hyaline frills.

Rostrum (Fig. 1A) large, widest at base, extending halfway along second antennular segment; with two delicate sensillae and a mid-dorsal pore.

Urosome (Figs 1A,B) 5-segmented, comprising P5-bearing somite, genital double somite and three free abdominal somites. Genital double-somite longer than wide; with transverse surface ridge dorsally and laterally (Fig. 1B) extending ventrally (Figs 1A; 2A), indicating original segmentation. Genital field (Fig. 2A) with small copulatory pore located in median triangular depression. A spermatophore attached to the copulatory pore. First and second somite of genital double-somite and second and third abdominal somites with continuous spinules near distal margin dorsally (spinules of first somite of genital double-somite interrupted midway) (Fig. 1A); genital double somite and second abdominal somite with spinular row near distal margin ventrally, interrupted midway; third abdominal somite with continuous spinular row near distal margin ventrally (Fig. 2A). Anal somite (Fig. 1A) with distal spinular row extending dorsally to the either side of anal operculum; operculum smooth, slightly convex.

Caudal rami (Figs 1C; 3D, E) tapering posteriorly with 4–5 dorsal spinules distally near the base of seta V; 1.7 times longer than wide; inner margin ornamented with spinules (Fig. 3D); with a pore on proximal third of dorsal surface (Fig. 3D), another pore

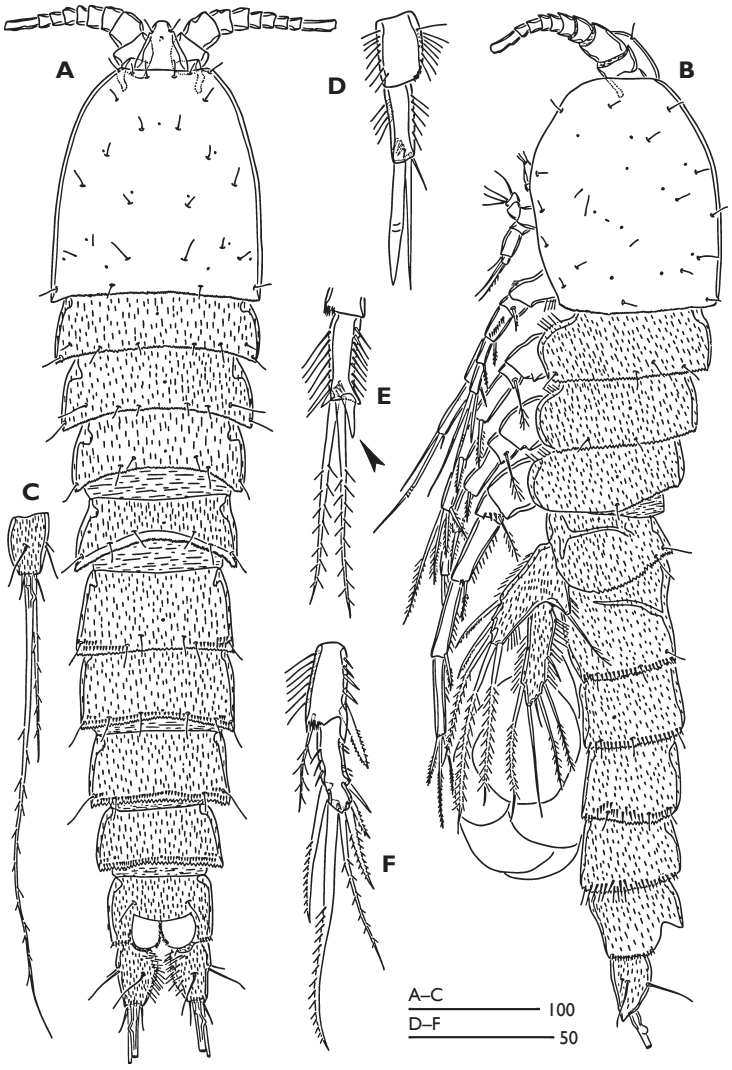

Figure 1. *Odaginiceps korykosensis* sp. n. Female. **A** habitus, dorsal **B** habitus, lateral **C** right caudal ramus with terminal complement, dorsal. Male. **D** P2 endopod, anterior **E** P3 terminal endopod segment, anterior **F** P4 endopod, anterior.

present on ventral surface near the base of seta III (Fig. 2A); with seven setae (Fig. 3D, E), seta I minute located near the base of seta II; setae II–III bare; setae IV–V strongly developed and bipinnate; seta V with swollen sinuate base; seta VI short and as long as seta III; seta VII tri-articulated.

Antennule (Fig. 3A) 9-segmented; segment 1 with a long plumose seta at anterodistal margin, a spinular row on anterior surface, long spinules along inner margin, small tube-pore on dorsal surface near inner margin. Segment 2 with long spinules on caudal margin. Segment 4 with long aesthetasc fused basally to seta. Segment 9

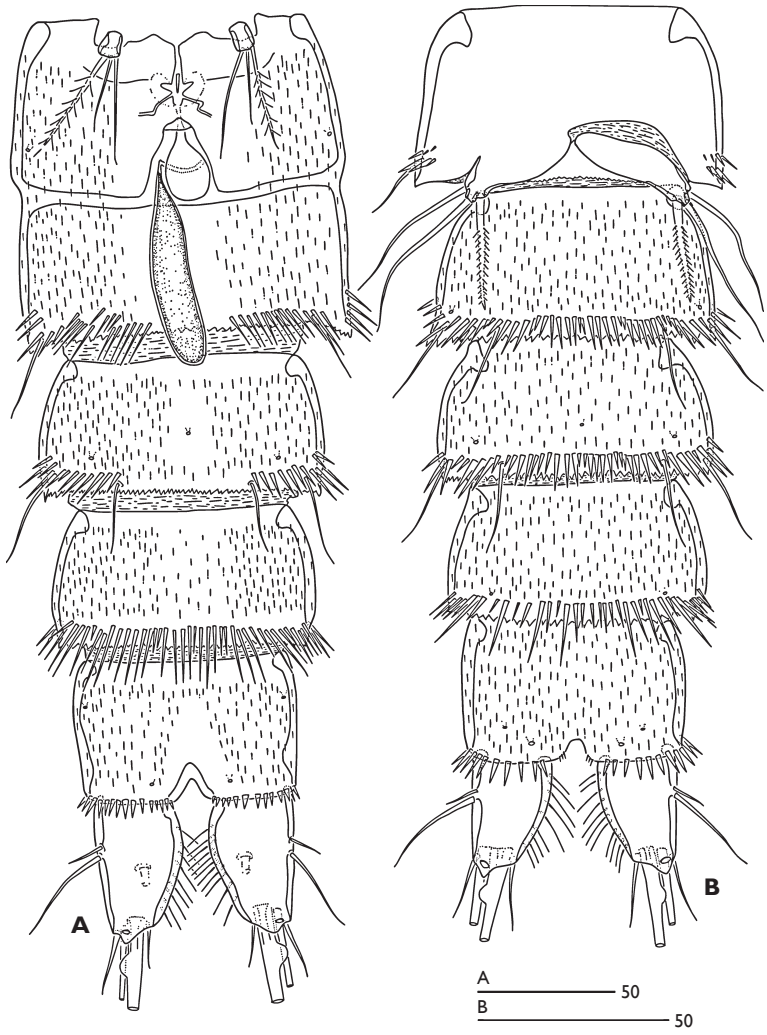

Figure 2. *Odaginiceps korykosensis* sp. n. **A** female, abdomen, ventral **B** male, abdomen, ventral.

longest, bears an apical acrothek consisting of a short aesthetasc and two setae. Armature formula 1-[1 plumose], 2-[6+3 plumose], 3-[6+1 plumose], 4-[3+(1+ae)], 5-[2], 6-[2+2 plumose], 7-[2], 8-[1+1 plumose], 9-[5+acrothek].

Antenna (Fig. 3B). Coxa small and smooth. Basis with 2 long spinules at outer margin. Exopod 1-segmented with one lateral pinnate seta, apical armature consists of one pinnate seta and one pinnate spine; a few spinules present around outer distal corner and midway along outer margin. Endopod 2-segmented; first endopod segment with one plumose seta at proximal third of outer margin. Distal endopod segment with various spinular rows as figured and with two abexopodal unipinnate spines laterally (both spines with subapical tubular extension). Apical armature of enp-2 consisting of

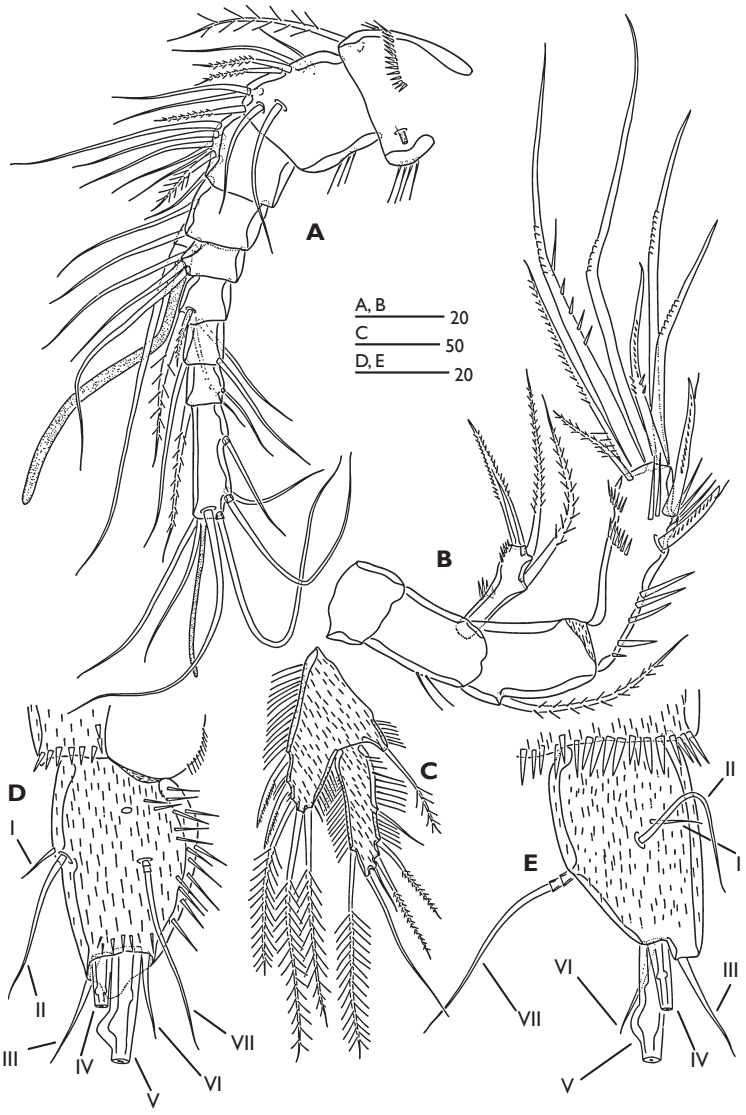

Figure 3. *Odaginiceps korykosensis* sp. n. Female. **A** antennule, dorsal **B** antenna **C** P5, anterior **D** left caudal ramus, dorsal **E** right caudal ramus, lateral.

two pinnate setae, and five geniculate setae; longest geniculate seta with large spinules and fused at base to long pinnate seta.

Labrum (Fig. 4D). Free margin straight, with spinular row at distal corners and fine spinular row subdistally on ventral surface.

Mandible (Fig. 4A, B). Coxa robust, gnathobase with one pinnate seta at dorsal corner and several blunt multicuspidate teeth along distal margin. Palp biramous; basis strong, with three plumose setae along inner margin, ornamented with a group of long spinules proximally. Exopod 3-segmented, first segment with two plumose setae, sec-

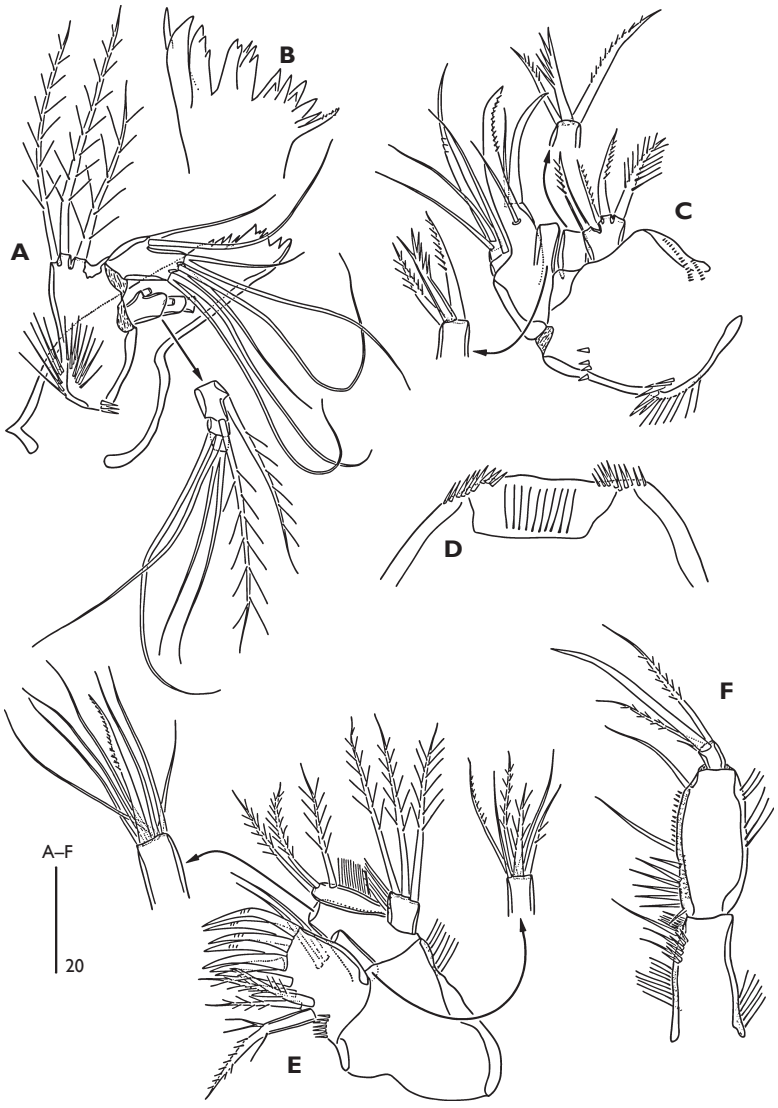

Figure 4. *Odaginiceps korykosensis* sp. n. Female. **A** mandible **B** distal margin of gnathobase **C** maxilla, posterior **D** labrum, ventral **E** maxillule, anterior **F** maxilliped, posterior.

ond segment with two bare setae and third segment with two bare setae fused at base. Endopod 1-segmented with two lateral and six distal bare setae (two inner distal setae and two outer distal setae fused at base).

Maxillule (Fig. 4E). Praecoxal arthrite with seven spines around distal margin, with spinules as figured; anterior surface with two bare setae; posterior surface with three plumose and one pinnate setae. Coxal endite with two smooth and four plumose setae. Basis with seven bare and one unipinnate setae. Long endopod segment and square exopod segment each with three plumose setae. Endopod and exopod with a row of fine marginal setules.

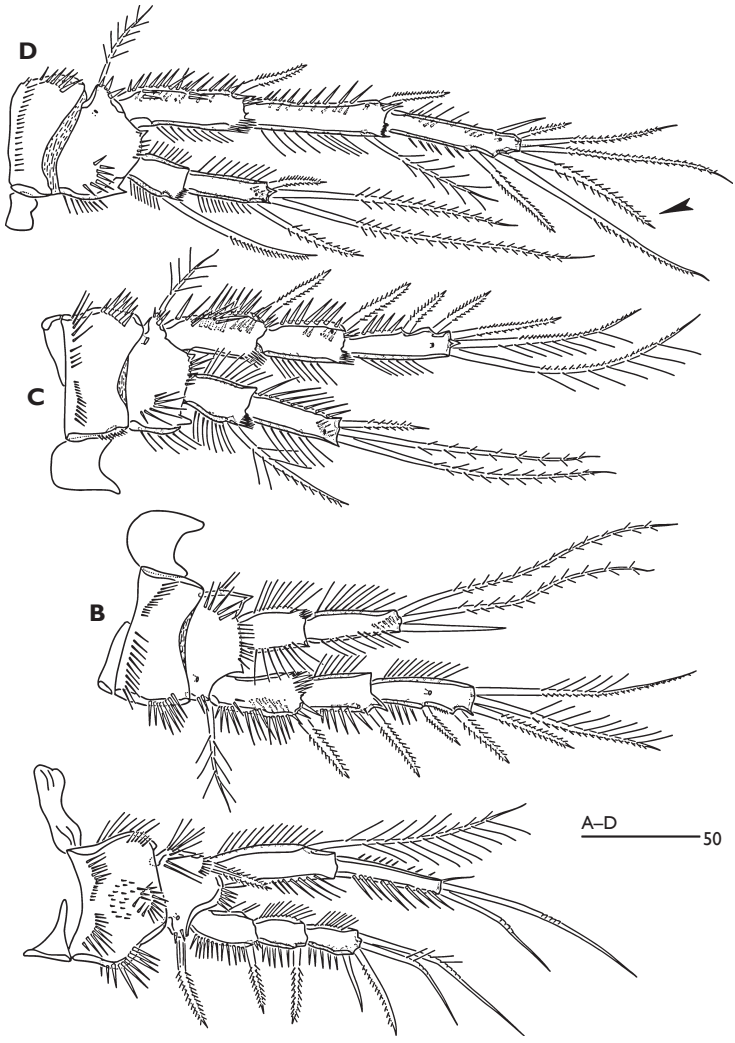

Figure 5. *Odaginiceps korykosensis* sp. n. Female. **A** P1, dorsal **B** P2, anterior **C** P3, anterior **D** P4, anterior.

Maxilla (Fig. 4C). Syncoxa ornamented with spinules as figured; with three endites. Proximal endite with one plumose and three unipinnate setae; middle endite with three unipinnate setae; distal endite with two unipinnate and one plumose setae. Allobasis drawn out into pinnate claw; accessory armature consisting of two bare setae and one curved spine. Endopod 2-segmented; proximal segment with one bare seta, distal segment with one geniculate and two bare setae.

Maxilliped (Fig. 4F). Subchelate and ornamented with spinular rows as figured. Syncoxa with three inner bare setae subdistally. Basis with two bare setae along inner margin. Endopod with one small accessory seta, one bare and two plumose setae.

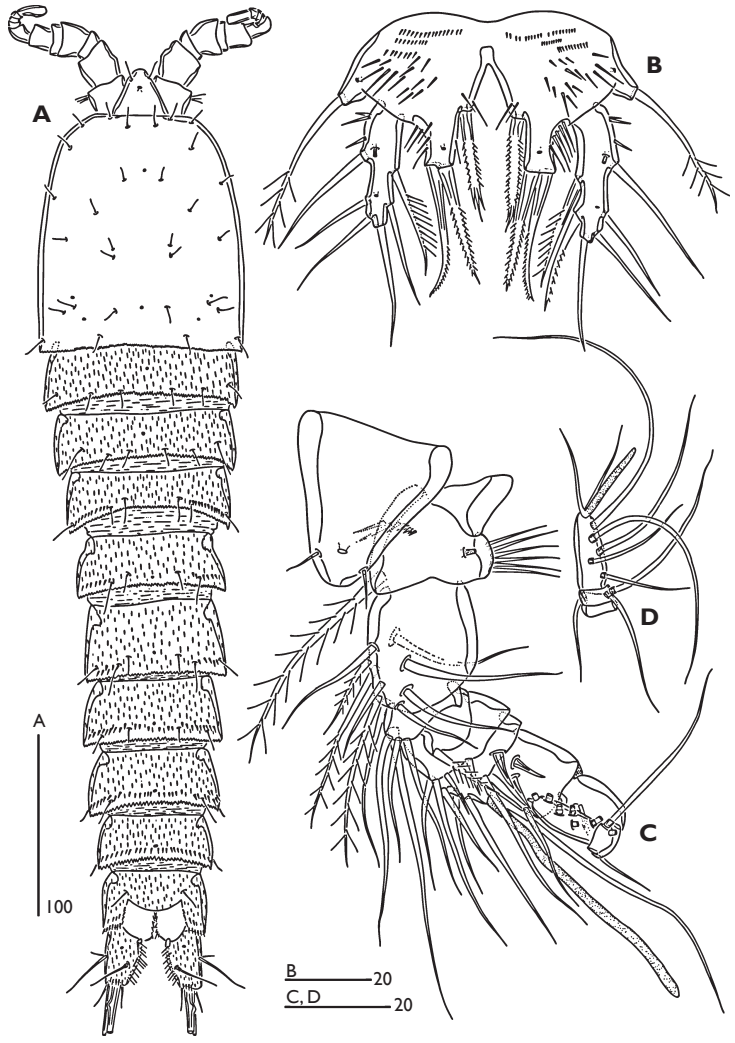

Figure 6. *Odaginiceps korykosensis* sp. n. Male. **A** habitus, dorsal **B** P5, anterior **C** rostrum and antennule, dorsal **D** terminal segments of antennule.

P1 (Fig. 5A). Intercoxal sclerite rectangular and smooth. Small praecoxa triangular and bare. Coxa with complex spinular ornamentation anteriorly as figured. Basis narrower than coxa; anterior surface with pore near the base of outer bipinnate spine; inner side with long slender spinules. Exopod 3-segmented, segments with spinular rows along inner and outer margins. Endopod 2-segmented; enp-1 reaching almost middle of exp-3, with spinular row along inner and outer margins; long inner seta plumose and located subdistally; enp-2 slightly shorter than enp-1, with spinules along inner and outer margins and with two long articulated setae and one small inner apical seta.

P2–P4 (Fig. 5B–D). Intercoxal sclerite unornamented. Coxa and basis with complex spinular ornamentation as figured. Exopod 3-segmented. Endopod 2-segmented. Endopodal and exopodal segments with spinular rows along inner and outer margins. Exp-1 of P2-P3 without spinules along inner margin. Enp-1 of P2 without inner seta. Terminal outer seta of P2 enp-2 bare. P4 exp-2 with one plumose inner seta. With a pore on anterior surface of enp-2 and anterior surface of exp-2 and -3. Exp-1 and -2 (and -3 in P4) with a posterior spinule patches. Enp-2 with a posterior spinular row subdistally.

Armature formula of swimming legs:

P1		**P2**		**P3**		**P4**	
Exp.	Enp.	Exp.	Enp.	Exp.	Enp.	Exp.	Enp.
0.0.022	1.120	0.0.023	0.021	0.0.023	1.021	0.1.322 (♀) 0.1.222 (♂)	1.121

P5 (Fig. 3C). Baseoendopod and exopod covered with fine spinules on anterior surface, with long slender spinules along inner and outer margins. Exopod 3.6 times longer than wide, with 6 setae; seta 1 longest and plumose; seta 3 smallest and bare. Baseoendopod longer than wide; with 2 unipinnate and 3 plumose setae.

P6 (Fig. 2A) represented by a small segment with one outer plumose seta and two slender bare setae.

Description. Male (Fig. 6A). Total body length 510 μm. Body smaller and more slender than female, largest width measured at midway of cephalothorax. Body ornamentation generally as in female. Sexual dimorphism observed in antennule, P2-P6 and genital segmentation.

Antennule (Fig. 6C, D) indistinctly 10-segmented, sub-chirocer. Segment 1 short, with small tube-pore on dorsal surface and with long spinules along caudal margin. Segment 2 longest. Segment 4 with partial suture line dorsally. Segment 5 with long aesthetasc fused basally to seta. Segment 10 bears an apical acrothek consisting of a short aesthetasc and two slender setae. Armature formula 1-[1 plumose], 2-[7+3 plumose], 3-[4], 4-[4+1 plumose], 5-[4+1 spine+(1+ae)], 6-[1+2 spines], 7-[2], 8-[1], 9-[2], 10-[5+acrothek].

P2 enp-2 (Fig. 1D); outer terminal spine more robust than female; middle terminal seta bare, shorter than female and as long as outer spine; inner terminal seta minute. P3 enp-2 (Fig. 1E); inner terminal seta modified to a short spine (arrowed in fig. 1E). P4 exp-3 (Fig. 1F) with 6 setae, inner terminal seta of female (arrowed in fig. 5D) absent in the male.

P5 biramous (Fig. 6B), fused medially. Baseoendopod ornamented with patch of spinules as figured; with two pores (one near the base of outer basal seta and the other near the base of inner terminal spine of endopodal lobe); endopodal lobe with one lateral and two distal spines. Exopod with three outer bare setae, 1 terminal bare seta and two inner unipinnate setae; with two pores (one tube pore near the base of outer proximal bare seta and the other near the base of outer median bare seta). P6 vestiges asymmetrical (Fig. 2B); each P6 with one plumose inner seta and two long bare setae.

Etymology. The specific name refers to "*korykos*" which is the historical name of Kızkalesi province (Mersin, TURKEY).

Discussion

The new species can be attributable to the genus *Odaginiceps* by the absence of inner seta on the proximal segments of P2-P4 exopod and P2 endopod, the short second antennulary segment, the large prominent rostrum, the presence of pinnate setae on the second and third antennulary segments, and the two-segmented P1 endopod with three armature elements on the second segment (Fiers 1995; Fiers and De Troch 2000). Thus far, four species have been assigned to the genus *Odaginiceps*: *O. clarkae*, *O. xamaneki*, *O. elegantissima* and *O. immanis*. The new species can easily be distinguished from its congeners by the presence of four setae/spines on the second endopodal segment of P4, by the shape of the caudal rami and by the occurrence of four setae on the proximal endite of maxilla. The new species is most closely related to the *O. xamaneki*. Both species differ from the 3 other congenerics by the presence of short, and compact caudal rami (long and semi-cylindrical in the other species) and the spinular posterodorsal ornamentation of the urosomites (spinular rows present only ventrally in the 3 other species). *O. korykosensis* sp. n. (female) differs from *O. xamaneki* by the presence of spinules (interrupted midway) along the posterioventral margin of genital double-somite, by the absence of a central spinular patch on ventral surface of second abdominal somite, by the longer outermost seta of P5 baseoendopod, by the much longer terminal plumose setae of P2-P3 enp-2, by the longer P3 enp-2, as well as other minor differences observed on the spinular ornamentations of various appendages.

Fiers (1995) assumed that the presence of an inner pectinate element on the P3 enp-1, the presence of an inner seta on P4 exp-2, and the distinctly shorter caudal rami in both sexes could be sufficient grounds to erect a new genus to accommodate *O. xamaneki*. The above mentioned potential generic characters for *O. xamaneki* are also observed in *O. korykosensis* which supports the previously formulated assumption. However, until the specific and generic importance of these characteristics are better understood and evaluated, both species are retained in the genus *Odaginiceps*.

The new species lacks a seta (arrowed in the Fig. 5D) on the third exopodal segment of the P4 in the male. The absence of this seta in the male supports the assumption of Fiers (1995) that almost all tetragonicipitid males bear one seta less on the third exopodal segment of the P4.

Note on the ecology and distribution. Examination of the extensive interstitial samples taken from almost all sandy beaches along the Turkish coasts revealed that the new species occurs at the type locality only. On the other hand three samples taken from the type locality in different seasons revealed no true interstitial forms. The absence of true interstitial forms but the presence of *O. korykosensis* sp. n. in the type locality can be explained by the very low oxygen levels measured at the type locality

(Table 1). Most harpacticoids are sensitive to reduced oxygen supply, which restricts their occurrence to the upper sediment layers and favours epibenthic life. It can be discerned from the general body shape of *Odaginiceps* spp. (see Fig. 1A, B; Fiers 1995; Fiers and De Troch 2000) that they are not truly interstitial, but are probably epibenthic forms crawling on/in the upper surface of sediment along the shallow/deeper waters, meaning that two specimens of *O. korykosensis* sp. n. accidentally entered into the interstitial sample. The effect of the oxygen supply on the horizontal composition of harpacticoid species in the sediment can be supported by the presence of several interstitial forms (such as *Arenosetella* Wilson, 1932) found in 95 % of stations sampled along the Mediterranean coast of Turkey (unpublished data). The oxygen levels in the sediments in these localities were much higher than those observed at the locality of *Odaginiceps korykosensis* sp. n.

Acknowledgements

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SHORT COMMUNICATION

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Discovery of the water scavenger beetle genus *Brownephilus* Mouchamps in Turkey (Coleoptera, Hydrophilidae, Hydrophilini)

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Abstract

The recently described *Hydrochara major* İncekara, Mart, Polat, & Karaca, 2009 from Turkey is transferred to the genus *Brownephilus* Mouchamps. New records and habitat information are given for the species, as well as diagnostic features for separating it from the only other described member of the genus, *B. levantinus* Balfour-Browne. The discovery of *Brownephilus* in Turkey marks the first time the lineage has been found since its original description more than seventy years ago.

Keywords

Aquatic beetles, Hydrophilidae, Middle East, Turkey, new combination

Introduction

Members of the Hydrophilina (or "giant water scavenger beetles") are common and readily collected in all biogeographic regions. Defined by their large size and prominent sternal keels, they are easily distinguished from other groups of hydrophiloids. Recently, Short (2010) presented a complete review and phylogenetic analysis of the subtribe. In addition to the description of an enigmatic new genus from Vene-

zuela, Short (2010) elevated *Brownephilus* Mouchamps, 1959 from a subgenus of *Hydrobiomorpha* to full generic status. The taxon *Brownephilus*, diagnosed by having a broadly emarginated clypeo-labral margin but lacking long hairs on the antennal club, was erected for a single species hitherto known only by two specimens from "Palestine".

In a recent review of the *Hydrochara* of Turkey, İncekara et al. (2009) described an unusually large new species of the genus, *H. major*. The authors note that the specimens represent the largest known examples of the genus *Hydrochara* yet described. However, the male genitalia of the species bear striking resemblance to that of *Brownephilus levantinus* (Balfour-Browne, 1939), which is also a very large species of similar size to *H. major*. We have made additional collections of *H. major*, including the first known females, and confirm that it is not a member of the genus *Hydrochara*, but a second species of *Brownephilus*. The species can easily be excluded from *Hydrochara* by possessing a broadly emarginated clypeo-labral margin (which, at the time the species was described, would have assigned the species to the genus *Hydrobiomorpha*; *Brownephilus* was not yet elevated to its current rank). The lack of long hairs on the antennal club and distinctive aedeagus further unambiguously place the species within the genus *Brownephilus*.

***Brownephilus major* (İncekara, Mart, Polat, & Karaca, 2009), comb. n.**
Figures 1–2, 4–5

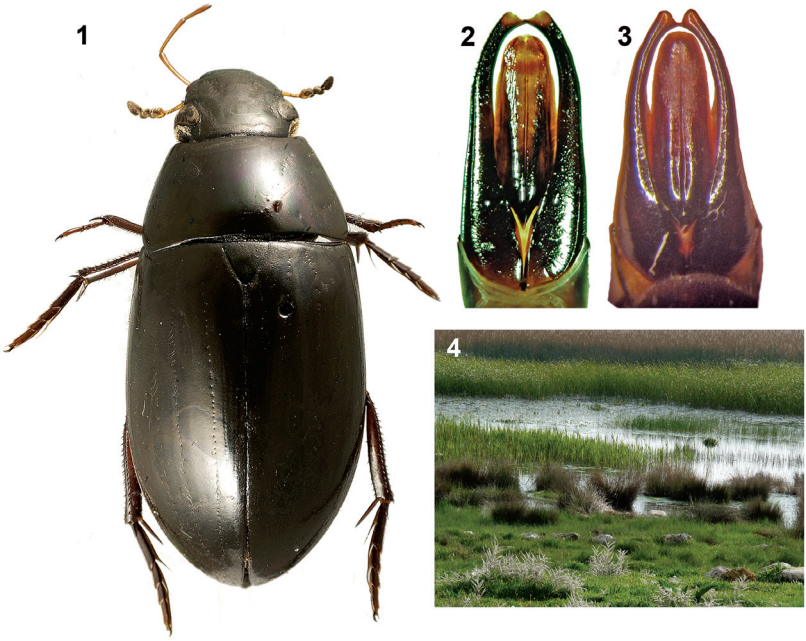
Hydrochara major İncekara, Mart, Polat, & Karaca, 2009: 318.

Type locality. Turkey: Samsun Province, Ondokuzmayıs, Fish Lake, 41°35'10"N, 36°06'42"E, 0 m elev.

Material examined. TURKEY: Afyon Province: 2 ♂♂, 3 ♀♀, Dinar (Karakuyu Lake), 38°04.587"N, 30°16.505"E, 1020 m, 22.V.2009; 1 ♂, 1 ♀, same locality, 20.VI.2009 (specimens are deposited in the Gazi University Zoological Museum, Ankara, Turkey, and the Snow Entomological Collection, University of Kansas, Lawrence, USA).

Differential diagnosis. Total body length 20.0–21.5 mm. Very similar to *B. levantinus*, from which it may be distinguished by the shape of the aedeagus: the outer margins of the parameres are slightly sinuate medially, with the apex noticeably prolonged apically in *B. levantinus* (Fig. 3) while they are straight with the apex only slightly prolonged apically in *B. major* (Fig. 2).

Biology. All collecting events for this species were from the margins of moderately to densely vegetated, standing waters (Fig. 4).



Figures 1–4. 1 *Brownephilus major*, dorsal habitus **2** *B. major*, aedeagus **3** *B. levantinus*, aedeagus (holotype) **4** Karakuyu Lake, Turkey, habitat of *B. major*.

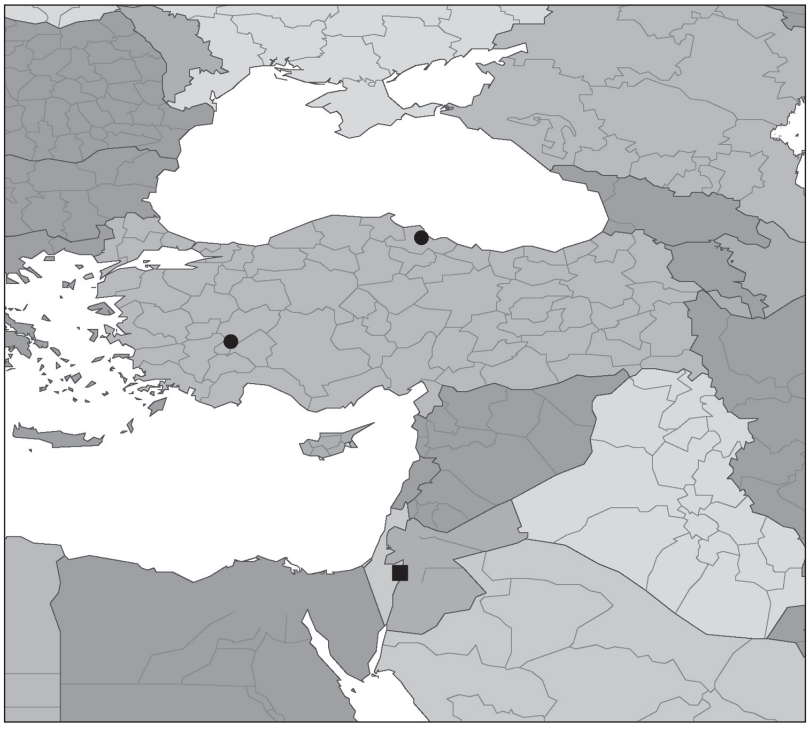


Figure 5. Known distribution of *Brownephilus* species: *B. major* (●); *B. levantinus* (■).

Discussion

The rediscovery of the genus *Brownephilus* is significant as its taxonomic and phylogenetic placement has been enigmatic, the genus was known from only two slightly damaged specimens, and nothing was known of its biology or distribution.

The locality where we recollected the genus (Karakuyu Lake) is included in the Ramsar List of Wetlands of International importance under the UNESCO's Convention on Wetlands of International importance especially as waterfowl habitat. The lake, with a total area of 1220 ha and a maximum depth of 3.5 m, is fed by both surface and groundwater (Nergiz and Tabur 2007).

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RESEARCH ARTICLE

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A new species of *Myrmedonota* Cameron from eastern Kansas (Coleoptera, Staphylinidae, Aleocharinae)

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Abstract

Myrmedonota heliantha **sp. n.** is described from eastern Kansas (USA). All specimens were collected from dung. A modified new key to the species of *Myrmedonota* of America north of Mexico is provided.

Keywords

Lomechusini, myrmecophily, termitophily, taxonomy, Nearctic region

Introduction

The genus *Myrmedonota* Cameron (Aleocharinae: Lomechusini) currently contains 25 species, mostly described from the Old World (23 species), including Borneo (one species), Malay Peninsula (two species), New Guinea (19 species) and Sulawesi (one species) (Hlaváč personal communication). Recently, two new Nearctic species, *M. aidani* Maruyama & Klimaszewski and *M. lewisi* Maruyama & Klimaszewski were described from the states of Ohio and Indiana (USA), respectively (Maruyama et al. 2008). Life histories of most species are not known, but some have been collected in the presents of ants or termites; these species are presumed to be myrmecophilous or termitophilous, respectively (Bourguignon and Roisin 2006; Kistner 2003).

Recently, the author collected specimens of an undescribed *Myrmedonota* species from dung. This species is treated as new and described along with a new key to separate North American species.

Methods

Dry specimens were observed using an Olympus SZX7 stereomicroscope. Dissected structures were observed with the stereomicroscope and an Olympus BX51 compound microscope. Illustrations were made using a camera lucida, Olympus U-DA, mounted on the compound scope. Scale bars were drawn using an Olympus slide micrometer. Body measurements were made using a stereomicroscope ocular micrometer.

All specimens examined were mounted using water soluble fish glue; all dissected body parts were cleared, preserved in Euparal mounting medium and are pinned under appropriate specimens.

Terminology follows the work of Gusarov (2002; aedeagal orientation), Maruyama (2006; epipharyngeal surface), Sawada (1970, 1972; chaetotaxy, mouthpart and median lobe morphology) and Seevers (1978; parameral morphology).

Abbreviations applied in this paper are as follows: HW = head width; HL = head length; HW/HL = head width over head length; OL = ocular length; OL/HL = ocular length over head length; CKTE = private collection of K. Taro Eldredge; SEMC = Snow Entomological Collection, University of Kansas.

Systematics

Genus *Myrmedonota* Cameron, 1920

See Kistner (2003) and Pace (2009) for references and keys to species.

Type species. *Myrmedonota cingulata* Cameron, 1920, by monotypy (pp. 272–273).

Diagnosis. Members of the genus *Myrmedonota* may be separated from other genera of Lomechusini by the following combination of characters (partially adopted from Maruyama et al. 2008): 1) head dorsally subcircular, excluding mouth parts; 2) head lacking neck; 3) occipital suture complete; 4) antennae generalized, clavate and slightly laterally compressed; 5) pronotum with complete marginal line; 6) pronotum without depressions or macrosculpture; 7) body surface finely punctate; 8) abdomen with no horn-like ornamentation; 9) dorsal abdominal surface with sparse to moderate setation but never with dense setal cover, nor with thick macrosetae creating a bristle-like texture; 10) cardo partially overlapping stipes, ventrally; 11) lacinia and

galea extremely elongate and parallel sided; 12) labial palpomeres I and III subequal in length and longer then palpomere II; 13) glossa bifid with each lobe housing two sensillate elements; 14) mentum trapeziform and almost as long as wide; 15) labrum with lateral apices rounded and extending apically beyond maximum midpoint; 16) apical lobe of paramere short; 17) vellum and velar sac of paramere large and extending past the maximum reach of apical lobe and partially concealing it.

In North America *Myrmedonota* most closely resembles the genus *Pella*, but can be separated from the later by the following combination of characters: 1) smaller size (< 3.5 mm [Maruyama et al. 2008]); 2) extremely elongate lacinia and galea; 3) mentum almost as long as wide.

New key to *Myrmedonota* species of America north of Mexico

1 Length of body at least 3.0 mm, ranging up to 3.2 mm; pronotum reddish brown or black in color; spermatheca with proximal end not curved atop itself (Fig. 12 & 21 in Maruyama et al. 2008)..... **2**

– Length of body less then 3.0 mm, on average 2.6 mm; pronotum yellowish in color; spermatheca with proximal end curved atop itself (Fig. 20)..... ..... ***M. heliantha* sp. n.**

2 Pronotum reddish brown in color; elytra uni-colored reddish light brown; abdomen bi-colored with tergites II-IV light brown and V-VIII brown; spermatheca S-shaped (Fig. 12 in Maruyama et al. 2008); athetine bridge wide in lateral view (Fig. 8 in Maruyama et al. 2008)..... ..... ***M. aidani* Maruyama & Klimaszewski**

– Pronotum black in color; elytra bi-colored with at least distal margin cream colored and rest grey to black in color; abdomen uni-colored black; spermatheca V-shaped (Fig. 21 in Maruyama et al. 2008); athetine bridge narrow in lateral view (Fig. 17 in Maruyama et al. 2008)..... ..... ***M. lewisi* Maruyama & Klimaszewski**

***Myrmedonota heliantha* Eldredge, sp. n.**

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Figs 1–20

Description. Body (Figs 1–2) length with a mean of 2.6 mm (n = 4), color yellowish to black. Head and abdominal tergites V-VII (segment V can be lighter or approaching yellowish grey) grey to black; pronotum and elytra yellowish light brown; abdominal tergites II–IV and VIII yellowish light brown to yellowish; mouthparts and legs yellowish; antennae dark brown, segments I–III and apex of segment XI may be yellow ish light brown to yellow ish brown.

Head subcircular (HW = 0.47 mm; HL = 0.42 mm; HW/HL = 1.11; n = 4) with apex narrowing to receive labrum and mouthparts; eyes large, occupying half of head (OL = 0.21 mm; OL/HL = 0.5; n = 4); setae of vertex growing posteromedially; la-

Figures 1–2. *Myrmedonota heliantha*. **1** habitus **2** elytra.

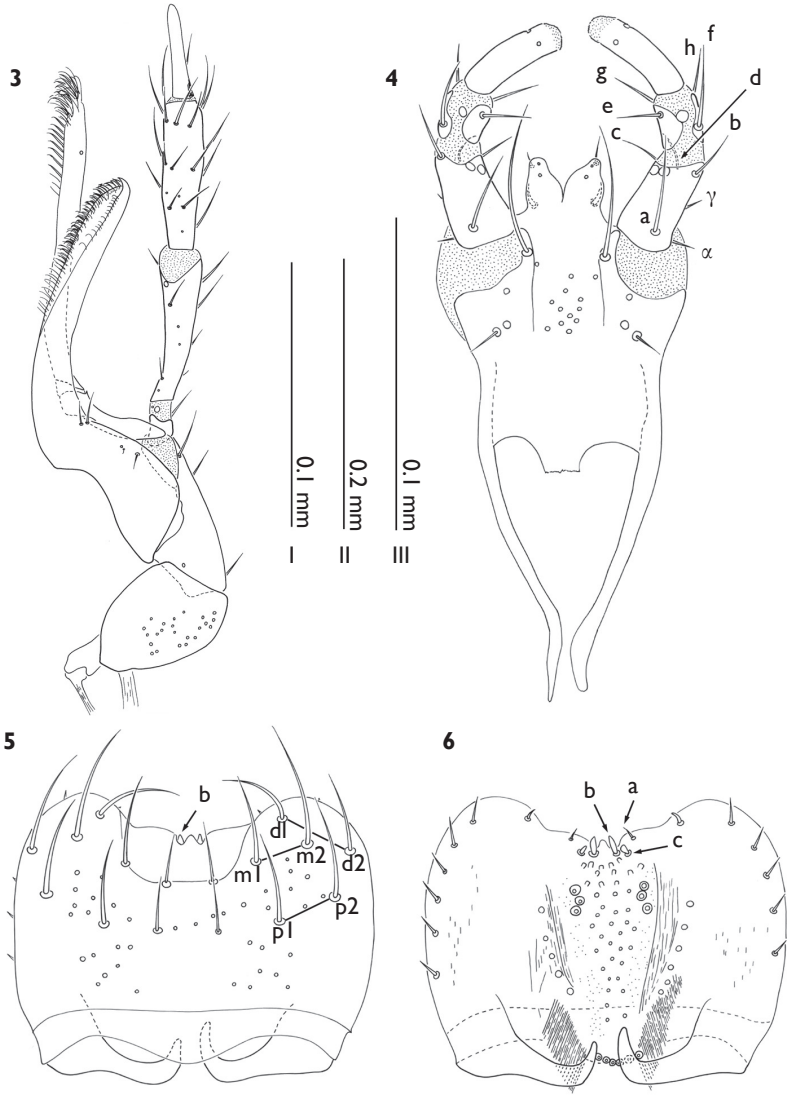
brum (Fig. 5) with apex broadly margined, apicomedially with paired emargination to receive seta b; epipharynx (Fig. 6) with relatively short seta a, six to seven lateral setae equally spaced apart, mesolateral area with relatively little sculpture; maxilla (Fig. 3) with galea and lacinia extremely elongate, galea with preapical margin with a row of spinose setae that are uninterrupted by confused setation, palpomere IV long, with filamentous sensillae, and greater then half the length of palpomere III; labium (Fig. 4) with palpomere I and III subequal in length and palpomere II short, setula β and δ absent, glossa with a pair of apical and basolateral-epipharyngeal sensillate elements, mentum (Fig. 14) trapeziform with apex approximately half as wide as base and length almost equally width at base.

Pronotum flattened, transverse (PW = 0.57 mm; PL = 0.39 mm; PW/PL = 1.46; n = 4), widest subapically and narrowest sub-basally, general form trapeziform ("approximately shield-shaped" [Klimaszewski et al. 2005, p. 709]), anterolateral corners rounded and slightly receding posterior for most of apical edge, posterolaterally with obtuse angles, posterior edge broadly rounded, lateral margins evenly arcuate, setae growing posterolaterally with no distinct midline.

Elytra together, transverse (EW = 0.73 mm; EL = 0.49 mm; EW/EL = 1.49; n = 2), longer then pronotum (EL/PL = 1.55) and acutely emarginated at suture.

Abdomen with dorsal surface relatively glabrous with tergites II-V with basal transverse impressions.

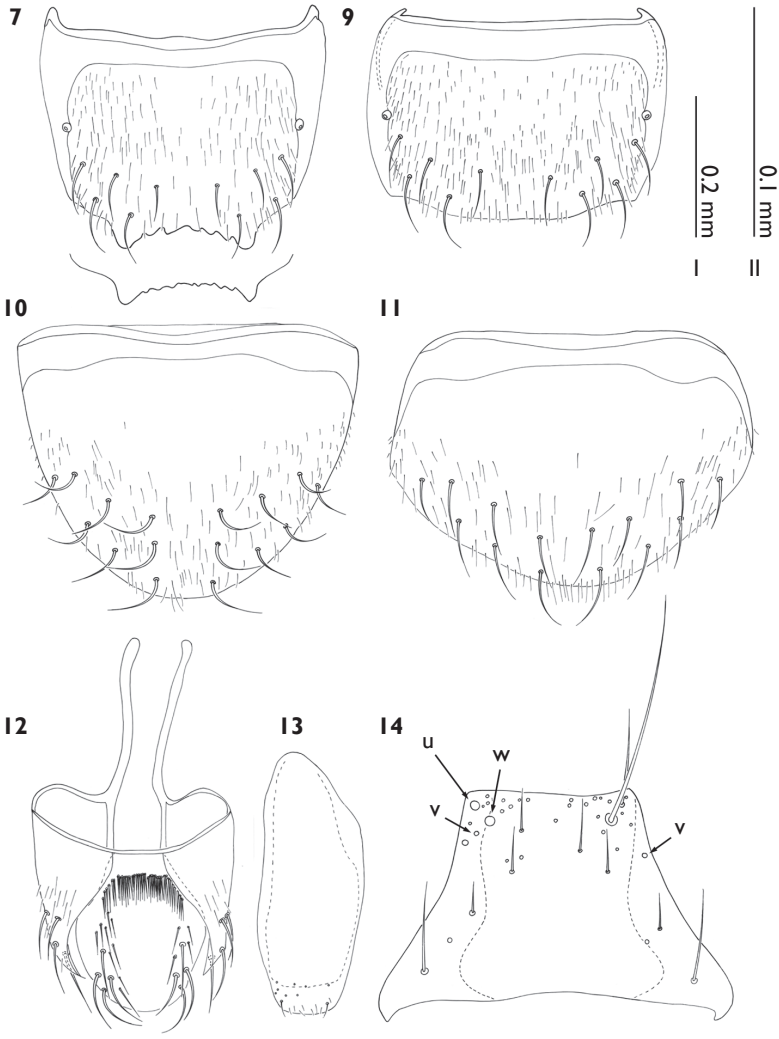
Male tergite VIII (Figs 7–8) apicomedially emarginate with lateral angles of emargination slightly produced and intermarginal edge variably serrate, with five pairs of macrosetae; sternite VIII (Fig. 10) with eight pairs of macrosetae; genital segments as in Fig. 12 and 13; aedeagus (Figs 15–16) relatively elongate with complete athetine bridge; copulatory piece (Fig. 17) long, occupying most of median lobe; paramere (Figs 18–19) with apical lobe partially visible on outer surface, internal velar pad pre-



Figures 3–6. *Myrmedonota heliantha*. **3** right maxilla, ventral view **4** labium, ventral view **5** labrum **6** epipharynx. Scale bars: **I** Figs 5–6 **II** Fig. 3 **III** Fig. 4.

sent (stippled area), vellum large and extending apically, partially obscuring apical lobe in outer view, apical lobe with chaetotaxy as in Fig. 19.

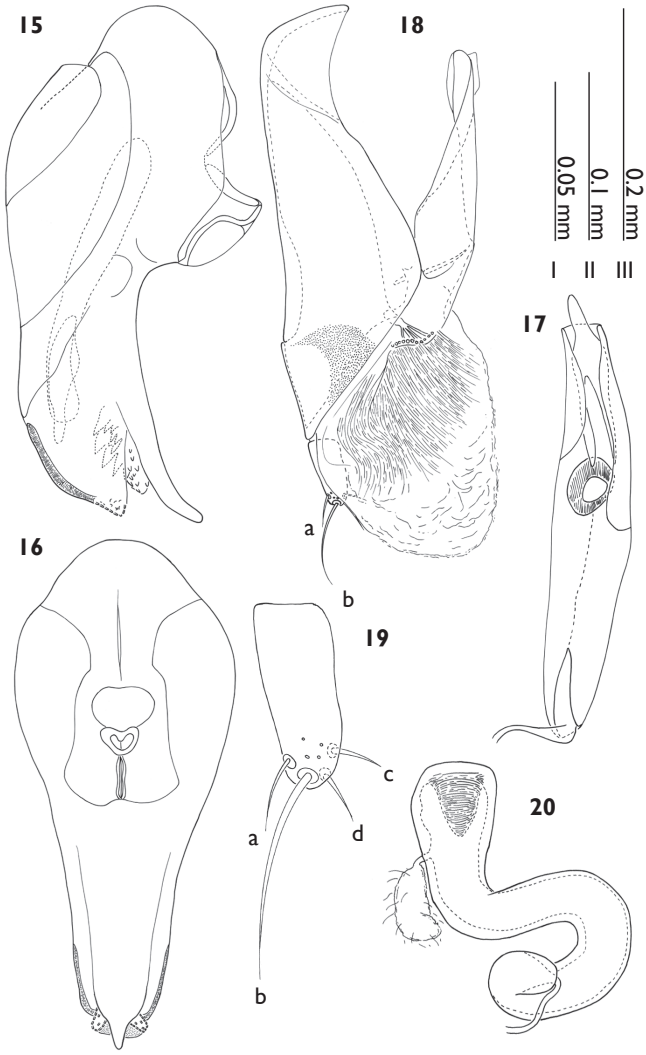
Female tergite VIII (Fig. 9) truncate with five pairs of macrosetae; sternite VIII (Fig. 11) with seven pairs of macrosetae (one fewer then males); genital segments with same macrochaetotaxy as in males; spermatheca (Fig. 20) in shape of the letter S with proximal end curved atop itself, internal cone with circumventral sculptural grooves.



Figures 7–14. *Myrmedonota heliantha* male (7–9, 10–13) and female (10–11). **7** tergite VIII **8** holotype tergite VIII, outline of apical margin **9** tergite VIII **10** holotype sternite VIII **11** sternite VIII **12** genital segments excluding sternite IX, dorsal view **13** sternite IX, ventral view **14** mentum, ventral view. Scale bars: **I** Figs 7–13 **II** Fig. 14.

Diagnosis. *Myrmedonota heliantha* most closely resembles *M. aidani*, but can be distinguished by the following combination of characters: 1) pronotum widest subapically; 2) internal sac with distinctive configuration (Fig. 15); 3) spermatheca without an apical process extending from internal cone and with proximal end curved atop itself.

Material examined. HOLOTYPE, ♂: "USA: KANSAS**:** Douglas Co.,/Lawrence, Baker Wetlands, N 38.92737°, W 95.23278°//ex. human dung baited pitfall trap (SEMC). PARATYPES, 2♀ and 1♂: same data as holotype (1♀, terminalia dissected



Figures 15–20. *Myrmedonota heliantha*. **15** median lobe, lateral view **16** median lobe, parameral view **17** copulatory piece, oblique parameral view **18** paramere, outer lateral view **19** apical lobe of paramere, outer lateral view **20** spermatheca. Scale bars: **I** Fig. 19 **II** Figs 17, 20 **III** Figs 15–16, 18.

but spermatheca not recovered, SEMC; 1♂, completely disarticulated permanent slide mount [additional label data "Euparal slide#007, K.T. Eldredge 2009"], CKTE); same locality data, differing data reads "13.ix.2009", "ex. mammal dung" (1♀, terminalia dissected, SEMC).

Bionomics. All specimens were collected off dung at Baker Wetlands, a 573 acre tract of restored wetland and prairie habitat, approximately 250 meters in elevation and two miles south of the University of Kansas campus.

Etymology. Derived from the generic nomen *Helianthus*, in dedication to the sunflower state Kansas, where the type series was collected.

Acknowledgments

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RESEARCH ARTICLE

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Redescription of *Stenolophus thoracicus* Casey (Coleoptera, Carabidae, Harpalini), a valid species

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Abstract

Stenolophus thoracicus Casey is revalidated. The species is redescribed based on a study of the syntypes and of several conspecific specimens from eastern North America. The species differs from the other eastern species of the subgenus *Agonoleptus* in having the metasternum shorter and the wings reduced to tiny stubs. The dorsal habitus and median lobe of the aedeagus, along with the structures of the internal sac, are illustrated.

Keywords

Coleoptera, Carabidae, *Stenolophus*, *Agonoleptus*, Nearctic, taxonomy

Introduction

Lindroth (1968: 921), in his comprehensive monograph of the carabids of Canada and Alaska, synonymized *Stenolophus thoracicus* Casey with *S. conjunctus* (Say) pointing out, however, that the microsculpture on the pronotum of the female "type" was considerably stronger than normal. A study of Casey's syntypes revealed that the specimens are in fact specifically distinct from those of *S. conjunctus*. The purpose of this paper is to redescribe *S. thoracicus* and to discuss the structural differences between *S. thoracicus* and the other eastern species of the subgenus *Agonoleptus* Casey.

The holdings of the following collections were studied: Buffalo Museum of Science, New York (BMSC), California Academy of Sciences (CAS), National Collection of Insects, Arachnids and Nematodes (CNC), Field Museum of Natural History, Chicago (FMNH), Los Angeles County Museum of Natural History (LACM), Museum of Comparative Zoology (MCZ), Michigan State University Collection (MSUC), North Dakota State University (NDSU), National Museum of Natural History (USNM), University of Wisconsin-Madison Insect Research Collection (WIRC), and the collection of Peter W. Messer (PWM). No examples of *S. thoracicus* were observed in material from University of California at Berkely, Milwaukee Public Museum, Mississippi State University, and Washington State University.

Stenolophus thoracicus Casey, 1914

Stenolophus thoracicus Casey, 1914: 282. Type locality: «S[ain]t Louis, Missouri» (original citation for the lectotype).

Type material. Lectotype (♂), designated by Lindroth (1975: 143), in USNM labelled: "Mo / ♂ / Casey bequest 1925 / thoracicus Paratype USNM 48052 / Lectotype thoracicus Csy by C.H. Lindroth." Casey's collection includes six other specimens under the name *S. thoracicus* (one ♀, five ♂), each labelled later as "paratype." The unit tray bears a label "type missing Lindroth 73." It seems that the Casey's collection included another female specimen, labelled as "type," that Lindroth studied before 1968.

Description[1]**.** *Coloration*. Clypeus and labrum reddish; frons reddish-brown to reddish-black; antennomeres 1 and 2 yellow, antennomeres 3–11 slightly darker, brownish-yellow; pronotum entirely yellow to reddish-yellow; elytra reddish-brown to reddish-black, with base, intervals 1 and lateral margins paler, more or less yellowish to reddish; elytral epipleura yellow; legs entirely yellow. *Microsculpture*. Frons with isodiametric meshes, meshes indistinct or almost so in the male, faint but distinct in the female; pronotum with linear microlines, microlines indistinct or almost so in the male, distinct in the female; elytra with markedly transverse meshes, meshes well impressed in both sexes. *Head*. Clypeo-ocular line evident, complete (i.e., reaching medial edge of eye). *Pronotum*. Proportionally wide, LP/WP = 0.73–0.79 (mean = 0.76; n= 10); maximum width clearly anterior to middle; anterior angle markedly protruding; basal impression shallow, almost indistinct in some specimens; basal bead reaching just beyond level of basal impression. *Elytra*. Striae impressed, shallow but deeper toward apex, impunctate; intervals flat. *Thorax* (ventral side). Metasternum, short, length behind mesocoxa about 0.7 that of metacoxa along same line. *Male genitalia*. Median lobe with apex hooked; internal sac with two large U-shaped sclerotized structures and a small "scaly body" near middle.

Apparent body length: 3.5–4.1 mm.

[1] For character states of the subgenus *Agonoleptus*, see Lindroth (1968: 921), as "the *conjunctus* group."

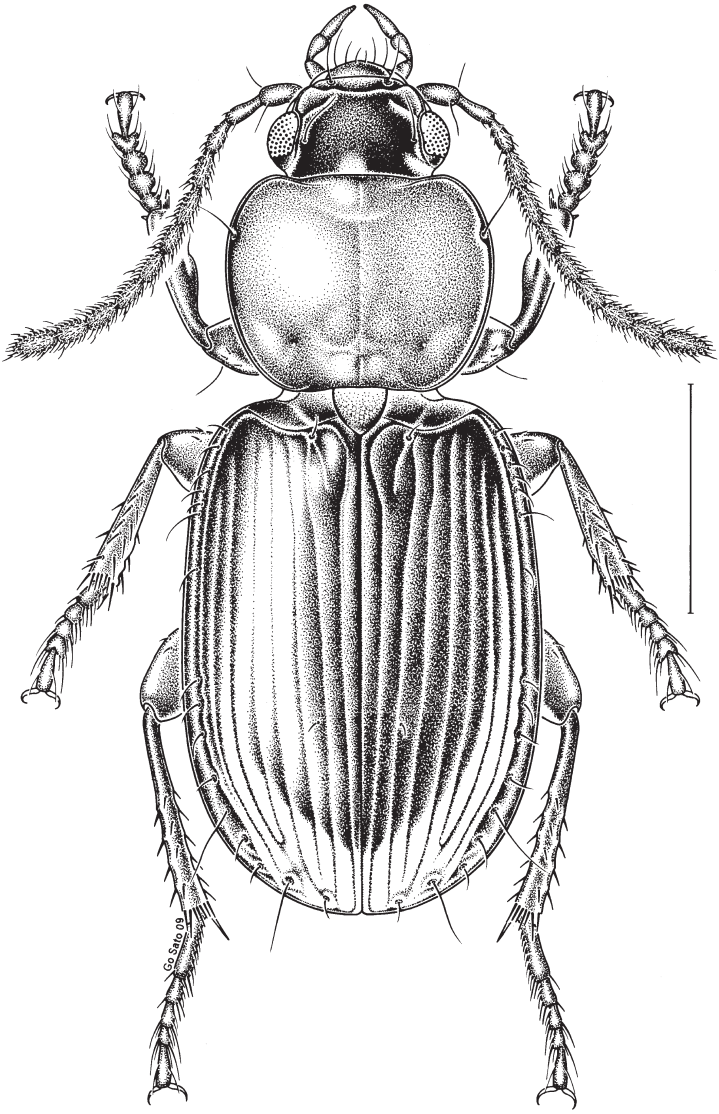

Figure 1. Habitus (dorsal view) of *Stenolophus thoracicus*.

Geographical distribution. This species ranges from east-central Vermont to southeastern North Dakota, southwardly to northeastern Kansas, Tennessee, and northeastern Virginia (Fig. 3). We have seen specimens from the following localities. *District of Columbia*. Woodridge, 14.IV.1898 (1, USNM). *Illinois*. Chicago, Cook Co., IV.1980, Blackwelder (1, WIRC). Pine Hills Field Station, Union Co., 15–22.V.1967, J.M. Campbell (3, CNC). *Indiana*. Pulaski Co., 14.V.1977, N.M. Downie (1, FMNH). Tippecanoe Co., 3.VII.1961, N.M. Downie (1, FMNH). *Iowa*. "Ia." (3, USNM). Jefferson Co. (1, USNM). Pottawattamie Co. (2, USNM).

Figure 2. Median lobe of aedeagus of *Stenolophus thoracicus*. **a** left lateral view **b** ventral view.

Iowa City, Johnson Co., 1.X.1917, L. Buchanan (1, USNM). Okoboji, Dickinson Co., VIII (2, USNM). *Kansas*. Atchison, Atchison Co., 25.IV. (1, USNM). *Kentucky*. Frankfort, Franklin Co., 16.IV.1892 (1, USNM). *Maryland*. Baltimore, 16.V.1909, F.E. Blaisdell (1, LACM). *Massachusetts*. Cambridge, Middlesex Co., 18.III.1974 (1, MCZ). Waverly, Middlesex Co. (1, USNM). Springfield, Hampden Co., G. Dimmock (1, MCZ). Dover, Norfolk Co., 19.IV.1904, F.C. Bowditch (1, MCZ). Dover, Norfolk Co., 4.VI.1908, A. P. Morse (1, MCZ). Wachusett, Worcester Co., 19.IV.1906, Perry Gardner Bolster (1, MCZ). Bolton, Worcester Co., 13.IV.2010, T. Murray (1, PWM). *Michigan*. Rose Lake Wildlife Experiment Station, Clinton Co., 18.XII.1971, D.K. Young (1, WIRC). Detroit, Wayne Co. (1, USNM). *Missouri*. "Mo" (2, USNM). Kansas City, 26.IV.1898 (1, USNM). *New Jersey*. "N.J.," R. Hopping (1, CAS). Tenafly, Bergen Co., 17.III.1917, F.M. Schott (1, CNC). *New York*. "N.Y." Schaupp (1, BMSC). Ithaca, Tompkins Co., 25.VIII.1911, Van Dyke (1, CAS). *North Dakota*. Mirror Pool, Richland Co., T135N-R52W-Sec 8, NE ¼, 27.V.1966, Gordon & Aarhus (1, NDSU). *Ohio*. Wayne Co., 1.V.1938 (2, MSUC). W' Loo Twn., Athens Co., 6.V.1936, W. Stehr (1, MSUC). Canaan Twn., Athens Co., 24.III.1939, W.C. Stehr (1, MUSC). Carbondale, Athens Co., 21.V.1938, 8.IV.1948, W.C. Stehr (2, MSUC). Columbus, Franklin Co., 23.IV.1929, R.T. Everly (2, MSUC). *Pennsylvania*. 6 km SW Buck Valley at Sideling Hill Creek,

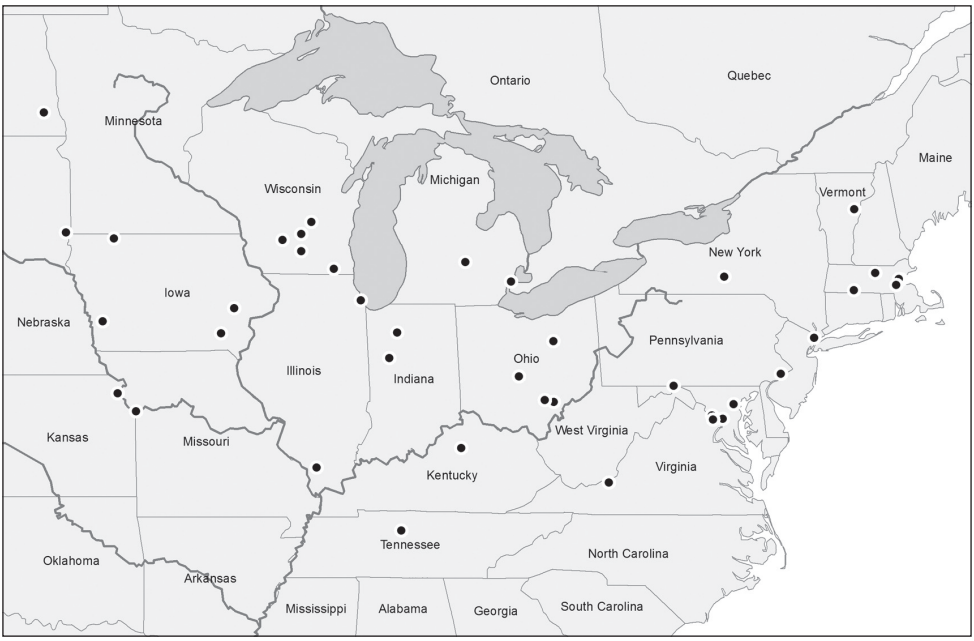

Figure 3. Collection localities for *Stenolophus thoracicus*.

39°44'N, 78°21'W, 10.X.1992, W.E. Steiner & J.M. Swearingen (1, USNM) [shale barren slope]. Frankford, Philadelphia Co., A. Schmidt (1, USNM). *South Dakota*. [East] Sioux Falls, Minnehaha Co., 25.IV.1967, V.M. Kirk (1, USNM) [sod, rock]. *Tennessee*. Nashville, Davidson Co. (1, USNM). *Vermont*. Topsham, Orange Co., 27.X.2008, T. Murray (1, PWM). *Virginia*. "Va", 29.V.1881 (1, USNM). Great Falls, Fairfax Co., 29.X., Banks (2, MCZ). Vienna, Fairfax Co., 2.X.1932 (1, USNM). Fairfax Co., 21.IX.1930, A. Nicolay (1, USNM). Fairfax Co., 4.VI.1972, R. Gordon & A. Cushman (1, USNM). 9 km N Mountain Lake, Wind Rocks, Giles Co., 19.VIII.1984, W. Steiner & J. Hill (1, USNM). *Wisconsin*. "Wis" E. Chope (1, FMNH). Mud Lake Nat. Site, Columbia Co., 21–27.V.1996 (1, WIRC). Madison, Dane Co., 27.IV.1910, J.G. Sanders (1, WIRC). Nevin Marsh, Dane Co., 12.VI.1974, D.T. Bach (1, WIRC). Green Lake Co., 22.IV.2000, C. Buss (1, WIRC). Hemlock Draw, Sauk Co., 6.V.2007, J.P. Gruber (1, PWM). Springfield Nat. Site, Walworth Co., 8–15.VII.1996 (3, WIRC).

Habitat. No information is available about the habitat requirements of the species.

Wing condition. Nine specimens were dissected and their wings were reduced to tiny stubs. Considering the size of the metasternum, the species is very likely constantly brachypterous.

Note. *Stenolophus thoracicus* belongs to the subgenus *Agonoleptus* Casey which includes six other species-group taxa: *S. conjunctus* (Say), *S. rotundicollis* (Haldeman), *S. rotundatus* LeConte, *S. parviceps* (Casey), *S. unicolor* Dejean, and *S. unicolor dolosus* Casey. The last three-named taxa are found in southwestern United States and are not

further dealt with. The other taxa occur sympatrically with *S. thoracicus* east of the Rocky Mountains, although one of them, *S. conjunctus*, also extends to the West Coast.

Adults of *S. thoracicus* differ most notably from those of the three other eastern species of the subgenus in having the metasternum shorter and the wings highly reduced. For comparative purpose, the ratio of the metasternal length behind the mesocoxa and the metacoxal length measured along the same line varies between 1.0 and 1.2 in *S. conjunctus*, *S. rotundicollis*, and *S. rotundatus*. In addition, the pronotum is more narrowed posteriorly on average.

Adults of *S. conjunctus* differ from those of *S. thoracicus* also in having the microsculpture on pronotum indistinct in both sexes and the elytral microsculpture less impressed. The apex of the median lobe of the aedeagus is proportionally longer, not hooked, and the internal sac has two slightly curved sclerotized structures (see Lindroth 1968: Fig. 446a).

Adults of *S. rotundicollis* differ from those of *S. thoracicus* also in having the pronotum darker, brownish-red to reddish-brown (except narrowly around the edges) and the microsculpture on pronotum and elytra more deeply impressed. The apex of the median lobe is hooked but the internal sac contains two small U-shaped and one slender, straight sclerotized structures (see Lindroth 1968: Fig. 446c).

Adults of *S. rotundatus* differ from those of *S. thoracicus* also in having the pronotum darker, reddish-brown to piceous (except for anterior and posterior margins), and more convex, the clypeo-ocular line clearly more deeply impressed, the anterior angles of the pronotum less protruding, the medial elytral striae deeper, and the pronotum and elytra without microsculpture. The apex of the median lobe is hooked, more bluntly so than in *S. thoracicus* and *S. rotundicollis*, and the internal sac has one large U-shaped and one straight sclerotized structures (see Lindroth 1968: Fig. 446b).

Key to eastern species of *Stenolophus*, subgenus *Agonoleptus*

1. Metasternum short, ratio of metasternal length behind mesocoxa and metacoxal length measured along the same line about 0.7 ..... ***S. thoracicus* Casey**
– Metasternum longer, ratio of metasternal length behind mesocoxa and metacoxal length measured along the same line 1.0 to 1.2 ..... **2**
2. Pronotum paler, reddish (in some specimens with a darkened central cloud), paler than head. Apex of median lobe not hooked ..... ***S. conjunctus* (Say)**
– Pronotum darker, reddish-brown to piceous (except narrowly around edges), not clearly paler than head. Apex of median lobe hooked..... **3**
3. Pronotum and elytra without microsculpture..... ***S. rotundatus* LeConte**
– Pronotum and elytra with well-impressed microsculpture meshes .... ***S. rotundicollis* (Haldeman)**

Acknowledgments

We thank Terry L. Erwin for making the type material of *S. thoracicus* available for study, Go Sato for the habitus drawing, Vasily Grebennikov for his help with producing the male genitalia images, and Eduard Jendek for providing the distribution map.

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RESEARCH ARTICLE

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Review of the genus *Thubana* Walker (Lepidoptera, Lecithoceridae) from China, with description of one new species

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Abstract

The genus *Thubana* Walker is reviewed for China. Nine species are recognized, of which *T. felinaurita* Li, **sp. n.** is described as new; *T. dialeukos* Park, 2003 and *T. xanthoteles* (Meyrick, 1923) are newly recorded for this country; *T. stenosis* (Park, 2003), **syn. n.** is synonymised with *T. xanthoteles*, and *T. microcera* (Gozmány, 1978), **syn. n.** with *T. leucosphena* Meyrick, 1931. Images of adults and genitalia are provided. A checklist of *Thubana* species in China is included, along with a key to these species.

Keywords

Lepidoptera, Torodorinae, *Thubana*, new species, synonym, China

Introduction

The genus *Thubana* was established by Walker (1864) with *T. bisignatella* Walker, 1864 as the type species. Park and Heppner (2009) listed 46 species in their catalogue of the genus. They included *T. laxata* (Meyrick, 1911) and *T. nodosa* (Meyrick, 1910),

which were once transferred to *Stelechoris* (Park and Wu 2001), and *T. adelella* (Walker, 1864), which was earlier removed from the list of *Thubana* (Park et al. 2005), but did not list *T. pedicucullata* Park, 2009 and *T. gyrostigmatis* Park, 2009 from Philippines (Park 2009), and *T. reniforma* Wu, 2000 from Malaysia (Wu 2000). Here we tentatively add these three species to the list of *Thubana*.

Prior to this study, seven species of *Thubana* were recorded in China (Wu 1997). In this paper we describe one new species *T. felinaurita* Li, **sp. n.** on the basis of Chinese material, and report *T. dialeukos* Park, 2003 and *T. xanthoteles* (Meyrick, 1923) as new for China. We synonymise *T. stenosis* Park, 2003, **syn. n.** with *T. xanthoteles*, and *T. microcera* Gozmány, 1978, **syn. n.** with *T. leucosphena* Meyrick, 1931. To date, the genus *Thubana* comprizes 48 species worldwide including the new species described herein, and nine of them occur in China.

Material and methods

Genitalia dissections were carried out following the methods described by Li (2002). All the studied specimens, including the types, are deposited in the Insect Collection, College of Life Sciences, Nankai University, Tianjin, China.

Taxonomic accounts

Genus *Thubana* Walker, 1864

Thubana Walker, 1864: 814. Type species: *T. bisignatella* Walker, 1864: 814, by original designation.

Titana Walker, 1864: 813. Type species: *Titana adelella* Walker, 1864: 814, by original designation.

Tiva Walker, 1864: 821. Type species: *Tiva binotella* Walker, 1864: 822, by original designation.

Inapha Walker, 1864: 999. Type species: *Inapha lampronialis* Walker, 1864: 999, by original designation.

Stelechoris Meyrick, 1925: 243. Type species: *Pachnistis exoema* Meyrick, 1911: 707, by original designation.

Diagnosis. *Thubana* is characterized by the combination of the following characters: forewing often having a white costal patch, costa gently curved with sharpened end, termen more or less concave, tornus broadly rounded, M_3 usually stalked with CuA_{1+2}, R_4 and R_5 often coincident (in some species R_4 and R_5 stalked basally), R_3 stalked with

R_{4+5}; hindwing with M_2 present, almost parallel to stalk of M_3+CuA_1; abdominal tergites with spinose zones; valva thumb-shaped, juxta plate-shaped, and aedeagus with diverse cornuti in male genitalia; antrum cup-shaped, ductus bursae usually with many internal spinules, signum with dense spinules in female genitalia.

Thubana is similar to the genus *Torodora* in the shape of the wings, the presence of M_2 on the hindwing, the spined tergites of the abdomen and the structure of male and female genitalia. But *Torodora* usually lacks the costal patch on the forewing, and M_3 is separated with CuA_{1+2}, which can separate the two genera from each other.

Distribution. China, Thailand, Malaysia, Indonesia, Philippines, India, Nepal, Sri Lanka.

Checklist of *Thubana* species in China

1. ***Thubana albinulla* Wu, 1994**
Thubana albinulla Wu, 1994: 130.
Distribution. China (Sichuan).

2. ***Thubana albiprata* Wu, 1994**
Thubana albiprata Wu, 1994: 130.
Distribution. China (Sichuan).

3. ***Thubana albisignis* (Meyrick, 1914)**
Lecithocera albisignis Meyrick, 1914: 50.
Thubana albisignis: Meyrick, 1925: 184.
Distribution. China (Taiwan).

4. ***Thubana bathrocera* Wu, 1997**
Thubana bathrocera Wu, 1997: 86.
Distribution. China (Hunan).

5. ***Thubana deltaspis* Meyrick, 1935**
Thubana deltaspis Meyrick, 1935: 563.
Distribution. China (Fujian, Taiwan).

6. ***Thubana dialeukos* Park, 2003**
Thubana dialeukos Park, 2003: 138.
Distribution. China (Yunnan), Thailand.

7. ***Thubana leucosphena*** **Meyrick, 1931**

Thubana leucosphena Meyrick, 1931: 69.
Thubana microcera Gozmány, 1978: 236, **syn. n.**
Distribution. China (Anhui, Fujian, Jiangxi, Henan, Hunan, Hubei, Guizhou, Zhejiang).

8. ***Thubana xanthoteles*** **(Meyrick, 1923)**

Lecithocera xanthoteles Meyrick, 1923: 38.
Lecithocera melitopyga Meyrick, 1923: 41.
Thubana xanthoteles: Clarke, 1965: 232.
Thubana stenosis Park, 2003: 147, **syn. n.**
Distribution. China (Yunnan), Thailand, India, Sri Lanka.

9. ***Thubana felinaurita*** **Li, sp. n.**

Distribution. China (Guangxi).

Key to male *Thubana* in China

1. Forewing with R_4 and R_5 short-stalked **2**
– Forewing with R_4 and R_5 coincident **3**
2. Juxta with posterolateral lobes narrowly rounded at apex; aedeagus with two sclerotized bars, the distal one needlelike, the median one acinaciform (Fig. 9) ..... ***T. xanthoteles***
– Juxta with posterolateral lobes acute at apex, aedeagus with two to three dentations near apex (Park 2000: Figs 13, 13a) ..... ***T. albisignis***
3. Forewing without white patch, with small black cell-dot and fold-dot ..... ***T. albinulla***
– Forewing with white patch **4**
4. Forewing with white basal patch occupying 1/3 of wing, costal patch absent ..... ***T. bathrocera***
– Forewing without basal patch, costal patch present **5**
5. Male juxta with a long spine at base (Clarke 1965: Figs 2–2b) ... ***T. deltaspis***
– Male juxta without spine at base **6**
6. Aedeagus longer than valva (Fig. 7) ..... ***T. felinaurita*** **sp. n.**
– Aedeagus shorter than valva **7**
7. Juxta without median projection (Fig. 8) ..... ***T. dialeukos***
– Juxta with median projection **8**
8. Juxta with a lobulated projection at middle, with two large thornlike processes on caudal margin; posterolateral lobes inconspicuous (Fig. 15) . ***T. leucosphena***
– Juxta with a horned projection at middle, without processes on caudal margin; posterolateral lobes mastoid (Wu 1994: Fig. 17) ..... ***T. albiprata***

***Thubana felinaurita* Li, sp. n.**
urn:lsid:zoobank.org:act:E86B6559-0A44-44A9-A3CD-62F2D3B8ABCF
Figs 1, 7

Type material. Holotype ♂ – **China**, **Guangxi Province:** Dongzhong Forestry Farm, Fangchenggang, (21°35'N, 108°22'E), 640 m, 9.IV.2002, coll. Shulian Hao & Huaijun Xue, genitalia slide No. ZYM06312; Paratype – 1 ♂, same data as holotype except dated 8.IV.2002, genitalia slide No.YLL08061.

Diagnosis. The new species is similar to *T. leucosphena*, but can be distinguished from it by the juxta having a median membranous protuberance, the posterolateral lobes rounded apically, and the aedeagus longer than valva. In *T. leucosphena*, the juxta has a lobulate projection at middle near anterior margin and two large thornlike processes on caudal margin, the posterolateral lobes are inconspicuous, and the aedeagus is obviously shorter than the valva.

Description. Adult (Fig. 1). Wingspan 20.5–21.0 mm. Head grayish brown on vertex, with grayish white scales around eyes. Antenna yellowish white, longer than forewing. Labial palpus brown; inner surface of second segment yellowish white mixed with grayish scales; third segment dark fuscous, longer than second. Thorax and tegula grayish brown, with shining luster. Forewing rectangular, costa gently curved, apex blunt, termen slightly concave inward at about 1/3; color brown with dark purple; costal patch triangular, yellowish white, extending to middle of cell; fringe grayish black, with yellowish white basal line. Hindwing grayish brown; fringe fawn black, with yellowish white basal line. Fore leg with dorsal surface dark grayish, ventral surface yellowish white; mid leg yellowish white, with scattered brown scales; hind leg yellowish white on inner surface, grayish brown on outside except tarsus and distal end of tibia yellowish white.

Male genitalia (Fig. 7). Uncus relatively stout, broad basally, narrowed to bluntly rounded apex. Gnathos large, broad in basal 2/3, strongly bent beyond basal 2/3, then narrowed toward apex; apex hooked, greatly curved ventrally. Valva broad at base, slightly narrowed to basal 1/3; distal 2/3 curved upward like a finger, with dense setae on inner surface; apex rounded; costa protruded basally, incurved medially; ventral margin concave inward at basal 1/3, gently arched outward medially. Sacculus weakly sclerotized, broad at base, narrowed distally, straight ventrally, terminating at basal 1/4 length of valva. Juxta quadrate, with a membranous protuberance at middle; posterolateral lobes like cat's ear in shape, setose, rounded posteriorly. Vinculum narrow, weakly sclerotized. Aedeagus very stout, longer than valva, broad in basal 2/5, narrowed toward apex, with caducous setae at apex; vesica slightly sclerotized at base, medially with a bundle of numerous brushlike spines, a slightly arched plate and a slender dentate band.

Female. Unknown.

Distribution. China (Guangxi).

Etymology. The specific name is derived from the Latin *felinus* (= feline) and *auritus* (= auricular), referring to the shape of the posterolateral lobes of the juxta.

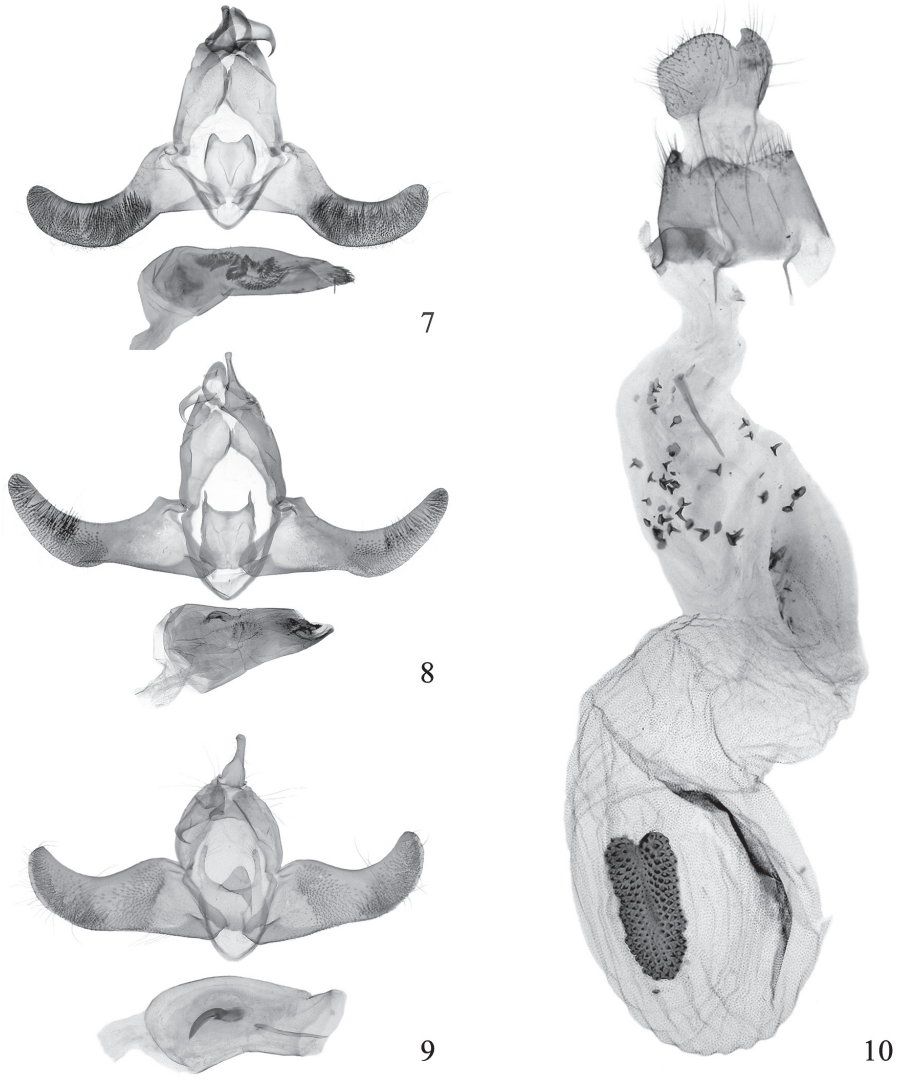
Figures 1–6. Adults of *Thubana* spp. **1** *T. felinaurita* sp. n., paratype **2** *T. dialeukos* Park **3–6** *T. xanthoteles* (Meyrick), showing variation of costal patch (1–4 ♂, 5–6 ♀).

Thubana dialeukos Park, 2003

Figs 2, 8

Thubana dialeukos Park, 2003: 138.

Material examined. 1 ♂, **China, Yunnan Province:** Rare Botanical Garden, Ruili (24°00'N 97°50'E), 1000 m, 6.VIII.2005, coll. Yingdang Ren, genitalia slide No. YLL08075.



Figures 7–10. Genitalia of *Thubana* spp. **7** *T. felinaurita* sp. n., paratype, slide No. YLL08061 ♂ **8** *T. dialeukos* Park, slide No. YLL08075 ♂ **9** *T. xanthoteles* (Meyrick), slide No. ZYM06119 ♂ **10** *T. xanthoteles* (Meyrick), slide No. ZYM06121 ♀.

Diagnosis. This species is very close to *T. leucosphena* and hardly distinguishable from the latter by the superficial characters (Fig. 2) and the venation. However, it can be easily differentiated by the following characters of the male genitalia (Fig. 8): the valva broad at base, narrowed to before middle, gently raising obliquely upward in distal half, narrowed to blunt apex; the costa straight in basal 1/6, gently concave in distal 5/6; the juxta quadrate, with small, slender, almost straight posterolateral lobes; the aedeagus stout, shorter and broader than valva, with two dentate

preapical lobes, and the cornuti consisting of a S-shaped fragment and a mass of short spines.

Distribution. China (Yunnan), Thailand.

Notes. This species is recorded for the first time from China.

Thubana xanthoteles (Meyrick, 1923)

Figs 3–6, 9, 10

Lecithocera xanthoteles Meyrick, 1923: 38.
Lecithocera melitopyga Meyrick, 1923: 41; Clarke, 1965: 232, as synonym of *Thubana xanthoteles*.
Thubana xanthoteles (Meyrick, 1923): Clarke, 1965: 232.
Thubana stenosis Park, 2003: 147, **syn. n.**

Material examined. 1 ♂, 7 ♀, **China, Yunnan Province:** Mengla (21°29'N 101°33'E), 650 m, 23–25.VIII.2005, coll. Yingdang Ren; 2 ♂, 1 ♀, Jinghong (22°01'N, 100°48'E), 585 m, 17–18.IV.1995, coll. Hongjian Wang & Guangyun Yan.

Diagnosis. This species can easily be separated from its allies by the elongate narrow forewing without patch (Figs 3, 4), or with an orange-yellow cuneate (Fig. 5) or bandlike costal patch (Fig. 6); in male genitalia (Fig. 9), the juxta with digitate, setose posterolateral lobes and a large triangular median projection, the aedeagus as long as and broader than valva, and the cornuti consisting of two sclerotized bars: the distal one needlelike, about 1/2 length of aedeagus, the median one stouter, somewhat acinaciform; in female genitalia (Fig. 10), the caudal margin of 8th sternite deeply emarginate at middle, the ostium broad, the antrum fan-shaped and weakly sclerotized, the ductus bursae narrowed basally, with many short spines medially, and the signum strawberry-shaped.

Distribution. China (Yunnan), Thailand, India, Sri Lanka.

Discussion. Meyrick (1923) described *T. xanthoteles* on the basis of two female specimens and described *T. melitopyga* from one female specimen. Clarke (1965) regarded *T. melitopyga* as a junior synonym of *T. xanthoteles*. Thus previously only three female specimens of *T. xanthoteles* have been known and none of these has the costal patch on the forewing. Park (2003) described *T. stenosis* on the basis of the specimens collected from north Thailand, which bears the "golden yellow bandlike costal patch" on the forewing. He also noticed that the "female genitalia" of *T. stenosis* "are hardly distinguishable from those of *T. xanthoteles*". In this study, we found that the male genitalia of the three specimens collected in south Yunnan undoubtedly match with those of *T. stenosis* described by Park, and the female genitalia match with those of *T. stenosis* and of *T. xanthoteles*. We also found deciduous needlelike cornuti in the ductus bursae of female genitalia. Superficially, the males have no costal patch, but the females usually have a bandlike or cuneate costal patch. Thus we treat *T. stenosis* as a junior synonym of *T. xanthoteles*, and regard the presence or absence of the costal patch as intraspecific variation.

Notes. This species is recorded for the first time in China.

***Thubana leucosphena* Meyrick, 1931**
Figs 11–16

Thubana leucosphena Meyrick, 1931: 69; Clarke, 1965: 231; Gozmány, 1978: 235; Wu, 1997: 84; Park, 2003: 143.
Thubana microcera Gozmány, 1978: 236, **syn. n.**

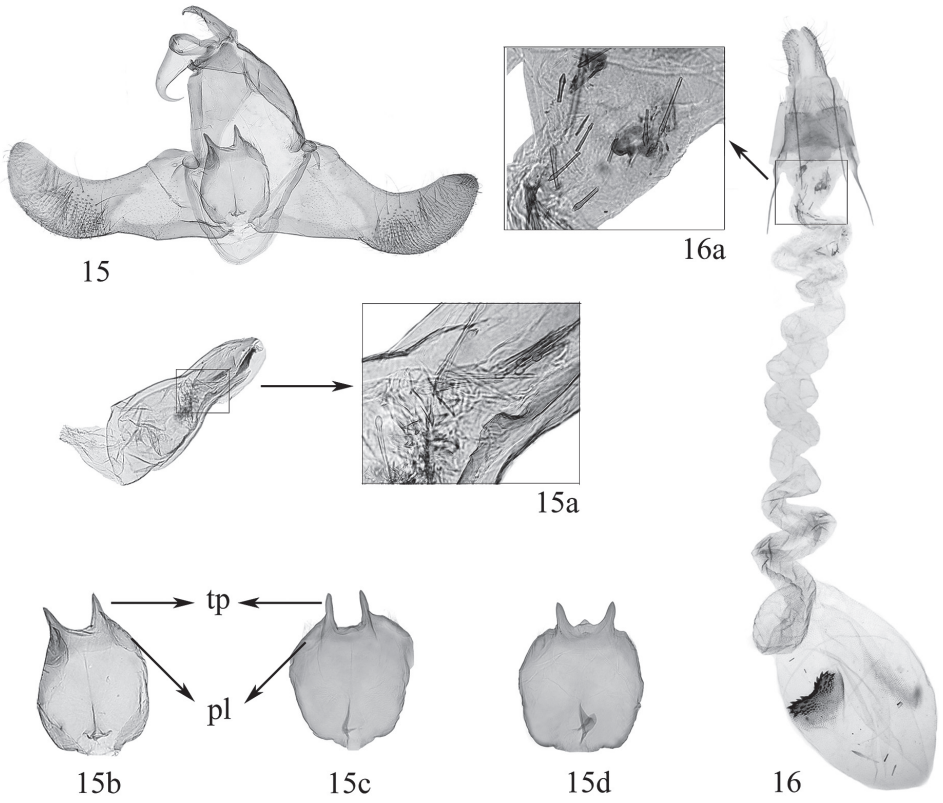
Material examined. China, Zhejiang Province: 13 ♂, Wuyanling, Taishun (27°33'N 119°42'E), 790 m, 2–3.VIII.2007, coll. Qing Jin; 2 ♂, 2 ♀, same locality, 680 m, 930 m, 28–31.VII.2005, Yunli Xiao; 4 ♂, 2 ♀, Tianmushan (30°26'N 119°34'E), Lin'an, 350 m, 7–8.VIII.2007, coll. Qin Jin, 10 ♂, 800 m, 19.VIII.1999, coll. Houhun Li et al., 5 ♂, 2 ♀, 500 m, 16.VIII.1999, coll. Houhun Li et al.; 1 ♂, Qingliangfeng (30°07'N 118°51'E), Lin'an, 900 m, 12.VIII.2005, coll. Yunli Xiao. **Anhui Province:** 4 ♂, Mozitan, Huoshuan (31°24'N 116°19'E), 12.VIII.2004, coll. Jiasheng Xu & Jialiang Zhang; 5 ♂, Huangshan (29°43'N 118°18'E), 6–7.VIII.2004, coll. Jiasheng Xu and Jialiang Zhang; 6 ♂, Jiuhuashan (30°23'N 117°48'E), 8–9. VIII.2004, coll. Jiasheng Xu & Jialiang Zhang. **Fujian Province:** 2 ♂, Wuyishan (26°54'N 116°42'E), 740 m, 19–24.V.2004, coll. Haili Yu; 1 ♂, Qingyunshan, Yongtai (25°52'N 118°57'E), 550 m, 18.IX.2002, coll. Xinpu Wang. **Jiangxi Province:** 4 ♂, Xiaoxidong, (26°57'N 114°17'E), 1,3–4.VII.1978; 2 ♂, Tonggu (28°32'N, 114°22'E), 28.VII.1982, 10.V.1983; 3 ♀, Ciping (26°34'N 114°10'E), 13.VII.1978; 1 ♂, 1 ♀, Xiashan, Yichun (27°47'N 114°23'E), 7,30.VII.1980; Jinpenshan (29°20'N 117°00'E), 2 ♂, 18–19.VIII.2006, coll. Jiasheng Xu & Weichun Li. **Henan Province:** 3 ♂, 1 ♀, Xiaguan, Neixiang (33°02'N 111°50'E), 650 m, 10,12.VII.1998, coll. Houhun Li; 1 ♀, Huangshi'an (33°40'N 111°37'E), Xixia, 890 m, 19.VII.1998, coll. Houhun Li. **Hunan Province:** 1 ♂, Zhangjiajie (29°49'N 110°26'E), 650 m, 7.VIII.2001, coll. Houhun Li & Xinpu Wang. **Hubei Province:** 3 ♂, 2 ♀, Maoba (30°02'N, 109°02'E), Lichuan, 700 m, 28–29.VII.2007, coll. Houhun Li et al. **Guizhou Province:** 1 ♂, Jiangkou (27°41'N 108°50'E), 600 m, 27.VII.2001, coll. Houhun Li & Xinpu Wang.

Diagnosis. This species is characterized by the following characters: male genitalia (Fig. 15) with juxta having a lobulate projection at middle near anterior margin and two large thornlike processes on caudal margin, the posterolateral lobes inconspicuous (Fig. 15b-d), the aedeagus shorter than valva, the cornuti consisting of a long slender band, a bundle of brushlike spines, a dentate plate, and sometimes with a few dispersed deciduous spicules (Fig. 15a); female genitalia (Fig. 16) with apophysis anterioris about 1/2 length of apophysis posterioris, the caudal margin of 8th sternite slightly emarginate at middle, the ductus bursae long, twisted, with spicules on inner surface (Fig. 16a), and the signum spinulose, semiovate, slightly emarginate at upper margin. *Thubana leucosphena* is very close to *T. felinaurita*, but differs as noted in the description of the latter.

Distribution. China (Anhui, Fujian, Jiangxi, Henan, Hunan, Hubei, Guizhou, Zhejiang).

Figures 11–14. Adults of *Thubana leucosphena* Meyrick, showing variation of costal patch (11–12 ♂, 13–14 ♀).

Discussion. This species was described by Meyrick (1931) based on three specimens collected from Guanxian of Sichuan Province in China: "two males" and "a third example". Clarke (1965) rectified the "two males" as Oecophoridae and chose the "third example", a female, as the lectotype of *T. leucosphena*. Meyrick (1935) mentioned the occurrence of this species in Tianmushan of Zhejiang Province. Gozmány (1978) described *T. microcera* on the basis of a male specimen collected from Tianmushan and noticed that it could be distinguished from *T. leucosphena* by the shape of the costal patch. In this study, however, we noticed that the costal patch varies from triangular to trapezoidal both within male specimens of *T. microcera* (Figs 11–12) and female specimens of *T. leucosphena* (Figs 13–14). We also found that males collected from Zhejiang, Jiangxi, Hubei and Henan provinces match with those of *T. microcera* described by Gozmány, females match with those of *T. leucosphena*. Besides, we observed the deciduous spicules from the male aedeagus in the ductus bursae of *T. leucosphena*. What is more, no other species of *Thubana* were collected in these localities so far. Hence, we treat *T. microcera* as a junior synonym of *T. leucosphena*, and regard the variation of the shape of costal patch from triangular to trapezoidal as intraspecific variation.



Figures 15–16. *Thubana leucosphena* Meyrick. **15** male genitalia **15a** aedeagus, showing spicules **15b–d** variation of juxta (**pl** = posterolateral lobes, **tp** = thornlike processes; slide Nos. **b**: ZYM06315, **c**: ZYM06321, **d**: ZYM06179) **16** female genitalia **16a** ductus bursae, showing spicules on inner surface, slide No. ZYM06193.

Notes. The previous description did not mention the median projection on posterior margin of the juxta. Though this projection (Fig. 15b) is not present in most individuals, we found it present in some males, either inconspicuous (Fig. 15c) or small but visible (Fig. 15d). We consider this variation as intraspecific because other characters fit well with *T. leucosphaena*.

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RESEARCH ARTICLE

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Identity of *Squalius* (Actinopterygii, Cyprinidae) from Istra Peninsula in Croatia (Adriatic Sea basin)

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Abstract

A chub of previously ambiguous identity from the Boljunšćica and Pazinčica rivers (south-eastern Istra Peninsula) was studied and compared with geographically close *Squalius squalus, S. zrmanja,* and *S. janae* recently described from the Dragonja River drainage in the Adriatic Sea basin in Slovenia. It was shown that the chub from the south-eastern Istra Peninsula differs from all know species of *Squalius* but one: *S. janae.* Three samples examined from Boljunšćica and Pazinčica rivers and *S. janae* from its type locality, Dragonja River, show the following characters typical for the latter species: a long head (the head length 27–32% SL); a pointed conical snout with a clearly projecting upper jaw; a long straight mouth cleft, the lower jaw length (39–45% HL) exceeding the caudal peduncle depth; a large eye; commonly 9½ branched anal-fin rays; commonly 44 total vertebrae (24+20 or 25+19); bright silvery colouration, scales easily lost; iris, pectoral, pelvic and anal fin pigmentation with yellow shades. The data on the distribution of *Squalius* chubs in the northern Adriatic basin support the assumption that the range of *S. janae* is determined by the geology of the Trieste Flysch Basin and the Pazin Flysch Basin forming the base of the Istra Peninsula. The distribution pattern of this species does not support a simple model of fish dispersal and a complete connectivity within the whole Palaeo-Po historical drainage. Indeed, it indicates a disrupted surface palaeohydrography that was heavily fragmented by karstification in the whole Dinaric area.

Keywords

freshwater fish distribution, Cyprinidae, Istrian chub, *Squalius*, morphology, Adriatic Sea basin, Istra Peninsula, Slovenia, Croatia

Introduction

Istra [Istria, formerly Histria], is the largest peninsula in the Adriatic Sea. It is located in the northern Adriatic between the Gulf of Trieste and the Bay of Kvarner, and shared by three countries: Croatia, Slovenia and Italy. The largest portion, Hrvatska Istra [Croatian Istria] lies in Croatia. Larger rivers of the western cost of the Istra Peninsula are (from north to south) Osapska Reka [Osbo], Rižana [Risano], Badaševica [Kornalunga] (with a reservoir called Vanganel Lake), Dragonja with its largest tributary Pinjevec [Rokava], and Mirna [Quieto], which is the largest river in Istra. The Butoniga River, a tributary of the Mirna, was dammed in 1989 in its upper part and now flows into a reservoir called Butoniga Lake. In the south-east from the Mirna, Pazinčica [Foiba, Fojba] River flows for 16.5 km and in the Pazinska Jama [Pazin Cave] becomes a subterranean river which used to flow underground near Beram, Kringa and Dvigrad to the sea forming the Lim Valley; its former estuary is the Lim Bay [Limski Kanal]. Rivers Raša [Arsia] (flowing into the Raški Zaljev [Raski Inlet, Porto d'Arsia] and Boljunšćica [Boljunčica] (used to flow into the Plumin Luka Inlet or Plumin Bay) go southwards along the western slope of the Učka mountains [Monte Maggiore] and the Ćićarija [Ciceria] mountain range. At present, the Boljunšćica and Raša drainage systems in the region of Čepić Polje (ca. 45°12'N 14°08'E) are interconnected by a number of irrigational canals and canalised streams. Till 1932 Čepić Polje had been a lake, which is now drained.

Chubs were known to occur in the Istra Peninsula, and historically they were identified as *Squalius cavedanus* (Bonaparte, 1838) in Osapska Reka and Rižana (Heckel and Kner 1858), as *Leuciscus cephalus cabeda* Risso, 1827 in Rižana, Pazinčica, and Mirna (Gridelli 1936), as *Leuciscus cephalus albus* Bonaparte, 1838 in Čepić Lake [Lago d'Arsa nell Istria, Cepich-See] (Gridelli 1936: fig. 13), as *Squalius cephalus* (Linnaeus, 1758) in Badaševica [Kornalunga] (Porečnik 1958), as *L. cephalus albus* in Dragonja with Pinjevec (Povž and Sket 1990, Povž 2002) and in Butoniga Lake (Mrakovčić et al. 2000), as *Leuciscus cavedanus* in Mirna and Pazinčica (Mrakovčić et al. 2006), and as *Squalius squalus* (Bonaparte, 1837) in the whole of Istra (Kottelat and Freyhof 2007). Leiner and Popović (1984) reported *Leuciscus svallize* (Heckel and Kner, 1858) and *L. cephalus albus* for all Istrian rivers and reservoirs. Povž and Sket (1990) had doubts which subspecies (*L. cephalus cabeda* or *L. cephalus albus*) inhabits the numerous Adriatic rivers southwards from Dragonja. Leiner et al. (1995) reported *L. cephalus albus* from Čepić Lake and Pazinčica based on literature sources and from Mirna (with its tributary Bracan [Bračana]), Butoniga River and Butoniga Lake, Pazinčica, Raša, Boljunšćica, Letaj Reservoir, Dragonja with its tributary Pinjevec, and Vanganel Lake based on their own data. At the same time they mentioned (Leiner et al. 1995) *L. cephalus cabeda* as occurring in Rižana, Pazinčica, Mirna, and Badaševica with tributaries and *L. cephalus* in Mirna and Boljunšćica rivers based on literature sources. Besides, *Leuciscus leuciscus* (Linnaeus, 1758) is reported as occurring in Pazinčica and Mirna based on literature data (Leiner et al. 1995), and *Leuciscus svallize* in Mirna, Pazinčica, Raša, Boljunšćica, Letaj Reservoir, Rakov Potok Reservoir

at Cerovlje (Leiner et al. 1995). Bogutskaya and Zupančič (1999) had no specimens from the Istra Peninsula available for examination and assumed that the reports of *L. svallize* might refer to either *L. zrmanjae* (Karaman, 1928) or *L. illyricus* (Heckel & Kner, 1858).

Zupančič (2008) in his review of endemic species of the Adriatic basin provided a list of forms he considered to be undescribed species, and gave the chub from Dragonja, Mirna, Pazinčica, Boljunšćica and Raša rivers as *Squalius* sp. 1 (Zupančič 2008). The Dragonja material has been recently described as a new species *Squalius janae* Bogutskaya and Zupančič, 2010 which is distinguished from other species of the genus *Squalius* in the Adriatic basin by a long head, a pointed conical snout, a straight oblique mouth cleft, a long lower jaw length, a large triangular 5th infraorbital, commonly 44–47 total lateral line scales, commonly 9½ branched anal-fin rays, commonly 24+20 or 25+19 vertebrae, strong silvery tint in colouration, iris, pectoral, pelvic and anal fin pigmentation with yellow shades, and scales easily lost. Bogutskaya and Zupančič (2010) showed that a chub from northern Istra Peninsula: Osapska Reka, Rižana, Malinska and Mirna (except for Dragonja) belongs to *S. squalus.*

The purpose of the present article is to describe the chub from Pazinčica and Boljunšćica rivers (south-eastern Istra), compare it with *S. janae* and *S. squalus*, and decide on its identity.

Material and methods

Measurements were taken point to point to the nearest 0.1 mm following Bogutskaya and Zupančič (1999). The standard length (SL) was measured from the tip of the upper jaw to the end of the hypural complex. The length of the caudal peduncle was measured from behind the base of the last anal-fin ray to the end of the hypural complex, at mid-height of caudal-fin base. Head length (HL) and interorbital width were measured including the skin fold. Postdorsal length was measured from the dorsal-fin insertion to the posterior end of the hypurals, and the dorso-hypural distance was taken from the origin of the dorsal fin to the posterior end of the hypurals. A further character was added from Doadrio et al. (2007): a point where the dorso-hypural distance, which is taken from the dorsal-fin insertion to the end of the hypural complex, falls when measured forward. The last two branched rays articulated on a single pterygiophore in dorsal and anal fins were counted as "1½". Total lateral line scale counts include all pored scales, from the first one just behind the posttemporal bone to the posteriormost one located on the bases of the caudal-fin rays. Osteological characters were examined from radiographs.

Abbreviations used: CBD, Collection of G.A.C. Balma and G.B. Delmastro, Torino; NMW, Naturhistorisches Museum Wien; SMNH, Slovenian Museum of Natural History, Ljubljana; PZC, Collection of P. Zupančič, Dolsko (Slovenia); ZISP, Zoological Institute, Russian Academy of Sciences, St. Petersburg; CNHM, Croatian Natural History Museum, Zagreb.

Material from the south-eastern Istra Peninsula

Squalius janae. NMW 3077–080, 7, 160.1–186.8 mm SL; Croatia: Čepić Lake; Steindachner don., V.1900. – NMW 49229, 16, 120.1–168.4 mm SL; same locality and donator, 1900 v.2a. – NMW 49250, 1, 222.8 mm SL; Croatia: Čepić Lake; coll. Krauss, August 1877. – PZC 406, 29, 49.5–133.2 mm SL; Croatia: Boljunšćica River at Katun Boljunski, ca. 45°17'N 14°08'E; coll. Zupančič, 4 September 2004. – PZC 457, 5, 74.5–160.6 mm SL; same locality and collector; 3 September 2007. – PZC 415, 16, 50.8–118.0 mm SL; Croatia: Pazinčica River, ca. 45°14'N 13°55'E; 13 July 2000, coll. Mrakovčić; CNHM 5005, 5002, 6021 and 5164, 4, 96.6–113.0 mm SL; Croatia: Istra Peninsula [no exact locality, probably Pazinčica]; no date, leg. Leiner.

Comparative Material

Squalius janae. SMNH 207, holotype 183.7 mm SL; Slovenia: Dragonja River about 2 km upstream from bridge on road from Župančiči, 45°28'N 13°46'E; coll. Zupančič, 1 August 2008. – PZC 475, 6 paratypes, 85.9–174.9 mm SL; same data as holotype. – PZC 452, 6 paratypes, 74.9–132.5 mm SL; Slovenia: Dragonja River at bridge on road from Župančiči, 45°28'15"N 13°45'11"E; coll. Zupančič, 24 November 2007. – PZC 453, 6 paratypes, 66.2–157.6 mm SL; same locality; coll. Zupančič, 17 May 2009. – PZC 454, 19 paratypes, 85.8–158.0 mm SL; Slovenia: Dragonja River downstream from confluence with Pinjevec [Rokava], 45°28'30"N 13°44'31"E; coll. Zupančič, 10 April 2009. – PZC 455, 7 paratypes, 68.4–212.7 mm SL; Slovenia: Dragonja River south from Koštabona, 45°28'20"N 13°44'11"E; coll. Zupančič, 10 April 2009. – PZC 456, 8 paratypes, 111.2–190.0 mm SL; Slovenia: Dragonja drainage: Pinjevec River [Rokava] at Župančiči, 45°29'N 13°46'E; coll. Zupančič, 1 February 2007. – PZC 476, 4 paratypes, 80.4–120.0 mm SL; same locality and collector; 24 November 2007. – ZISP 54690, 11 paratypes, 88.5–149.3 mm SL; same locality as PZC 455; coll. Zupančič and Naseka, 5 July 2008.

Squalius squalus (samples are presented below in geographical order, from north-west to south-east). NMW 48920, 1 [probable syntype] of *Squalius tyberinus* Bonaparte, 1841, 187 mm SL; Italy: Tyber; "[C.L. Bonaparte], 1844.VI.19". – NMW 49189, 5, 65.7–193.8 mm SL; Treviso; "[Tausch], 1844.V". – NMW 49259, 4, 150.6–195.5 mm SL; Slovenia: Rižana [Risano, 1848.I.10]. – PZC 287 (from CBD–F1996/44384–44391), 8, 80.5–155.4 mm SL; Italy: Po drainage: stream Orco, 100 m from confluence with Po River at Chivasso, 45°12'N 07°53'E; coll. Balma and Delmastro, 18 September 1991. – PZC 288 (from CBD–F2057/45572–45576), 5, 75.5–140.5 mm SL; Italy: Po drainage: Torrente Malone, about 1 km upstream of the bridge of Lombardore, 45°14'N 07°44'E; Balma and Delmastro, 12 May 1992. – PZC 458, 4, 140.0–185.0 mm SL; Slovenia: Soča drainage: Nadiža [Natisone] River at Podbela, 46°14'30"N 13°27'30"E; coll. Zupančič, 2 May 2007. – PZC 459, 3, 139.3–185.0 mm SL; Slovenia: Soča drainage: Idrija [Idria] River at Velendol, 46°05'N

13°34'E; P. Zupančič, 2 May 2007. – PZC 460, 5, 107.0–145.0 mm SL; Slovenia: Soča drainage: Idrija system, Koncnar River, 45°59'N 13°22'E; coll. Zupančič, 8 December 2007. – PZC 461, 12, 120.0–220.0 mm SL; Slovenia: Soča drainage: Idrija system, Birša River at Dolnje Cerovo, 45°58'N 13°33'E; P. Zupančič, 26 April 2007. – PZC 462, 4, 140.0–215.0 mm SL; Slovenia: Soča drainage: Vipava [Vipacco] system, Močilnik River at Slap; 45°50'N 13°56'E; P. Zupančič, 26 April 2007. – PZC 463, 7, 135–205 mm SL; Slovenia: Soča drainage: Vipava system, River Močilnik at Vipava, 45°50'08"N 13°57'E; coll. Zupančič and Naseka, 6 August 2009. – ZISP 54687, 13, 107.8–208.2 mm SL; Slovenia: Soča drainage: Vipava system, Branica River at Steske, 45°52'30"N 13°46'E; coll. Zupančič and Naseka, 5 July 2008. – PZC 465, 2; Slovenia: Soča drainage: Vipava system, Vrtovinšček River at Fuzine, 45°53'40"N 13°48'40"E; coll. Zupančič and Naseka, 5 July 2008. – PZC 466, 14, 98.5.0–190.0 mm SL; Slovenia: Soča drainage: Vipava system, Vogršček River at Vogrsko; 45°50'N 13°56'E; coll. Zupančič, 1 December 2007. – PZC 467, 9, 97.0–155 mm SL; Slovenia: Osapska Reka River (flows into Miljski Zaliv east of Muggia) at Osp, 45°33'N 13°52'E; coll. Zupančič, 1 February 2007. – ZISP 54689, 7, 96.7–165.5 mm SL; same locality as PZC 467, coll. Zupančič and Naseka, 10 July 2008. – ZISP 54689, 6, 88.0–190.6 mm SL; Slovenia: Rižana River (flows into Miljski Zaliv at Koper [Capadistria]) at Dekani, 45°32'30"N 13°48'E; coll. Zupančič and Naseka, 5 July 2008. – PZC 468, 2, 175, 182 mm SL; Croatia: Malinska River (endorheic, south from Dragonja) at Koromači Buskini, 45°27'N 13°50'E; coll. Zupančič, 28 March 2009. – PZC 469, 4, 129.5–172.7 mm SL; Croatia: Mirna River at Livade, 45°21'N 13°50'E; coll. Zupančič, 4 August 2005. – PZC 470, 7, 112.5–176.5 mm SL; Slovenia: Reka [Bračana] River, tributary of Mirna, at Olika, 45°27'40"N 13°53'40"E; coll. Zupančič, 12 November 2008.

Lists of examined specimens of *S. cephalus, Squalius* cf. *squalus, S. zrmanjae, S. svallize*, *S. illyricus, S. prespensis,* and *S. orientalis* can be found in Bogutskaya and Zupančič (1999, 2010).

A map showing the localities of samples from the Istra Peninsula is given in Fig. 1.

Results

Description of specimens from Boljunšćica and Pazinčica rivers. Morphometric data of 30 specimens from the Boljunšćica and Pazinčica rivers are given in Table 1, and the general appearance can be seen from Figs 2–5.

The body is elongate, depth at the dorsal-fin origin is 21–24% SL. The head is long, its length, 27–31% SL, is greater than the body depth being 113–131% of the latter, and exceeds the caudal peduncle depth by a factor of 2.6–3.2. The upper head profile is almost straight, the snout is pointed, and the preorbital part of the head is almost triangular in lateral view. The mouth is subterminal (Figs 2, 3) or almost terminal though never clearly terminal even in smaller specimens (Fig. 4), and the upper jaw is clearly projecting beyond the lower jaw. The mouth cleft is straight, oblique,

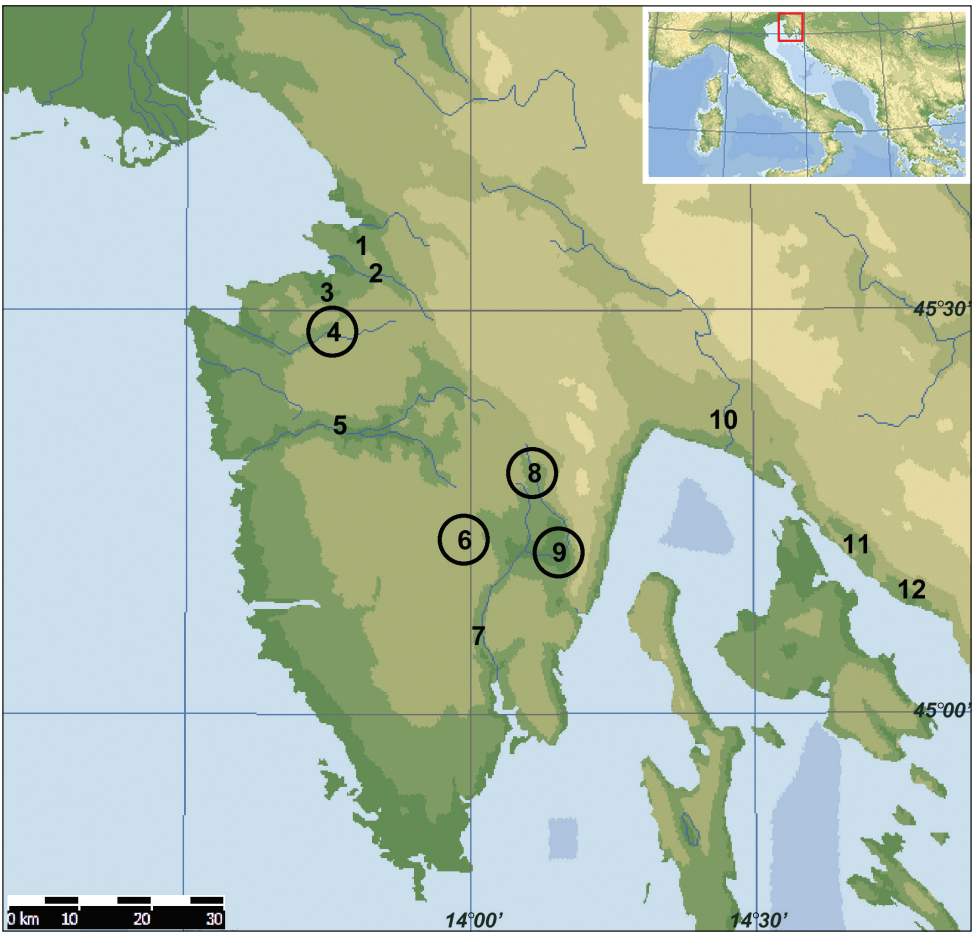

Figure 1. Map showing the main localities mentioned in the text: **1** Osapska Reka **2** Rižana **3** Badaševica and Vanganel Lake **4** Dragonja with Pinjevec **5** Mirna with Reka and Butoniga **6** Pazinčica **7** Raša **8** Boljunšćica **9** Čepić Polje (formerly Čepić Lake) **10** Rječina **11** Dubračina and Tribalj Reservoir **12** Ričina. Localities where *Squalius janae* is recorded are circled.

and the lower jaw-quadrate junction is commonly well visible forming a distinctive obtuse angle (Figs 2–5); the lower jaw-quadrate junction is on the vertical through the middle of the eye. The lower jaw length, 39–44% HL, exceeds the caudal peduncle depth by a factor of 1.0–1.3, commonly 1.1–1.2. The length of the lower jaw is always greater than both the operculum depth (being 106–116% of the former) and the interorbital width. The eye is large, its horizontal diameter being 20–25% in HL, and 54–71% in interorbital width. The eye diameter negatively correlates with the fish size as it can be seen from comparisons of larger and smaller specimens (Figs 2–3 and 4), for example, it is 26–28% in HL in specimens of 50–60 mm SL and 20% in HL in a specimen of 222 mm SL (NMW 49250) though we did not perform a statistic comparison.

Figure 2. *Squalius janae,* live specimen. PZC 457, 160.6 mm SL, Croatia: Boljunšćica.

Figure 3. *Squalius janae* NMW 49229, 147.5 mm SL, Croatia: former Čepić Lake.

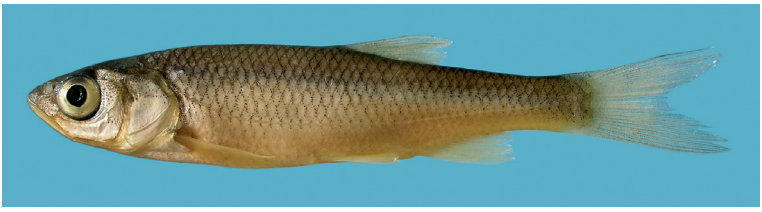

Figure 4. *Squalius janae* PZC 406, 50.0 mm SL, Croatia: Boljunšćica.

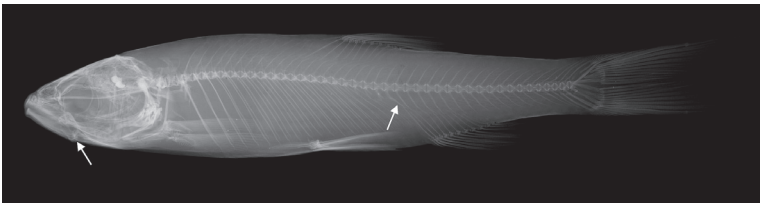

Figure 5. Radiograph of *Squalius janae,* PZC 406, 133.2 mm SL, Croatia: Boljunšćica, showing 24+20 total vertebrae (arrow shows first caudal vertebra) and lower jaw length (arrow shows posterior end of lower jaw).

The dorsal fin has 3 simple and 8½ branched rays in all specimens. Its outer margin is straight. The dorsal fin is located slightly behind the end of the pelvic-fin base. The dorso-hypural distance falls when measured anteriorly in the posterior half of the eye, rarely at the posterior eye margin. The dorsal fin is high, its depth being 16–19% in SL. The anal fin has 3 simple and 9½ branched rays; 8½ branched rays were found only in two specimens. The anal-fin outer margin is slightly to markedly convex.

The total number of gill rakers in the outer row on the first left gill arch is 8(5), 9(22) or 10(3). Pharyngeal teeth (in five specimens examined) are 2.5–5.2, hooked and serrated. The number of total lateral line scales is 43(1), 44(2), 45(12), 46(11), 47(9) or 48(3). Scales on flanks are easily lost in both live and preserved specimens. The total vertebrae including four Weberian vertebrae and the last complex centrum are 44 in 10 specimens examined; the number of abdominal vertebrae (including intermediate ones; precaudal vertebrae auctorum) is 24(5) or 25(5); the number of predorsal vertebrae (anterior to the first dorsal pterygiophore) is 15(9) or 16(1); intermediate vertebrae are five in all specimens; the number of caudal vertebrae is 19(5) or 20(5). The vertebral formulae are 25+19 (5) or 24+20 (5) (Fig. 5).

In live specimens, the overall colouration has a strong silvery tint, and the back is only slightly darker than the flanks and the belly. No conspicuous dark reticulated pattern has been seen in live specimens. The iris, anal and pectoral fin pigmentation has yellow shades, and is never bright (Fig. 2). Formalin fixed and ethanol stored specimens keep silvery-grey colouration with no brownish or bronze shades; yellow pigments are often lost in preserved specimens. Pigmentation on scales shows a reticulate pattern with comparatively fewer pigment dots along the outer scale margins. A concentration of pigment on scale pockets forming dark vertical spots is commonly visible in larger specimens (Fig. 2) though not pronounced in a small specimen (50 mm SL, Fig. 3).

The Pazinčica and Boljunšćica specimens and the historical sample from Čepić Lake examined in this study are thus identified as *S. janae* based on the diagnostic characters of the latter (Bogutskaya and Zupančič 2010), see Table 1 and Figs 2–5.

Comparative remarks. The Pazinčica and Boljunšćica specimens and the Čepić Lake historical sample differ from *S. squalus* in general and from specimens from Osapska, Rižana (Fig. 6), Malinska and Mirna rivers in the northern Istra Peninsula in particular (see Bogutskaya and Zupančič 2010) by having a shallower body, the body depth at the dorsal-fin origin being 21–25% SL (means 22.5 and 23.4 in the Boljunšćica and Pazinčica samples, respectively) while in *S. squalus* the body is deeper, 23–28% SL (mean 25.4 in the Osapska sample, from Bogutskaya and Zupančič 2010). The head is longer in *S. janae* than in *S. squalus*: in *S. janae* the head length is 28–32% SL (means 28.2 and 29.1 in the Boljunšćica and Pazinčica samples, respectively) in contrast to 25–29% SL in *S. squalus* (mean 26.5 in the Osapska sample). The depth of the cau-

Figure 6. *Squalius squalus* NMW 49259, 195.5 mm SL, Slovenia: Rižana.

Table 1. Morphometric data of *Sualius janae* from Dragonja, Boljunščica and Pazinčica rivers. Diagnostic characters of *S. janae* are given in boldface.

	Dragonja (PZC 475, 452-54, ZISP 54690, holotype SMNH 207, n=42)				**Boljunščica (PZC 406, 457, n=20)**				**Pazinčica (PZC 415, n=10)**			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
SL, mm	63.3	190.0			80.0	160.6			75.3	118.0		
Body depth at dorsal-fin origin (% SL)	**20.4**	**26.1**	**23.16**	**1.09**	**20.9**	**23.6**	**22.48**	**0.87**	**22.9**	**25.2**	**23.41**	**0.86**
Depth of caudal peduncle (% SL)	9.7	11.0	10.46	0.38	9.8	10.9	10.37	0.38	9.3	10.8	10.37	0.48
Depth of caudal peduncle (% length of caudal peduncle)	47.9	58.8	54.31	3.32	47.47	58.30	53.09	3.21	49.1	57.4	54.43	2.64
Predorsal length (% SL)	55.4	59.0	57.04	1.06	55.6	58.4	56.61	0.87	57.1	59.3	58.00	0.83
Postdorsal length (% SL)	32.6	36.2	34.17	0.95	34.3	35.7	35.11	0.47	32.6	35.4	33.94	1.12
Preanal length (% SL)	71.2	76.0	74.05	1.30	71.0	74.4	72.60	0.96	70.6	73.7	72.56	1.04
Pectoral – pelvic-fin origin length (% SL)	24.3	29.0	26.76	1.20	24.4	26.8	25.70	0.75	25.5	26.6	26.20	0.37
Pelvic – anal-fin origin length (% SL)	19.3	22.7	21.32	0.85	19.7	22.8	21.38	0.98	20.2	22.3	21.43	0.86
Length of caudal peduncle (% SL)	18.0	21.1	19.31	0.89	18.1	21.0	19.58	0.83	18.5	19.4	19.05	0.32
Dorsal-fin base length (% SL)	10.1	12.1	10.98	0.60	9.9	11.6	10.92	0.42	10.0	11.0	10.65	0.35
Dorsal fin depth (% SL)	**16.3**	**20.2**	**18.09**	**1.32**	**17.4**	**19.4**	**17.91**	**0.57**	**16.1**	**19.1**	**17.62**	**1.04**
Anal-fin base length (% SL)	9.7	11.0	10.48	0.66	10.0	11.4	10.79	0.46	9.9	11.1	10.46	0.51
Anal fin depth (% SL)	12.5	16.1	14.28	0.98	13.3	15.8	14.63	0.64	13.4	15.0	13.99	0.61
Pectoral fin length (% SL)	18.8	22.0	20.17	0.94	18.8	21.6	19.92	0.81	18.5	20.7	19.83	0.78
Pelvic fin length (% SL)	15.2	17.6	16.21	0.74	15.4	17.1	16.36	0.57	14.3	16.5	15.69	0.79
Head length (% SL)	**28.6**	**31.6**	**29.44**	**0.80**	**27.1**	**29.6**	**28.15**	**0.64**	**28.1**	**30.2**	**29.09**	**0.77**
Head length (% body depth)	**111.0**	**137.2**	**123.07**	**6.18**	**118.08**	**131.03**	**125.33**	**3.69**	**112.6**	**129.6**	**119.33**	**5.40**
Head depth at nape (% SL)	17.3	18.8	18.07	0.51	16.14	18.40	17.36	0.70	17.0	18.3	17.53	0.46
Head depth at nape (% HL)	**59.1**	**64.2**	**61.39**	**1.63**	**58.2**	**64.6**	**61.67**	**1.92**	**58.9**	**62.6**	**61.29**	**1.28**
Head depth through eye (% HL)	42.3	47.5	44.55	1.43	41.6	48.1	44.61	1.84	42.7	46.3	44.44	1.54
Maximum head width (% SL)	14.9	18.9	15.98	1.07	14.13	15.34	14.68	0.36	14.9	15.8	15.34	0.38
Maximum head width (% HL)	50.8	60.3	54.29	1.64	50.4	54.1	52.15	1.10	51.3	54.2	52.74	1.23

	Dragonja (PZC 475, 452-54, ZISP 54690, holotype SMNH 207, n=42)				**Boljunšćica (PZC 406, 457, n=20)**				**Pazinčica (PZC 415, n=10)**			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
Snout length (% SL)	8.4	9.7	8.97	0.42	7.81	9.00	8.32	0.39	8.0	9.1	8.54	0.40
Snout length (% HL)	28.1	32.4	30.46	1.19	27.9	31.6	29.57	1.25	27.5	30.6	29.36	0.96
Eye horizontal diameter (% SL)	5.6	7.8	6.56	0.50	5.60	6.85	6.23	0.42	6.2	7.2	6.76	0.44
Eye horizontal diameter (% HL)	19.3	25.2	22.27	1.60	19.7	23.8	22.13	1.30	21.0	24.8	23.24	1.41
Eye horizontal diameter (% interorbital width)	**53.7**	**69.5**	**60.57**	**5.51**	**54.22**	**65.59**	**60.14**	**3.42**	**55.6**	**71.1**	**63.13**	**5.82**
Postorbital distance (% HL)	48.2	54.6	50.87	1.67	49.5	57.3	53.46	1.90	50.5	53.8	51.85	1.13
Interorbital width (% HL)	33.4	41.7	36.87	1.87	34.2	40.8	36.83	1.74	34.8	40.6	36.94	1.97
Length of upper jaw (% HL)	31.3	36.6	34.73	1.31	31.3	36.1	33.70	1.28	31.5	34.4	33.30	1.09
Length of lower jaw (% SL)	11.3	13.2	12.24	0.54	11.13	12.78	11.87	0.47	11.5	12.7	12.31	0.39
Length of lower jaw (% HL)	39.2	44.8	41.58	1.66	39.0	44.0	42.17	1.40	41.1	43.6	42.33	1.12
Length of lower jaw (% operculum depth)	106.7	126.7	115.38	5.81	105.95	113.54	109.67	2.42	106.6	115.8	111.08	3.18
Depth of operculum (% HL)	33.1	39.3	36.09	1.75	36.8	39.4	38.44	0.75	37.0	39.2	38.12	0.78
Ratios												
Interorbital width/eye horizontal diameter	1.4	2.0	1.65	0.16	1.5	1.8	1.67	0.10	1.4	1.8	1.60	0.15
Snout length/eye horizontal diameter	1.2	1.6	1.35	0.12	1.2	1.6	1.34	0.09	1.1	1.4	1.27	0.10
Head depth at nape/eye diameter	2.4	3.2	2.74	0.19	2.6	3.1	2.79	0.15	2.4	2.8	2.60	0.15
Head length/depth of caudal peduncle	**2.6**	**3.0**	**2.82**	**0.10**	**2.6**	**2.9**	**2.72**	**0.85**	**2.6**	**3.2**	**2.81**	**0.19**
Length of caudal peduncle /depth of caudal peduncle	1.7	2.1	1.86	0.13	1.7	2.1	1.88	0.12	1.7	2.0	1.83	0.9
Length of lower jaw/caudal peduncle depth	**1.1**	**1.3**	**1.17**	**0.06**	**1.0**	**1.2**	**1.15**	**0.07**	**1.1**	**1.3**	**1.19**	**0.06**
Pectoral fin length/pectoral – pelvic-fin origin distance	0.7	0.9	0.76	0.06	0.7	0.9	0.78	0.04	0.7	0.8	0.76	0.04
Predorsal length/head length	1.8	2.0	1.95	0.05	1.9	2.1	2.01	0.04	1.9	2.1	1.99	0.05

dal peduncle is 2.6–3.2 in HL in *S. janae* (means 2.7 and 2.8 in the Boljunšćica and Pazinčica samples, respectively) while in *S. sqaulus* the ratio is 2.2–2.8. The length of the lower jaw clearly exceeds the caudal peduncle depth in most specimens from the Boljunšćica and Pazinčica samples that is typical of *S. janae*, while it is about equal to or less than the caudal peduncle depth in *S. squalus* (Fig. 6). Additionally, the Boljunšćica and Pazinčica specimens have a straight oblique mouth cleft with a distinct angle at the lower jaw-quadrate junction, similar to the condition seen in *S. janae* and in contrast to *S. squalus*, which has a rounded snout and a shorter mouth cleft, curved in its anterior part and in a more horizontal position (Fig. 6; Bogutskaya and Zupančič 2010: figs 4a, b, 9). The Boljunšćica and Pazinčica specimens are further distinguished from *S. squalus* by vertebral counts having 44 total vertebrae (Fig. 4), vertebral formulae being 24+20 or 25+19 vs. commonly 43 and 25+18, and a silvery colouration vs. darker colouration with brownish or slight bronze tones in *S. squalus*.

Squalius zrmanjae (Zrmanja and Krka Rivers) is another species geographically close to *S. janae*. A morphological comparison between the two species and between *S. janae* and *S. illiricus* distributed in Cetina and Krka can be found in Bogutskaya and Zupančič (2010), and some distinguishing characters are summarised in the key below.

Distribution of chubs in Istra Peninsula

The known range of *S. janae* (Fig. 1) includes Dragonja River (type locality) draining to the west, Pazinčica River that used to flow westwards but at present terminates in a cave at Pazin, and Boljunšćica River that used to flow southwards but now ends in canals in an area that was formerly Čepić Lake. We do not have materials from Raša River that is adjacent to the Boljunšćica and is now connected by canals to the latter. There are no historical samples known to us to decide upon the identity of the native Raša chub.

In rivers of north Istra (Osapska Reka, Rižana, Malinska, and Mirna) occurs a chub, which was identified by Bogutskaya and Zupančič (2010) as *S. squalus,* a species distributed widely further north- and westwards in the Adriatic Basin. Thus, in the north-west of the Istra Peninsula the range of *S. janae* is interrupted by Mirna River, which is now inhabited by *S. squalus.* This may be explained as a historic indication of a direct connection of the Mirna to the Palaeo-Po system but a relatively recent introduction cannot be excluded either. To the east, Rječina River is the stream closest to Istra Peninsula, flowing into the Adriatic Sea at Rijeka. No chubs (*Squalius*) are known from this river (Šprem 2006). Further southwards, there is the Dubračina, a small, now endorheic river system, with the Tribalj Reservoir, which is inhabited by a probably introduced *Alburnus,* a *Rutilus,* and introduced *Cyprinus carpio.* There is a chub in Dubračina (Zupančič's data) though no specimens were collected to check their identity. There are no published data indicating that a chub occurs in Ričina, a river located further down and flowing into the Adriatic at Novi Vinodolski. There are no native *Squalius* species in the entire Lika region endorheic drainages (Lika, Jadova,

Otuča and some others) that lie south and west from Velika Kapela and Mala Kapela mountains southwards to Gračac. *Squalius cephalus* was introduced from the Danube to the Lika River (specimens in PZC). Further southwards, the only species of *Squalius, S. zrmanjae,* inhabits Zrmanja River, and this species together with *S. illyricus* and *Squalius* sp. occurs in the Krka River drainage.

The data presented above on the distribution of *Squalius* chubs in the northern Adriatic Basin support the assumption by Bogutskaya and Zupančič (2010) that the range of *S. janae* encompassing most of Istra Peninsula, except for its north-western section, is determined by the geology of two flysch basins forming the base of the Istra Peninsula. These basins are the Trieste Flysch Basin and the Pazin Flysch Basin bordered by limestone areas of the Buje and West Istria anticlines in the west and the Čičarja and Učka mountain ranges, which belong to the Dinaric Alps, in the east (Fišer et al. 2006; Babić et al. 2007). It is well known and discussed in the literature (e.g. Lindberg 1972; Bianco and Miller 1990; Holčík and Mrakovčić 1997) that during several marine regressions including the most recent ones, for example during the last Würm glacial maximum, rivers of both slopes of the Adriatic basin used to form an extensive drainage of the Palaeo-Po-Isonzo (e.g. CLIMAP 1976, Rodić 1981: fig. 21). However, the distribution pattern of different fish species, the occurrence of a certain number of endemic species in particular, does not support a simple model of fish dispersal within the Palaeo-Po's tributaries. Indeed, the distributional pattern of most fish taxa stands against a hypothesis that assumes a complete Palaeo-Po habitat connectivity and indicates a disrupted surface palaeohydrography that was heavily fragmented by karstification in the whole Dinaric area. A similar assumption has been made for a number of taxa other than fish inhabiting the Dinaric Karst (Sket 2002, Trontelj et al. 2007).

Key to *Squalius* species occurring in Slovenia and north-western Croatia including Zrmanja

1. Lower jaw length less than operculum depth; 5th infraorbital narrow (deeper than wide) or absent ..... ***S. zrmanjae***
– Lower jaw length exceeding operculum depth; 5th infraorbital extensive (considerably wider than deep), covering together with large 4th infraorbital most part of outer surface of the musculus dilatatoris operculi..... **2**
2. Commonly 8½ branched anal-fin rays; pelvic and anal fins red or orange with no black pigment..... ***S. cephalus***
– Commonly 9½ branched anal-fin rays; pelvic and anal fins slightly red, orange or yellow with black pigment of varying intensity..... **3**
3. Conspicuous silvery tint in life colouration; scales easily lost; iris, pectoral, pelvic and anal fin pigmentation with yellow shades; head length 27–32% SL, lower jaw length exceeding caudal peduncle depth; mouth cleft straight, oblique ..... ***S. janae***

– No silvery tint in life colouration, overall colouration with brownish or bronze tones; scales not easily lost; iris, pectoral, pelvic and anal fin pigmentation with reddish or orange shades; head length 26–29% SL, lower jaw length equal to or shorter than caudal peduncle depth; slightly curved mouth cleft .... ***S. squalus***

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RESEARCH ARTICLE

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A new species of dactyloid anole (Iguanidae, Polychrotinae, *Anolis*) from the southeastern slopes of the Andes of Ecuador

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Abstract

We describe a new species of *Anolis* from the southeastern slopes of the Andes of Ecuador, province of Zamora-Chinchipe, Parque Nacional Podocarpus. It belongs to (1) the *aequatorialis* species-group by being of moderate to large size with narrow toe lamellae, and (2) the *eulaemus* sub-group by having a typical *Anolis* digit, in which the distal lamellae of phalanx II distinctly overlap the proximal scales of phalanx I. The new species is most similar morphologically to *A. fitchi* but differs from it mainly by having a dewlap with longitudinal rows of 2–5 granular, minute scales separated by naked skin (longitudinal rows of one or two keeled, large scales separated by naked skin in *A. fitchi*) and a vertically shorter dewlap (longer dewlap in *A. fitchi*).

Keywords

Andes, *Anolis*, Ecuador, new species, Parque Nacional Podocarpus, Polychrotinae, systematics

Introduction

The lizard genus *Anolis* (anoles) is the most species-rich genus of amniotes, with nearly 400 described forms (Poe 2004; Nicholson 2002). Although the phylogenetic relationships of many Caribbean and Central American species have been analyzed (e.g., Poe 1998, 2004; Creer et al. 2001; Schneider et al. 2001; Jackman et al. 2002; Nicholson 2002), the relationships of South American species formerly called "*Dactyloa*" (sensu Guyer and Savage 1986; *latifrons* series sensu Etheridge 1959) are relatively understudied. Accurate estimation of the relationships of this group and the entire *Anolis* clade requires taxonomic knowledge of South American species, many of which remain undescribed. Here we contribute to this growing body of taxonomic knowledge (e.g., Ayala-Varela 2004; Poe and Yañez-Miranda 2008; Ugueto et al. 2007) with the description of a new species of *Anolis* from Ecuador.

During revisionary work on anoles of Ecuador, we examined some specimens of *Anolis* similar to *A. fitchi* Williams and Duellman 1984 collected at the Parque Nacional Podocarpus in southeastern Ecuador. We found that the color pattern of these specimens differed dramatically from typical *A. fitchi*. Detailed examination of these specimens revealed other differences in squamation and color pattern indicative of separate species status.

Materials and methods

Specimens examined (Appendix and description below) are housed in the herpetological collections of the Escuela Politécnica Nacional, Quito (EPN), Fundación Herpetológica Gustavo-Orcés, Quito (FHGO), Museum of Comparative Zoology, Harvard University (MCZ), Museo Ecuatoriano de Ciencias Naturales, Quito (MECN) and Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito (QCAZ).

External character terminology follows Williams et al. (1995). Scale counts were made on the left side if applicable. Ten morphological measurements were taken with digital calipers to the nearest 0.1 mm: head length, head width, head height, forelimb length, hindlimb length, snout-vent length (SVL), snout length, ear opening maximum length, interparietal length, and dewlap height. In addition, tail length was measured with a ruler to the nearest 1 mm. Regenerated or broken tails were not measured. Sex was determined by the presence of hemipenes and size of the dewlap. Egg volume was calculated using the formula for the prolate spheroid: $V = 4/3\ \pi$ (length/2) x $(\text{width}/2)^2$. Osteological characters were observed in a cleared-and-double stained adult female specimen (QCAZ 6047).

All measurements were used in statistical analyses performed in PAST 1.27 (Hammer et al. 2004). Differences in quantitative characters between the new species and *Anolis fitchi* were evaluated with *t*-tests. One of the assumptions of the *t*-test for two samples is that the variances of both samples are equal: therefore, *F*-tests also were per-

formed for each character to test for equality of variances. If the variances were not the same (i.e., $P < 0.05$), an unequal variance *t*-statistic (Welch test) was used.

The distribution map was prepared in ArcMap 9.3 (ESRI, Inc.); WGS84 is the datum for all coordinates presented below.

Results

***Anolis podocarpus* sp. n.**
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Holotype. QCAZ 10126 (Fig. 1A,B), adult male, Ecuador, Provincia Zamora-Chinchipe, Romerillos Alto, 04°13'35.6"S, 78°56'23.0"W, 1550 m, 18 December 2009, collected by Fernando Ayala, Steven Poe, Levi Gray, and Julian Davis.

Paratypes. ECUADOR: QCAZ 6038, 6045–47, 6188, QCAZ 6199–200, same locality data as holotype, 1545–1618 m, 1 August 2002, collected by Fernando Ayala-V. and David Salazar; QCAZ 10127, same collection data as holotype; FHGO 1726–30, 1735, 1755, upper basin of Río Curintza, 04°09'36"S, 78°58'48"W, 25 March and 3 April 1998, collected by D. Almeida-Reinoso and F. Nogales-Sornosa; FHGO 2406–07, Numbami, upper basin of río Jambué, 04°10'11.9994"S, 78°57'0"W, 1530 m, 30 April 1999, collected by D. Almeida-Reinoso and F. Nogales-Sornosa; EPN 11354, Campamento San Antonio, Refugio de Vida Silvestre El Zarza, Los Encuentros, cantón Yantzaza, 03°50'27.00"S, 78°31'38.92"W, 1556 m, 07 November 2008, collected by A. Almendáriz, Marco Salazar and Marco Angamarca; EPN 11355, same locality data as former, 14 November 2008, collected by A. Almendáriz, Luis Benalcázar, Marco Angamarca and W. Torres.

Diagnosis. The new species belongs to the *punctatus*-subsection (Williams 1976a) by having an arrow-shaped interclavicle [T-shaped in the *carolinensis*-subsection Williams 1976a]. Within the *punctatus*-subsection, *Anolis podocarpus* is a member of (1) the *latifrons*-series sensu Etheridge 1959 by having at least four parasternal chevrons attached to the dorsal ribs, and the lateral processes of the interclavicle divergent from the proximal parts of the clavicles; (2) the *aequatorialis* species-group (Williams 1976b) by being of moderate to large size (SVL = 73.6–96.0 mm), with narrow toe lamellae; and (3) the *eulaemus*-subgroup (Williams and Duellman 1984) by having a typical *Anolis* digit, in which the distal lamellae of phalanx II distinctly overlap the first proximal subdigital scale of phalanx I. The new species lacks transverse processes on most or all of the autotomic caudal vertebrae.

Among species in the *eulaemus*-subgroup (*Anolis antioquiae* Williams 1985*, A. eulaemus* Boulenger 1908*, A. fitchi, A. gemmosus* O'Shaughnessy 1875*, A. maculigula* Williams 1984*, A. megalopithecus* Rueda-Almonacid 1989*,* and *A. ventrimaculatus* Boulenger 1911), *A. podocarpus* differs from *A. antioquiae* (character states in parentheses) in lacking a canthal ridge projecting above the loreal region (very sharp canthal ridge

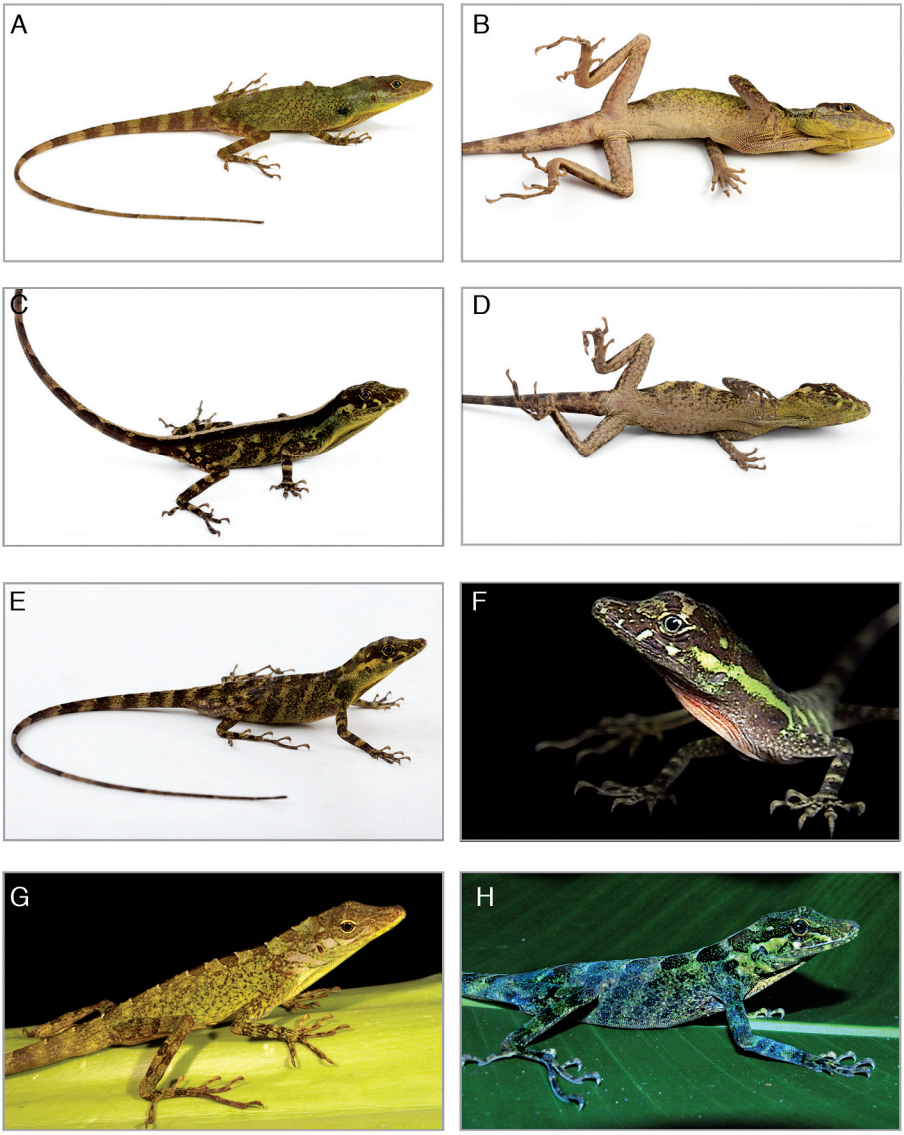

Figure 1. Two species of *Anolis* from eastern Ecuador. *Anolis podocarpus* sp. n.: holotype male (**A**, **B**, QCAZ 10126), female (**C**, **D**, QCAZ 10127), female (**E**, QCAZ 10129), juvenile (**F**, QCAZ 6200); *A. fitchi*: male (**G**, QCAZ 8770), female (**H**, QCAZ 9707). Photographs by L.A. Coloma (male of *A. fitchi*), F. Ayala-Varela (juvenile of *A. podocarpus* sp. n. and female of *A. fitchi*) and S.R. Ron (male and females of *A. podocarpus* sp. n.).

projecting above the loreal region), and 8–11 supralabials (6–7). *Anolis podocarpus* can be distinguished from *A. gemmosus* by having a SVL > 70 mm in adults (SVL < 70 mm in *A. gemmosus*), and from *A. megalopithecus* by having 6–9 postmental scales (3–4 in *A. megalopithecus*). From the remaining species in the *eulaemus*-subgroup (character states in parentheses), *A. podocarpus* differs by the combination of the following characters:

(1) dewlap moderate in size in females (rudimentary in *A. eulaemus* and *A. maculigula*; absent in *A. gemmosus* and *A. ventrimaculatus*); (2) dewlap skin uniform reddish brown or terracotta, with a dark brown tint anteriorly and orange or pink tint posteriorly in males, Fig. 2 (pale brown in *A. eulaemus*; dark brown, with a pale yellowish brown edge in *A. fitchi*; dull yellowish green, or bluish green proximally shading to yellow or orange distally in *A. gemmosus*; bluish gray proximally, with anterior third pale bluish rose and posterior portion white becoming pale blue towards the belly in *A. maculigula*; red in males and sepia in females in *A. megalopithecus*; dark brown or orange covered by yellow rows of scales and a dark blotch at its base in *A. ventrimaculatus*); (3) dewlap skin uniform dark violet, with a brownish-red tint in females (reddish orange, with black blotches and yellow border in *A. antioquiae*; dark brown in *A. eulaemus*; yellowish green to brown, with dark brown blotches in *A. fitchi*; sepia in *A. megalopithecus*); (4) dewlap with longitudinal rows of 2–5 granular, minute scales separated by naked skin, Fig. 3 (longitudinal rows of one or two keeled, large scales separated by naked skin in *A. fitchi* and *A. ventrimaculatus*); (5) iris bluish turquoise (iris gray or dull bluish gray in males and blue-green in females of Ecuadorian populations; blue in males and pale blue in females of Colombian populations (Williams and Duellman 1984) in *A. fitchi*; dark brown in *A. maculigula*; reddish brown in females in *A. megalopithecus*); (6) 1–3 scales between supraorbital semicircles (4–5 in *A. antioquiae*, and 5–6 in *A. megalopithecus*); (7) interparietal scale present (absent in *A. antioquiae* and *A. megalopithecus*).

Among all species in the *eulaemus*-subgroup *A. podocarpus* is most similar morphologically to *A. fitchi*; in addition to the differences mentioned above, *A. podocarpus* can be distinguished from *A. fitchi* (character states in parentheses, Table 1) by having more scales between second canthals (14–20 and 12–20, respectively; *t*-test, $t = 4.126$, $P < 0.05$); more scales bordering the rostral posteriorly (7–12 and 5–10, respectively; *t*-test, $t = 3.551$, $P < 0.05$); more rows of loreals (9–13 and 6–12, respectively; *t*-test, $t = 7.601$, $P < 0.05$); more postmentals (5–9 and 4–8, respectively; *t*-test, $t = 3.119$, $P < 0.05$); shorter dewlap in males (dewlap height/SVL = 0.10–0.23 and 0.18–0.36, respectively; *t*-test, $t = 4.212$, $P < 0.05$); shorter dewlap in females (dewlap height/SVL = 0.11–0.19 and 0.14–0.23, respectively; *t*-test, $t = 3.165$, $P < 0.05$); and sides of neck with light-blue and pale pink small spots in males (sides of neck with a light yellow irregular stripe, Fig. 1G,H).

Description of holotype (variation in paratypes in parentheses). Male (Fig. 4); SVL 87.0 mm (73.6–96.0 mm); tail length 192.0 mm (168.0–224.0 mm); head length 23.3 mm (19.3–25.4 mm); head width 13.0 mm (11.5–13.8 mm); head height 11.0 mm (9.0–12.0 mm); forelimb length 44.9 mm (39.3–49.9 mm); hindlimb length 75.4 mm (70.0–83.9 mm); dewlap height 12.4 mm (8.2–20.2 mm); interparietal length 1.1 mm (0.9–2.0 mm); ear opening maximum length 2.72 mm (2.3–2.9 mm); snout length 9.81 mm (8.6–11.6 mm).

Head scales unicarinate (smooth or rugose); 19 (14–20) scales between second canthals; 17 (16–20) scales between first canthals; 10 (7–12) scales bordering the rostral posteriorly; circumnasal separated from rostral by one scale or in contact (anterior nasal or divided anterior nasal in contact with rostral); supraorbital semicircles separat-

Table 1. Summary of morphological characters and measurements (mm) of *Anolis fitchi* and *A. podocarpus* sp. n. from Ecuador. For each quantitative character, the *F*-value, *t*-value, and corresponding *P*-values are given. Range and sample size (*N*) followed by mean ± standard deviation are given.

Character	*A. fitchi*	*A. podocarpus*	*F*-value	P	*t*-value	P
Scales between second canthals	12–20 (37) 14.95 ± 1.88	14–20 (19) 17.11 ± 1.79	1.107	0.843	4.126	<0.05
Postrostrals	5–10 (37) 7.68 ± 1.27	7–12 (19) 8.89 ± 1.10	1.333	0.522	3.551	<0.05
Rows of loreals	6–12 (37) 8.38 ± 1.23	9–13 (19) 10.84 ± 0.96	1.655	0.255	7.601	<0.05
Scales between supraorbital semicircles	1–3 (36) 2.28 ± 0.66	1–3 (19) 1.79 ± 0.63	1.094	0.864	2.650	0.011
Scales between interparietal and semicircles	3–7 (37) 4.46 ± 0.99	2–6 (19) 3.79 ± 1.03	1.089	0.800	2.366	0.022
Supralabials	8–11 (37) 9.05 ± 0.81	8–11 (19) 9.26 ± 0.93	1.313	0.474	0.865	0.391
Postmentals	4–8 (37) 6.00 ± 1.00	5–9 (19) 6.89 ± 1.05	1.099	0.782	3.119	<0.05
Lamellae under phalanges II-III of fourth toe	19–25 (37) 22.19 ± 1.76	20–25 (19) 22.42 ± 1.43	1.524	0.342	0.496	0.622
Head length/SVL	0.24–0.28 (30) 0.26 ± 0.01	0.26–0.28 (12) 0.27 ± 0.01	1.957	0.240	2.748	0.009
Head length/head width	1.61–1.94 (30) 1.79 ± 0.07	1.66–1.86 (12) 1.77 ± 0.07	1.009	0.953	0.784	0.438
Head height/head width	0.75–0.86 (30) 0.81 ± 0.03	0.76–0.87 (12) 0.81 ± 0.03	1.097	0.796	0.379	0.706
Forelimb length/SVL	0.50–0.57 (30) 0.54 ± 0.02	0.47–0.61 (12) 0.52 ± 0.04	4.355	<0.05	1.510	0.155
Hindlimb length/SVL	0.87–1.02 (30) 0.94 ± 0.04	0.82–1.00 (12) 0.90 ± 0.06	2.168	0.094	2.411	0.021
Tail length/SVL	1.84–2.57 (15) 2.33 ± 0.20	1.83–2.48 (10) 2.29 ± 0.19	1.101	0.912	0.563	0.579
Dewlap height/SVL in males	0.18–0.36 (17) 0.27 ± 0.06	0.10–0.23 (5) 0.16 ± 0.05	1.340	0.851	4.212	<0.05
Dewlap height/SVL in females	0.14–0.23 (13) 0.19 ± 0.03	0.11–0.19 (7) 0.14 ± 0.04	1.500	0.517	3.165	<0.05
Maximum SVL males	96	96				
Maximum SVL females	87	89				

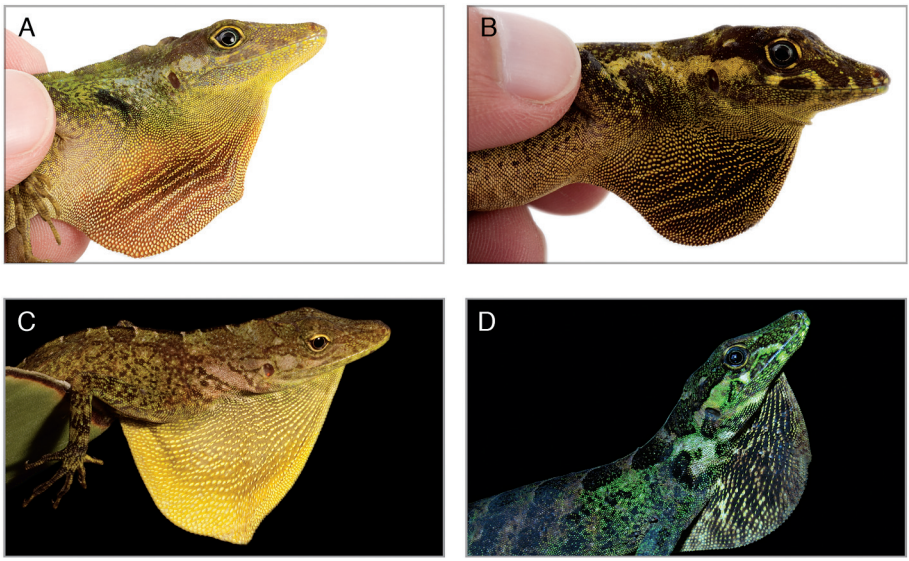

Figure 2. Dewlap of *Anolis podocarpus* sp. n. (**A**, holotype male, QCAZ 10126; **B**, female, QCAZ 10129) and *A. fitchi* (**C**, male, QCAZ 8770; **D**, female, QCAZ 9707). Photographs by L.A. Coloma (male of *A. fitchi*), F. Ayala-Varela (female of *A. fitchi*) and S.R. Ron (male and female of *A. podocarpus* sp. n.).

ed by two (1–3) scales; supraocular disk not differentiated and keeled; one (1–2) short superciliary followed by granules; 12 (9–13) loreal rows; 113 loreal scales (81–135); interparietal smaller (much smaller or similar) than ear opening; 3–5 (2–6) scales between interparietal and semicircles on each side; scales behind interparietal grading into nape scales; suboculars and supralabials separated (in contact) by one scale; 10 (8–11) supralabials counted up to a point below center of eye; 9 (9–11) infralabials counted up to a point below center of eye; six (5–9) postmentals; enlarged sublabials absent (one enlarged sublabial in contact with infralabials).

Dorsal crest absent; two enlarged middorsal rows (enlarged middorsal rows absent); dorsals swollen, unicarinate or conical; flank scales more or less separated by skin (juxtaposed); ventrals equal than dorsals (ventrals larger than dorsals); ventrals slightly protuberant, smooth, and subimbricate (separated from each other by skin or juxtaposed).

Toepads overlap the first phalanx in all toes; 20 (20–25) lamellae under second and third phalanges of fourth toe; supradigitals multicarinate; tail weakly compressed; postanals absent (present or inconspicuous).

Nuchal and dorsal folds weakly developed (folds absent in females); dewlap large in both sexes extending posteriorly behind forelimbs, with longitudinal rows of 3–4 (2–5) granular, minute scales separated by naked skin.

Sexual variation of meristic and morphometric characters in *A. podocarpus* is presented in Table 2.

Coloration in life of holotype (Fig. 1A,B). Head, body and limbs green; head with two dark green transverse bands on the supraocular disk separated by one yellow-

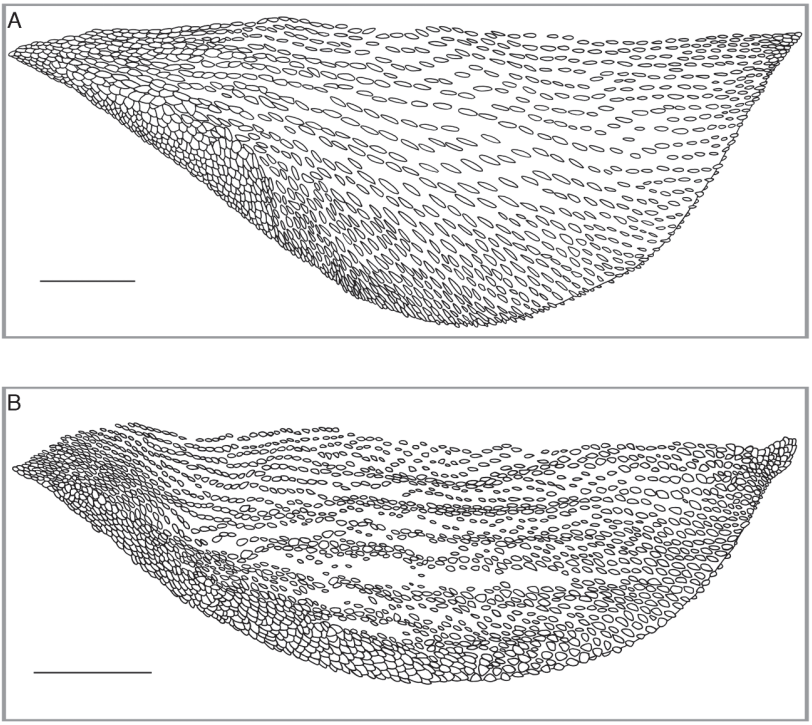

Figure 3. Male dewlap of *Anolis fitchi* (**A**, QCAZ 9028) and *A. podocarpus* sp. n. (**B**, QCAZ 10126) in lateral view. Scale bar = 5 mm. Illustrations by D. Paucar-Guerrero.

ish green transverse band; body with a vertebral series of wide, dark brown blotches that diffuse without reaching flanks; limbs and tail with wide, dark brown transverse bands; side of neck with an aquamarine irregular longitudinal stripe that extends from postocular region above the tympanum to level of shoulder; side of shoulder with a greenish black irregular spot and opaque pink dots; body flanks with small turquoise dots; ventral surface of head pale yellow, with two pairs of lateral, yellow, short bands; ventral surface of body yellowish cream; ventral surface of tail cream anteriorly, with reddish-brown transverse bands posteriorly; ventral surface of hindlimbs pinkish cream with reddish brown reticulations; dewlap skin terracotta with dark brown tint anteriorly and orange tint posteriorly; dewlap scales yellow anteriorly, and white-yellow posteriorly; upper and lower palpebrals yellow; iris bluish-turquoise with white ring; tongue pink (Fig. 5).

Coloration in preservative of holotype. Head, body and limbs brown; head with a light brown transverse band on the supraocular disk; body flanks brown with dark green small reticulations; limbs and tail brown, with wide, dark brown transverse bands; side of neck brown with cream dots; side of shoulder with a black irregular spot and cream dots; ventral surface of head brownish cream; ventral surface of body brownish cream with brown dots; ventral surface of tail cream anteriorly and brown posteriorly; ventral surface of hindlimbs cream with brown reticulations; dewlap skin

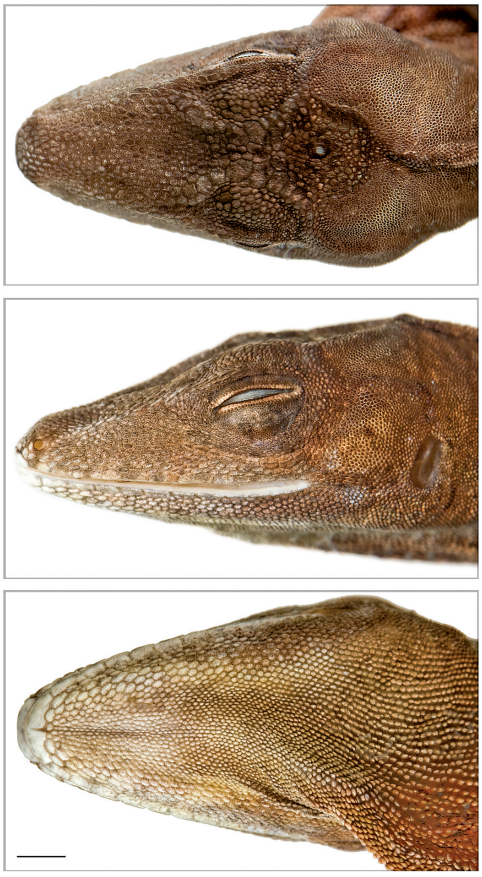

Figure 4. Head of the holotype (QCAZ 10126) of *Anolis podocarpus* sp. n. in dorsal (top), lateral (middle), and ventral (bottom) views. Photographs by L. Bustamante. Scale bar = 10 mm.

dark brown; dewlap scales brownish cream with white scales posteriorly; upper and lower palpebrals brownish cream.

Color in life variation. Adult male QCAZ 6038: Head and limbs yellowish green, body green, and tail creamish green; body with a series of seven vertebral wide, yellowish brown bands that diffuse without reaching flanks; sides of head with a light blue irregular stripe extending from postocular region to level of the shoulder; sides of neck with pale pink dots; sides of shoulder with a blackish brown spot and pale pink dots; body flanks green with dark green and turquoise dots, and with dark greenish brown spots assembling alternating bands extending posteroventrally; ventral surface of head greenish yellow anteriorly and pale yellow posteriorly, with two pairs of lateral, yellow, short bands; ventral surface of hindlimbs cream with pale brown reticulations; dewlap skin reddish brown with dark brown tint anteriorly and pink tint posteriorly; dewlap scales greenish yellow anteriorly, and white posteriorly.

Adult male EPN 11355 (Fig. 6) differs from the descriptions above in having a cream irregular stripe that extends from the angle of the jaw above the tympanum to

Table 2. Sexual variation in scutellation and measurements (mm) of *Anolis podocarpus* sp. n. Range and sample size (*N*) followed by mean ± standard deviation are given.

Character	Males	Females
Scales between second canthals	16–20 (6) 17.33 ± 1.75	14–20 (13) 17.00 ± 1.87
Postrostrals	7–10 (6) 8.50 ± 1.22	8–12 (13) 9.08 ± 1.04
Rows of loreals	9–12 (6) 10.83 ± 0.98	9–13 (13) 10.85 ± 0.99
Scales between supraorbital semicircles	1–2 (6) 1.67 ± 0.52	1–3 (13) 1.85 ± 0.69
Scales between interparietal and semicircles	2–6 (6) 3.67 ± 1.51	3–5 (13) 3.85 ± 0.80
Supralabials	8–11 (6) 9.33 ± 1.21	8–11 (13) 9.23 ± 0.83
Postmentals	5–8 (6) 6.50 ± 1.05	6–9 (13) 7.08 ± 1.04
Lamellae under phalanges II-III of fourth toe	20–24 (6) 22.17 ± 1.33	21–25 (13) 22.54 ± 1.51
Head length/Snout-vent length	0.26–0.28 (5) 0.27 ± 0.01	0.26–0.27 (7) 0.26 ± 0.01
Head length/head width	1.77–1.86 (5) 1.81 ± 0.03	1.66–1.83 (7) 1.73 ± 0.07
Head height/head width	0.81–0.87 (5) 0.83 ± 0.02	0.76–0.83 (7) 0.79 ± 0.03
Forelimb length/snout-vent length	0.49–0.58 (5) 0.52 ± 0.04	0.47–0.61 (7) 0.52 ± 0.05
Hindlimb length/Snout-vent length	0.85–0.98 (5) 0.89 ± 0.05	0.82–1.00 (7) 0.91 ± 0.06
Tail length/Snout-vent length	1.83–2.48 (5) 2.26 ± 0.26	2.19–2.45 (5) 2.32 ± 0.11
Dewlap height/Snout-vent length	0.10–0.23 (5) 0.16 ± 0.05	0.11–0.19 (7) 0.14 ± 0.04
Maximum SVL	96	89

the neck; side of neck with a cream irregular stripe that forms an arc extending from the proximal border of the dewlap to the shoulder; shoulder with a greenish black irregular spot and pink dots.

Adult female QCAZ 10127 (Fig. 1C,D): Head lime-green with two blackish brown transverse bands on supraocular disk; body and tail blackish brown with a whitish-cream vertebral stripe; limbs yellowish green with wide, blackish-brown transverse bands; two subocular pale yellow stripes extending anterodorsally (posteriormost stripe) and posterodorsally (anteriormost stripe) from supralabials; lateral aspect of neck with a longitudinal aquamarine stripe that extends posteriorly from the posterior end of the eye over the tympanum to the level of the forelimb; body flanks yellowish green with dark brown spots that cluster anteriorly, posteriorly, and at midbody; ventral surface of head greenish cream with two pairs of lateral, pale yellow, short bands; ventral surface of body brownish cream with blackish brown spots; ventral surface of limbs brownish cream, with blackish brown reticulations; ventral surface of tail brownish cream on the base, with blackish brown transverse bands; dewlap skin dark violet with a brownish-red tint; dewlap scales yellow; iris bluish-turquoise; tongue dark blue (Fig. 5). Adult female QCAZ 10129 (Fig. 1E) differs from the previous description in having a longitudinal series of five wide, dark brown transverse bands that extend posteroventrally over flanks.

Juvenile QCAZ 6200 (Fig. 1F): Color pattern is similar to adult female QCAZ 10129, but differs in having dewlap skin orange-red with white scales and tongue orange.

Natural history and ecology. An adult female (SVL 89.1 mm, QCAZ 6045) collected on 1 August 2002 and held in captivity until 27 September 2002 laid an egg (18.5 x 8.4 mm; 682.1 mm^3) on 24 August 2002. A juvenile (FHGO 1730) was

Figure 5. Tongue of *Anolis podocarpus* sp. n. Left: holotype adult male (QCAZ 10126); right: adult female (QCAZ 10127). Photographs by F. Ayala-Varela.

Figure 6. Male of *Anolis podocarpus* sp. n. (EPN 11355) from El Zarza (Zamora Chinchipe province). Photograph by A. Almendáriz.

collected on 25 March 1998 (37.0 mm SVL, 82.5 mm tail length); a larger juvenile (QCAZ 6200) was collected on 1 August 2002 (43.5 mm SVL, 96.0 mm tail length).

Specimens of *Anolis podocarpus* were collected in secondary forest near small streams or in ravines. All individuals were found between 19:00 and 23:00 h sleeping head-up on leaves of ferns, Araceae, Musaceae, on branches 0.30–2.50 m above streams, or on stream shores. This species occurs in sympatry with two undescribed species of anoles at the type locality.

Distribution and conservation. *Anolis podocarpus* inhabits the eastern slopes of the eastern Andean cordillera in southern Ecuador, Zamora-Chinchipe province, be-

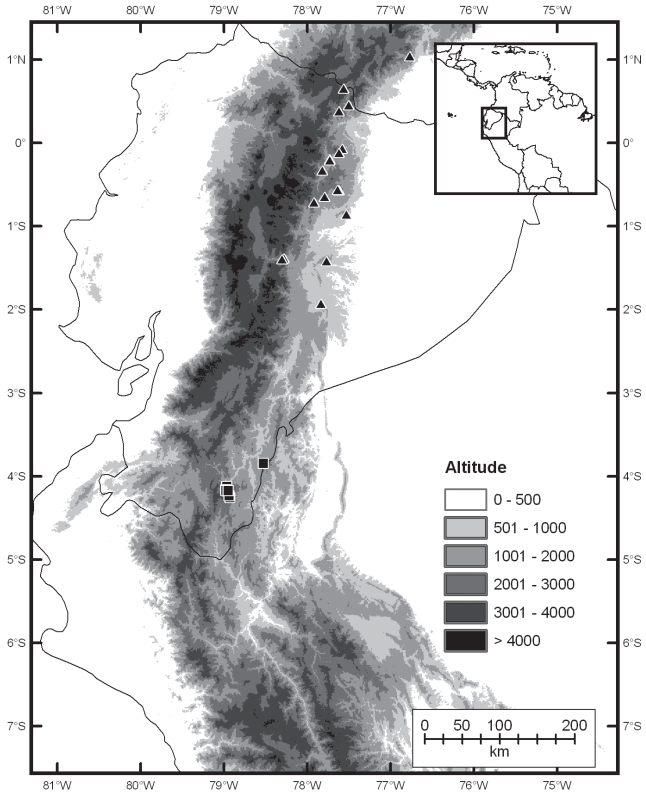

Figure 7. Distribution of *Anolis fitchi* (triangles) and *A. podocarpus* sp. n. (squares).

tween 1530–1910 m (Fig. 7). It is known from the upper basin of the Zamora river (Atlantic drainage) in montane cloud forest and low montane evergreen forest (Sierra 1999). Most individuals of this species have been collected within two protected areas in southern Ecuador, Parque Nacional Podocarpus and Refugio de Vida Silvestre El Zarza, which suggests that at least some populations of *A. podocarpus* are well protected.

Etymology. The specific epithet *podocarpus* alludes to the conifer *Podocarpus* and derives from the Greek words *pous, podos* (=foot), and *karpos* (=fruit). The tree *Podocarpus* gives its name to Parque Nacional Podocarpus, where the new species described in this paper was discovered.

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Appendix

Additional specimens examined

Anolis fitchi – Ecuador: *Morona-Santiago*: "Chiquara" (sic Chiguaza), 01°55'60"S, 77°49'60"W, MCZ 124355–56; Cordillera del Cutucú, Comunidad Uuntzuanz, 1250–1300 m, EcoC 1348; *Napo*: Cordillera de los Guacamayos, 2200 m, QCAZ 3112, 3173; El Chaco, 1400 m, QCAZ 3092; Galeras, QCAZ 3758; Parque Nacional Sumaco Napo-Galeras, Cocodrilos, 00°38'57"S, 77°47'35"W, 1846 m, QCAZ 5439–42; Volcán Sumaco, vertiente Este, 1570–1642 m, QCAZ 920, 926; 30 km N of turnoff to Baeza, 00°17'31.7394"S, 77°46'30.6582"W 1661 m, QCAZ 9707; *Orellana*: Alto Napo, Loreto, MCZ 124351; Cabecera del río Sola, MCZ 124352; Región de Loreto, MCZ 124350; *Pastaza*: "Río Villaro" (sic Río Villano), 01°25'11.9994"S, 77°46'11,9994"W, MCZ 124353–54; *Sucumbíos*: El Reventador, Gonzalo Pizarro, EPN 7056–57; El Reventador, Recinto La Libertad, La Virgen, 00°4.29'1, 77°34.8'1, 1679 m, QCAZ 5997, 8770; La Bonita, 1500–1590 m, FHGO 446, EPN 3158; La Sofía, 00°22'40"N, 77°38'02"W, 1648–1800 m, EPN 7583–93; Río Azuela, 1700 m, QCAZ 5425, 5435–38, 5502–03; Santa Bárbara, Sebundoy, 2200 m, EPN 3159; *Tungurahua*: Parque Nacional Los Llanganates, El Topo, 01°23'08"S, 78°16'49"W, 2150 m, MECN 35; Río Verde, 01°24'16"S, 78°17'48.3"W, 1512 m, QCAZ 5648–49, 5715.