

# On Kiefer's American *Eucyclops* (Copepoda, Eucyclopinae): redescriptions and comments on the historical records of *E. delachauxi*, *E. prionophorus*, *E. bondi* and *E. leptacanthus*

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Academic editor: D. Defaye | Received 17 August 2013 | Accepted 26 March 2014 | Published 16 April 2014

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**Citation:** Mercado-Salas NF, Suárez-Morales E (2014) On Kiefer's American *Eucyclops* (Copepoda, Eucyclopinae): redescriptions and comments on the historical records of *E. delachauxi*, *E. prionophorus*, *E. bondi* and *E. leptacanthus*. ZooKeys 402: 1–41. doi: 10.3897/zookeys.402.6112

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## Abstract

The freshwater copepod genus *Eucyclops* contains many supposedly cosmopolitan species whose taxonomic status is still under discussion; some of them represent species complexes. The problem is not exclusive to these widespread species; there are several American *Eucyclops* needing a taxonomic re-evaluation. Based on the examination of Friedrich Kiefer's collection in Karlsruhe, Germany, the type specimens of four American species of *Eucyclops* (*E. delachauxi* (Kiefer, 1926), *E. prionophorus* Kiefer, 1931, *E. bondi* Kiefer, 1934, *E. leptacanthus* Kiefer, 1956) were re-examined and redescribed using upgraded descriptive standards. Kiefer's translated descriptions and unpublished original drawings of these species are also presented. Characters like the ornamentation of the antennal basis, ornamentation of intercoxal sclerites of the swimming legs 1–4, length of basipodal seta of leg 1, ornamentation of caudal rami, the presence of aesthetascs and modified setae on the antennules in male, and the structure of the male sixth leg are compared herein to aid a more accurate separation of these American species. A revision of the American records of these species confirms that some are likely to refer to undescribed species. Overall, the diversity of the American *Eucyclops* appears to be underestimated and certainly deserves further study.

## Keywords

Freshwater copepods, Eucyclopinae, morphology, systematics, taxonomy

## Introduction

The freshwater genus *Eucyclops* Claus, 1893 is currently known to contain more than 108 species and subspecies (Alekseev and Defaye 2011), thus being one of the most speciose genera among the Cyclopoida. Only a few species have been completely described following upgraded standards; in addition, the genus taxonomy was based, until recent years, on a small number of highly variable characters. Consequently, *Eucyclops* has a complex taxonomic history that includes several widely distributed species with an uncertain status (Collado et al. 1984; Reid 1985; Ishida 1997; Suárez-Morales 2004; Mercado-Salas et al. 2012).

The taxonomic problems within this taxon started with the incomplete description of the type species of the genus: *Eucyclops serrulatus* (Fisher, 1851) from Russia (Alekseev et al. 2006). One of the first researchers in pointing out these deficiencies was Friedrich Kiefer. In his description of *Eucyclops delachauxi* (Kiefer, 1925) and in a subsequent paper on the Peruvian copepod fauna (Kiefer 1926) he stated that the systematics and geographical distribution of this group were far from being understandable if every single *Cyclops* with “*serra*” was identified as *E. serrulatus* and if other characters (besides the “*serra*”) were not incorporated into the delimitation of species. He also noticed that the *serrulatus*-group as a whole, rather than its member taxa, was cosmopolitan and ubiquitous as it had been previously assumed. After Kiefer’s studies, many species were described all over the world, but most scientists further continued using a reduced number of variable characters only. The morphological definition of *E. serrulatus* and its cosmopolitan status remained unchallenged until recent years. Alekseev (1990, 2008, 2010), Ishida (1997, 2001, 2002, 2003), Alekseev et al. (2006), and Alekseev and Defaye (2011) have been the pioneers solving the taxonomical problems among the *Eucyclops* taxa, with the delimitation of the “*serrulatus*-like” and “*speratus*-like” species from Japan, and the *serrulatus*-group worldwide. The comparison of new characters such as the ornamentation of the antennal basis, the ornamentation of swimming legs (especially the fourth), and the integumental pore signature have revealed consistent differences among species, which were previously overlooked and should be verified in the rest of the species of the genus.

In a project to explore the species diversity of the genus *Eucyclops* in Mexico, the type material of some of these species was examined. There are four species described by Kiefer, which have been recorded in Mexico: *Eucyclops delachauxi* (Kiefer, 1925), *E. prionophorus* Kiefer, 1931, *E. bondi* Kiefer, 1934 and *E. leptacanthus* Kiefer, 1956 (Suárez-Morales and Reid 1998, Grimaldo-Ortega et al. 1998; Elías-Gutiérrez 2000; Rodríguez-Almaraz 2000; Suárez-Morales 2004, Mercado-Salas 2009; Suárez-Morales et al. 2010; Mercado-Salas and Suárez-Morales 2012). In order to clarify the taxonomic identity of the Mexican material, the type specimens were examined at the Staatliches Museum für Naturkunde, Karlsruhe (Germany) where F. Kiefer’s collection is held. Herein we present the redescription of the four species mentioned above using upgraded standards; we also include Kiefer’s unpublished original illustrations. In addition, we provide English translations of the original descriptions, in order to make Kiefer’s detailed observations and complementary unpublished data available.

## Methods

In order to provide an upgraded morphological redescription of *E. delachauxi*, *E. pri-onophorus*, *E. bondi*, and *E. leptacanthus*, we examined the type material of Kiefer's collection deposited at the Staatliches Museum für Naturkunde Karlsruhe (Germany). Drawings were made at 1000× with a Zeiss Axioskop 2 plus compound microscope equipped with a camera lucida. Mapping of rows of spinules and setules on the antennal basis and on the coxopodite and intercoxal sclerite of P4 followed Alekseev et al. (2006) and Alekseev and Defaye (2011). Abbreviations used in the descriptive section are as follows: P1-P4, first to fourth thoracic limbs; Exp, exopod; Enp, endopod; s, seta(e); ae, aesthetasc; sp, spine; Bsp, basis; Fu, caudal ramus. Nomenclature used for armament of the antennule and antenna followed Alekseev et al. (2006) and Alekseev and Defaye (2011). Caudal seta nomenclature as follows: II – anterolateral (lateral) caudal seta; III – posterolateral (outermost) caudal seta; IV – outer terminal (terminal median external) caudal seta; V – inner terminal (terminal median internal) caudal seta; VI – terminal accessory (innermost) caudal seta; VII – dorsal seta.

## Results

For each of these four species we present first the complete translation from German to English of Kiefer's description, followed by an upgraded description based on our personal observations on Kiefer's material. Characters or structures not observed but previously published by other researchers are included in the descriptions with its reference. Figures mentioned in the translated text correspond to the numbers of the figures in the original descriptions published by Kiefer (1925, 1931, 1934, 1956).

### Order Cyclopoida Rafinesque, 1815

### Family Cyclopidae Rafinesque, 1815

### Subfamily Eucyclopinae Kiefer, 1927

### Genus *Eucyclops* Claus, 1893

### *Eucyclops delachauxi* (Kiefer, 1925)

Figs 1–7

*Cyclops delachauxi* (Kiefer, 1925)

*Cyclops delachauxi* (Kiefer, 1926)

*Eucyclops* (*Eucyclops*) *delachauxi* Kiefer, 1929

*Cyclops Delachauxi* Kiefer, 1925

*Cyclops Delachauxi* Kiefer, 1926

*Eucyclops* (*Eucyclops*) *Delachauxi*, Kiefer, 1929

*Eucyclops Delachauxi* Kiefer, 1943

*Eucyclops delachauxi* Lindberg, 1955, 1957

**Kiefer's description.**

a) *The female*: the general appearance as *Cyclops serrulatus*. Fifth segment of cephalothorax with lateral hair-setae. Last abdominal segment longer than the previous one. Caudal rami parallel, relatively short, about four times as long as wide; outer edge with *serra*, this is formed by a small number of (4–10) rather long, slender spinules. Inner edge naked (Fig. 1). Of the four setae on the end (apical), only the two median setae are strongly developed, the longest is approximately twice the length of the other, with fine plumage, almost the entire length is homogeneous, the innermost apical hair-like seta is as long as or slightly longer than the outermost seta, more similar to a spine. First antenna twelve-segmented, reaching only a little above of the posterior margin of the first segment of cephalothorax; the last three segments with a narrow hyaline membrane; the seta of the last member originates in the middle of the edge. The branches of all swimming legs with three segments. The terminal segment of the endopod of fourth leg is, usually, exactly twice as long as wide and its two setae on the inner margin and single seta on the outer margin are formed normally. Of the two apical spines, the innermost is strongly curved outside and it is longer than the segment, the outermost is just as long as the segment (Fig. 4). The rudimentary leg is a monomial plate; the inner edge is slightly distended, of the three elements the medial is significantly longer than the other two, which are approximately equal in length, the inner spine is, at its insertion, about twice as wide as one of the two setae (Fig. 2). The seminal receptacle was not correctly identified in the preserved animals (Fig. 1). Total length about 950  $\mu\text{m}$ .

b) *The male*: slender and slightly smaller than the female. Last abdominal segment also noticeably longer than the previous one, its posterior margin provided on ventral side with only very few spinules, as well as in the female. Caudal rami parallel, also four times as long as wide. The *serra* is missing on the outer edge. Ratios and plumage of the two middle apical setae as in the female. Of the two short terminal setae in the male the inner seems to be always longer than the outer (Fig. 3). The final segment of the endopod of the fourth pair of legs with its setae and apical spines as in the female (Fig. 4); the fifth leg as well. The shape of the genital valve reinforcement is best seen in the figure (Fig. 5).

This *Cyclops*, of the numerous “*serrulatus*-like” that I know cannot be identified as one, it comes from two closely located lakes in the Andes of Peru (Huaron and Naticocha, 5140 m high) and has been collected by Ing. E. Godet in 1915. It is named after Dr. Th. Delachaux, Neuenburg, which I am indebted for the provision of his Cyclopoida material. The above description must be regarded as provisional. A more detail, equipped with longer pictures in the description of the *Cyclops*-forms from the mentioned lakes will be published in Archives of Hydrobiology.

**Description based on Kiefer's material.**

**Material examined.** Holotype. Adult ♀ From Huaron, central highlands of Peru, specimen dissected (slide reference numbers SMNK00248, SMNK00249, SMNK00250). Additional material (adult ♂) from Lake Naticocha, Peru (slide reference number SMNK00253). Both Lake Huaron and Naticocha 5140 m high, samples collected



**Table 1.** Setation formula of the swimming legs in the types (females and males) of the four *Eucyclops* species here studied; (spines in Roman numerals, setae in Arabic numerals). (–) represents structures not observed on the type material.

Species		Coxa	Basis	Exp	Enp
<i>E. delachauxi</i>	P1	0-1	1-I	I-1; I-1; III-5	0-1; 0-21-I-4
	P2	–	–	–, –, –	–, –, –
	P3	0-1	1-0	I-1; I-1; IV-5	0-1; 0-2; 1-I-4
	P4	–	–	–, –, –	–, –, 1-II-2
<i>E. prionophorus</i>	P1	0-1	1-I	I-1, I-1, III-5	0-1, 0-2 1-I-4
	P2	–	–	–, –, –	–, –, –
	P3	0-1	1-0	I-1, I-1, IV-5	0-1, 0-2, 1-I-4
	P4	0-1	1-0	I-1, I-1, III-5	0-1,0-2, 1-II-2
<i>E. bondi</i>	P1	0-1	1-I	I-1, I-1, III-5	0-1, 0-2, 1-I-4
	P2	0-1	1-0	I-1, I-1, IV-5	0-1, 0-2, 1-I-4
	P3	0-1	1-0	I-1, I-1, IV-5	0-1, 0-2, 1-I-4
	P4	0-1	1-0	I-1, I-1, III-5	0-1, 0-2, 1-II-2
<i>E. leptacanthus</i>	P1	0-1	1-I	I-1, I-1, III-5	0-1, 0-2, 1-I-4
	P2	0-1	1-0	I-1, I-1, IV-5	0-1, 0-2, 1-I-4
	P3	0-1	1-0	I-1, I-1, IV-5	0-1, 0-2, 1-I-4
	P4	–	–	–, –, –	–, –, 1-II-2

by Ing. E. Godet in 1915. Deposited at the Staatliches Museum für Naturkunde Karlsruhe, Germany.

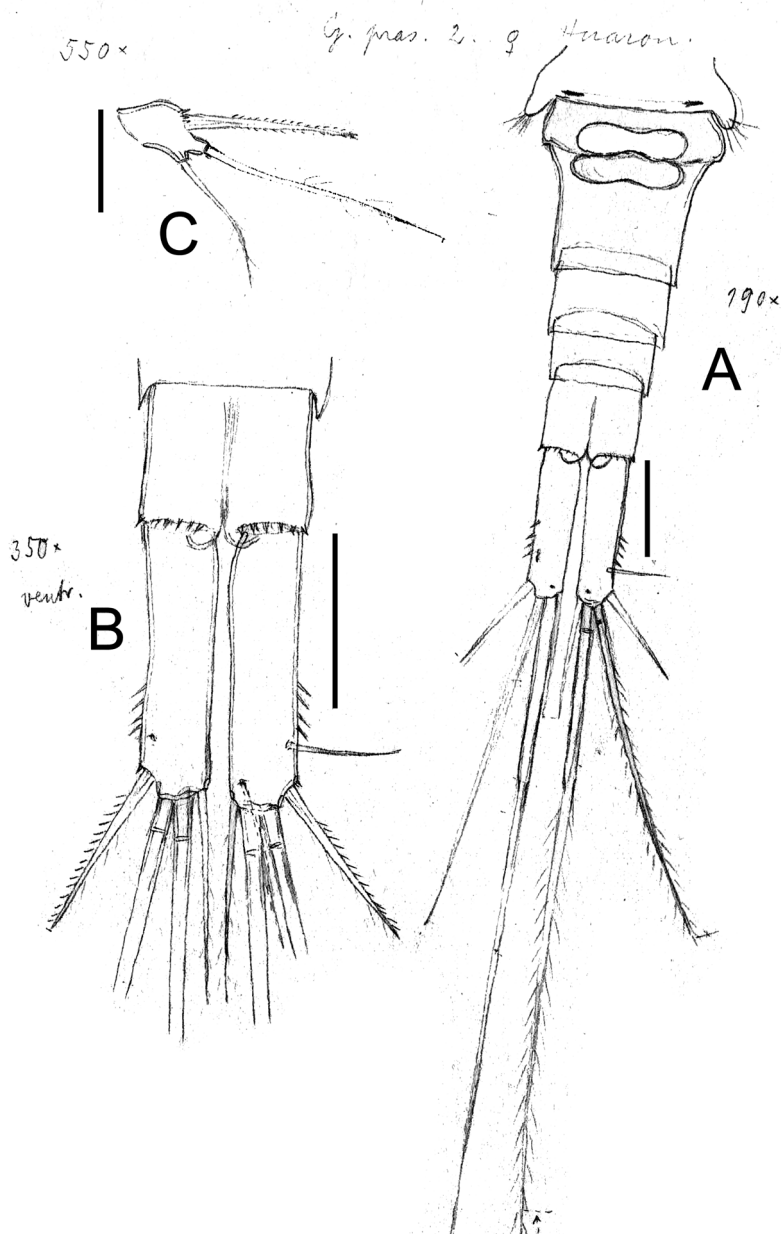
*Female*: Average length excluding caudal setae 950 µm. Five-segmented urosome (Figs 1A; 5A), relatively elongated; posterior margin of anal somite with one row of strong spinules. Genital double-somite symmetrical. Seminal receptacle typical of *ser-rulatus*-group, with rounded lateral arms. Genital double-somite 1.3 times as long as wide. Anal somite with a group of spinules at each side of anal opening, anal operculum rounded (see Fig. 2A). Length/width ratio of caudal ramus = 3.5–4.4; inner margin of caudal ramus naked. *Serra* with strong spinules covering 19.4–43% of outer margin, spinules about the same size (Figs 2B, 5B). Dorsal seta (VII) long: 0.6 times the length of caudal ramus and 0.9–1.0 times as long as outermost caudal seta (III). Ratio of innermost caudal seta (VI)/outermost caudal seta (III) = 1.1. Lateral caudal seta (II) inserted at 63–72% of caudal rami. All terminal caudal setae plumose.

*Antennule* (Figs 2C, 5C): 12-segmented. Armament per segment as follows (s = seta, ae = aesthetasc, sp = spine): **1**(5s), **2**(3s), 3(2s), **4**(**5s**), **5**(2s), 6 (1s+1sp), 7(0s), 8(3s), **9**(2s), 10(2s), **11**(2s), 12(8s). Numbers in bold face indicate segments with incomplete ornamentation.

*Antenna* (Fig. 5D): Basis (2s + Exp), and 3-segmented Enp (1s, 8s and 6s). Basis ornamentation as follows (*sensu* Alekseev and Defaye 2011): N1(V), N2(4), N3(4), N4(6), N5(16), N6(6), N7(5), N8(3), N9(4), N10(3), N11(9), N12(6), N13(10), N14(3), N15(6), N16(2), N17(8).

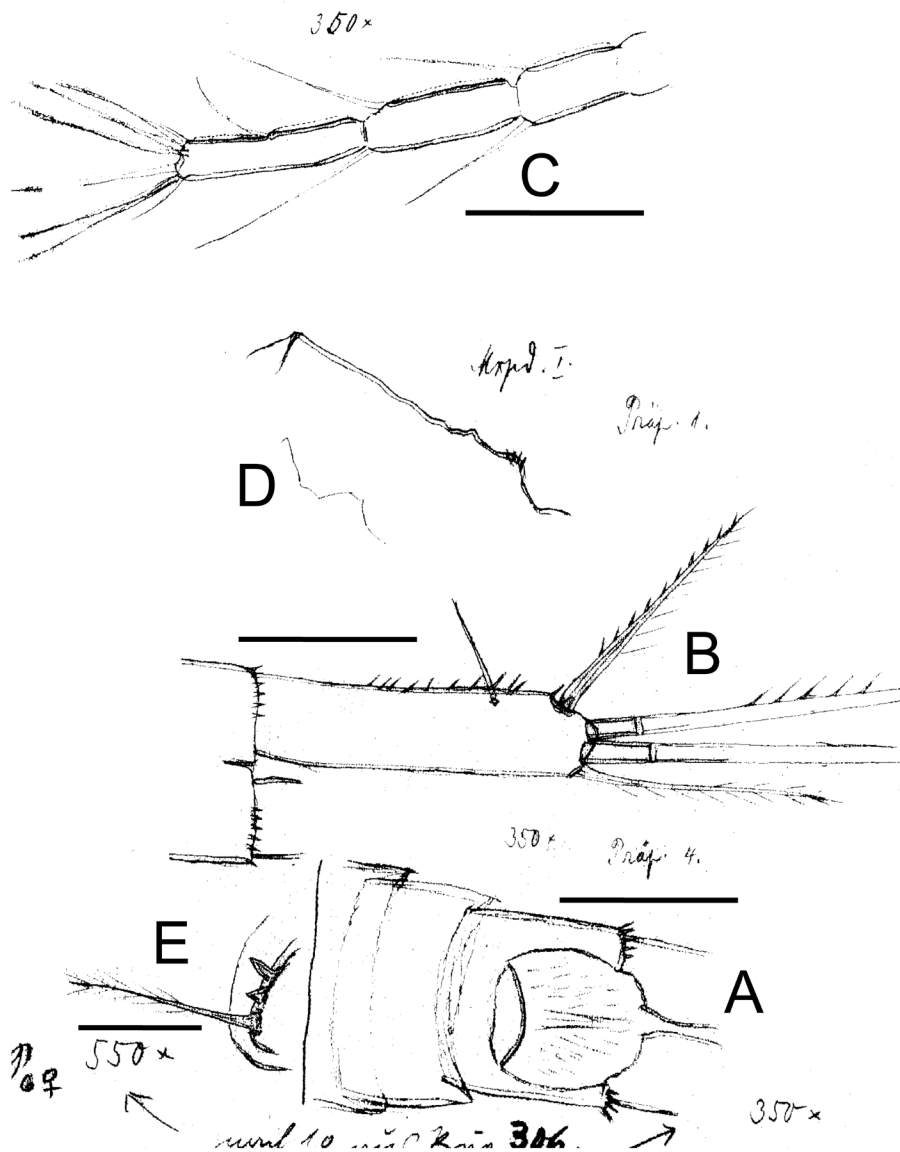
*Labrum*, *Maxillule*, and *Maxilliped* not observable in the slides.

gef. *Peru*; *Huaron-Lee*  
 am unders. 26. I. 1925.  
 Art *Cyclops delachauxi* n. sp. ♀



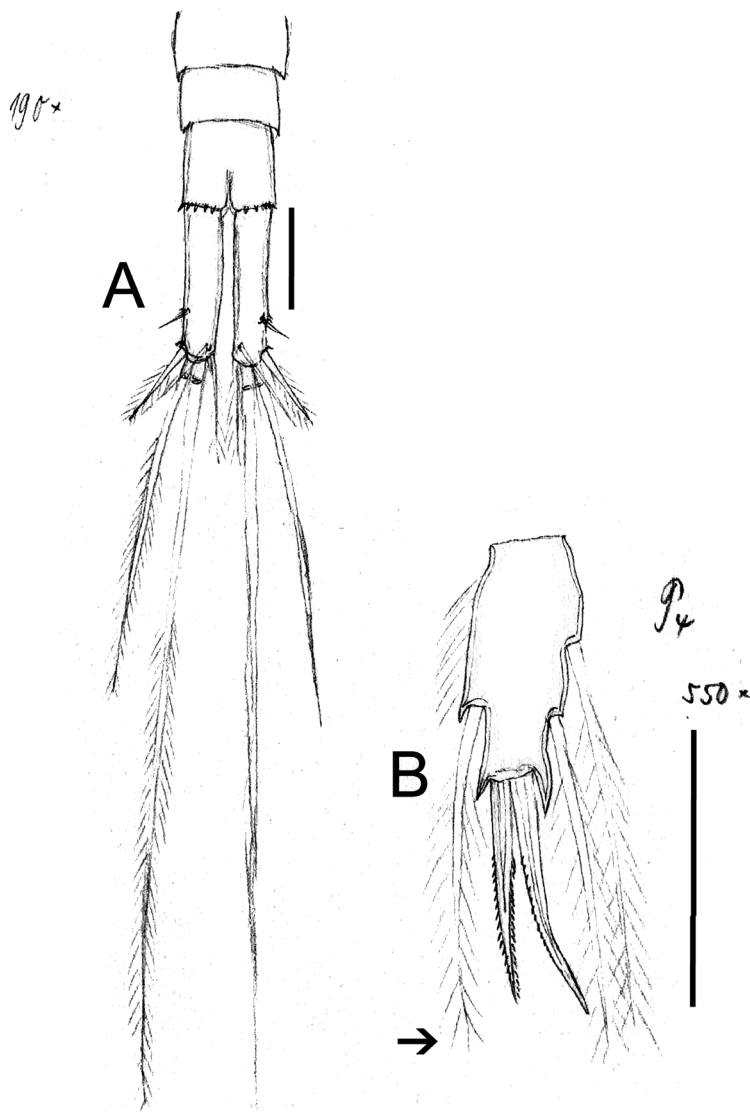
**Figure 1.** *Eucyclops delachauxi* (Kiefer, 1925). Original drawings of F. Kiefer. Female Holotype from Huaron, Peru. **A** Urosome, ventral view **B** Caudal rami **C** P5. Scale bars: **A–B** = 50  $\mu$ m, **C** = 20  $\mu$ m.

gef. *Alia Forfal 440.*  
 am unders. 26. I. 25.  
 Art *Cycl.* ♀



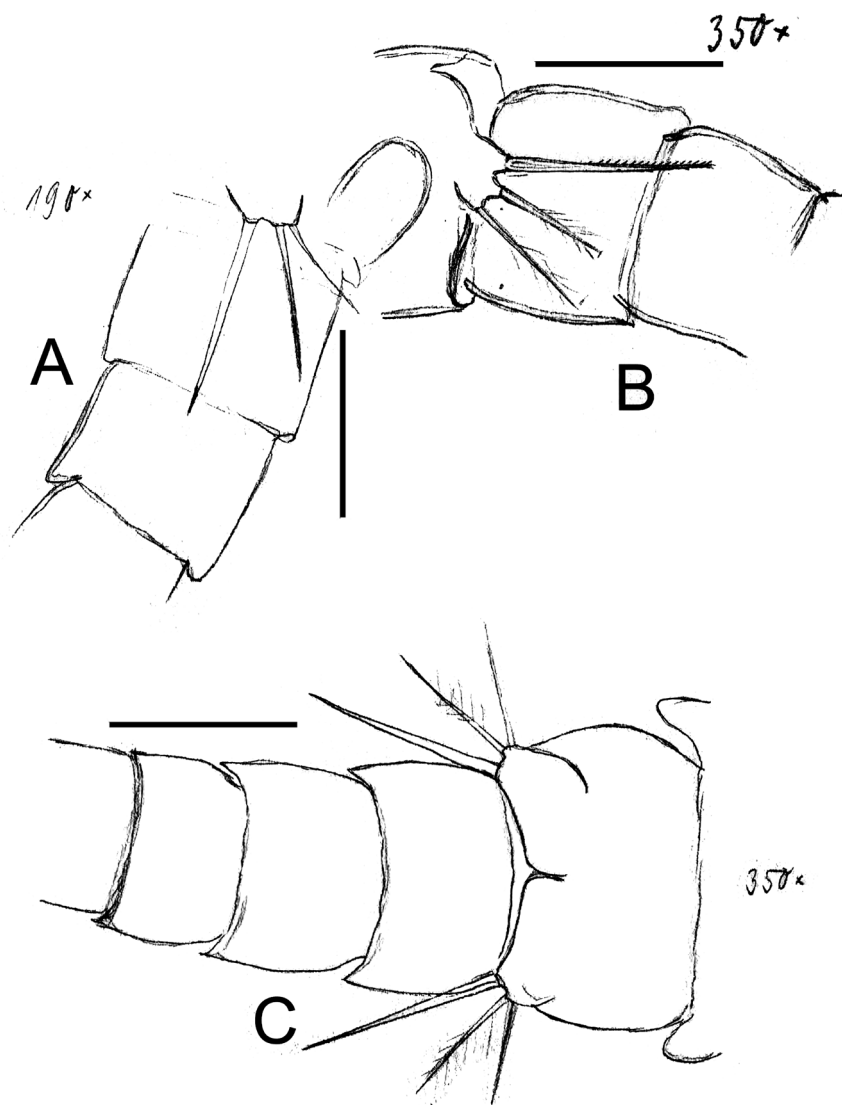
**Figure 2.** *Eucyclops delachauxi* (Kiefer, 1925). Original drawings of F. Kiefer. Female Holotype from Huaron, Peru. **A** Anal somite, dorsal view **B** Caudal rami **C** Antennule, segments 10–12 **D** Praecoxa of maxilla **E** P6. Scale bars: A–D = 50  $\mu$ m, E = 20  $\mu$ m.

gef. *Alia Infal* 444.  
 am 1915. unters. 27. 3. 1925.  
 Art *Cyclops delachauxi* n. sp. ♂  
 Obj. Ok. Vergr.

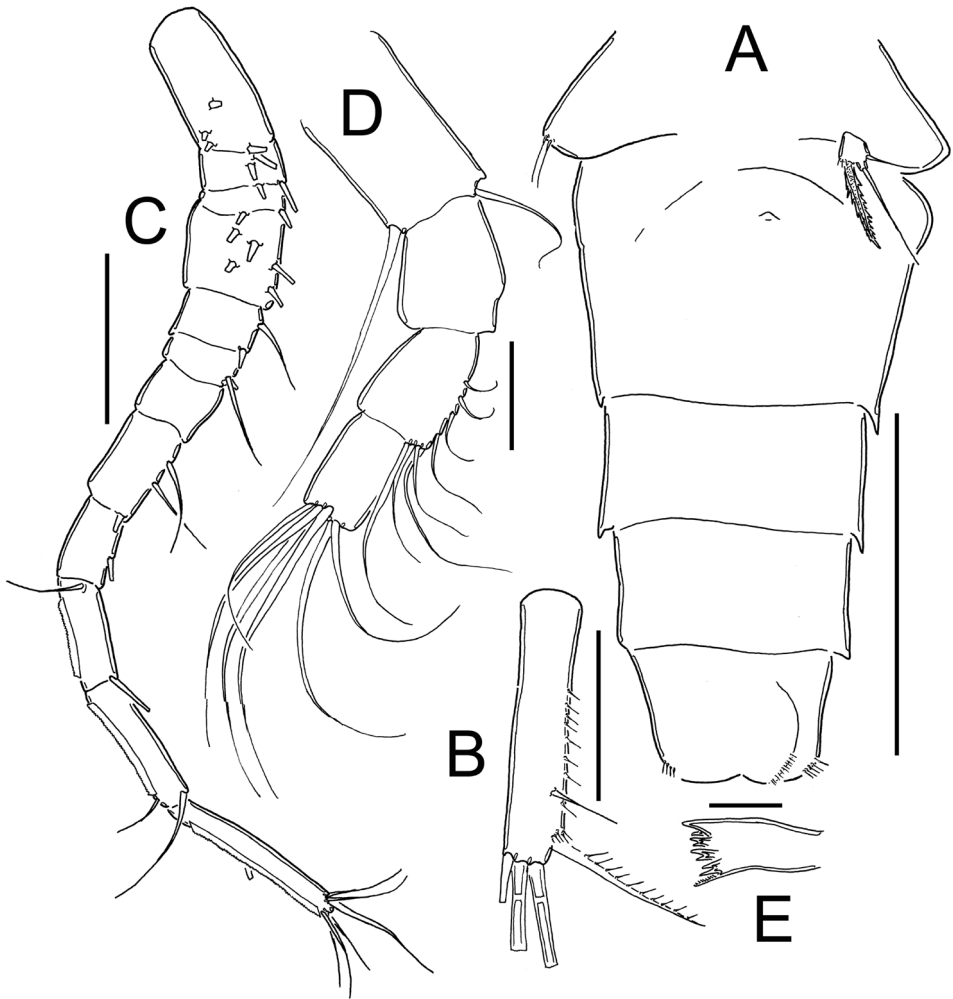


**Figure 3.** *Eucyclops delachauxi* (Kiefer, 1925). Original drawings of F. Kiefer. Paratype from Huaron, Peru. **A** Last urosomites and furca **B** Enp3P4. Scale bars: A–B = 50  $\mu$ m.

gef. Peru; Naticocha-Lac  
am unters. 28. I. 1925.  
Art *Cycl. delachauxi* ♂



**Figure 4.** *Eucyclops delachauxi* (Kiefer, 1925). Original drawings of F. Kiefer. Male Paratype from Naticocha, Peru. **A–C** P6 and urosomites, ventral. Scale bars: A–C = 50  $\mu$ m.



**Figure 5.** *Eucyclops delachauxi* (Kiefer, 1925). Author's drawings. Female Holotype from Huaron, Peru. **A** Urosome, ventral view **B** Caudal ramus **C** Antennule **D** Antenna **E** Mandible (part). Scale bars: **A** = 100  $\mu\text{m}$ ; **B–C** = 50  $\mu\text{m}$ ; **D–E** = 20  $\mu\text{m}$ .

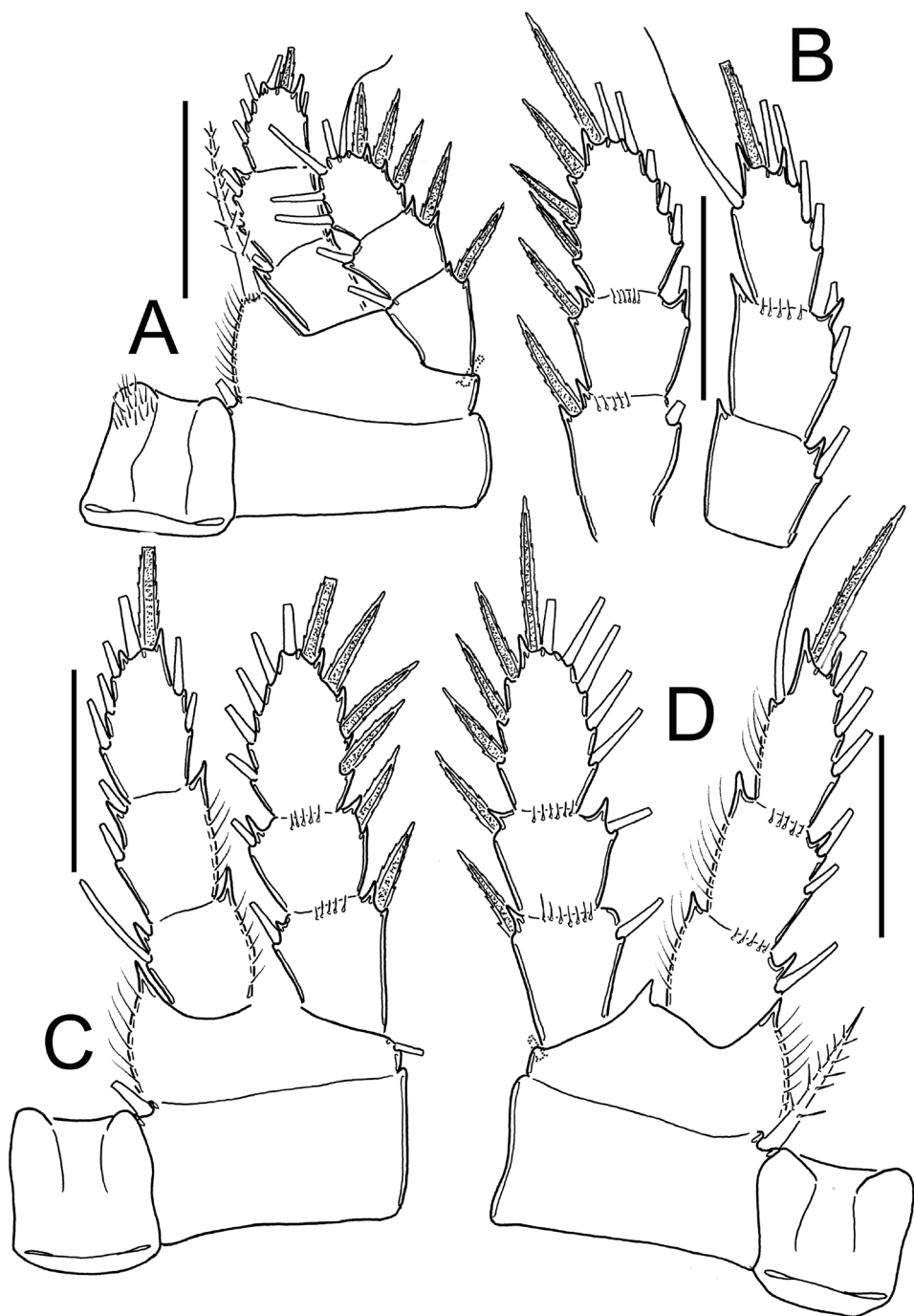
**Mandible** (Fig. 5E): with 6 tooth on gnathobase. Innermost margin with 1 spinulose seta.

**Maxilla** (Fig. 2D): Precoxa with row of small spinules on dorsal surface.

**P1–P4:** Endopod and exopods of all swimming legs 3-segmented. Armature formula as in Table 1.

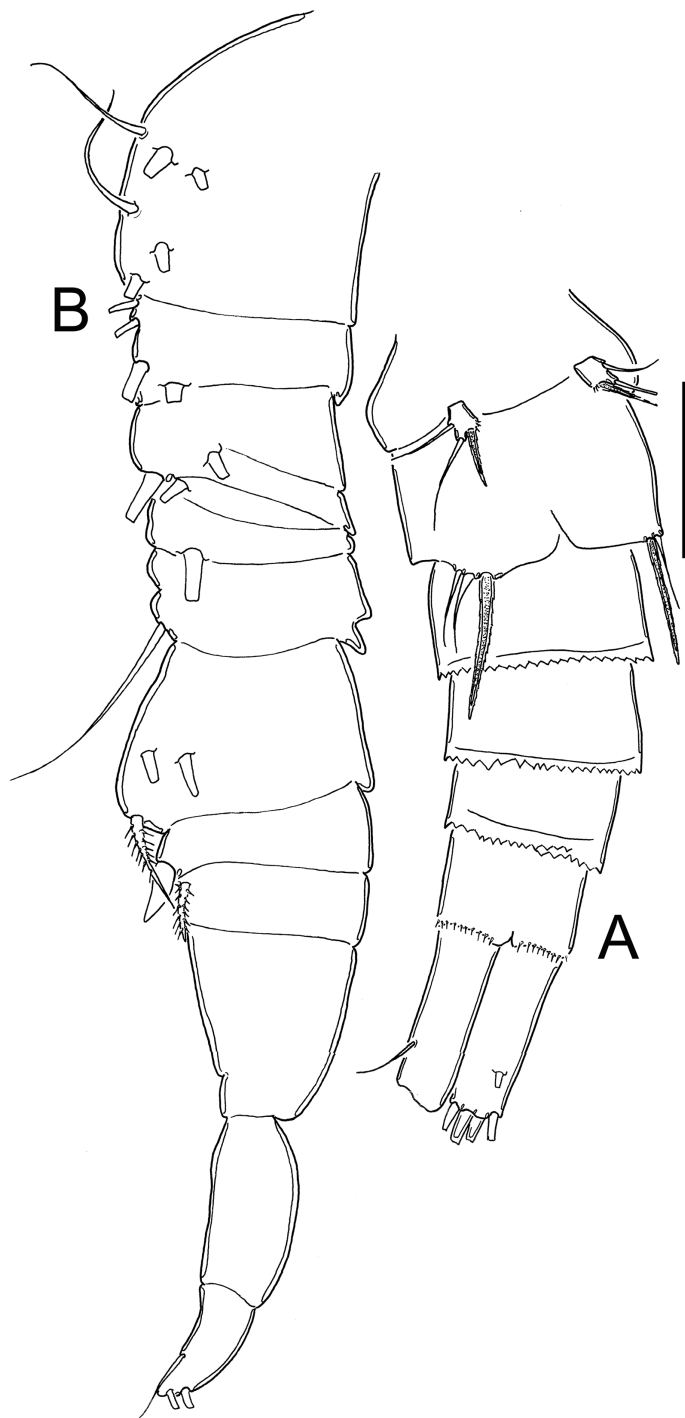
**Leg 1** (Fig. 6A): Group of small hairs present in each side on anterior surface of intercoxal sclerite, distal margin with 2 rounded chitinized projections. Basipodal spine reaching middle length of Enp3, 0.8 times as long as Enp.

**Leg 2 and 3:** General shape as in Fig. 6B–D.



**Figure 6.** *Eucyclops delachauxi* (Kiefer, 1925). Author's drawings. Female Holotype from Huaron, Peru.  
**A** P1 **B** P2 **C-D** P3. Scale bars: **A-D** = 50  $\mu$ m.





**Figure 7.** *Eucyclops delachauxi* (Kiefer, 1925). Author's drawings. Male Paratype from Huaron, Peru.  
**A** Urosome, ventral view **B** Antennule. Scale bars: **A–B** = 50  $\mu$ m.

*Leg 4* (Fig. 3B): Intercoxal sclerite with short hairs in rows I, II, III. Coxopodite with row A, B (3-4), C+D (21), E (5), F and H (from Alekseev and Defaye 2011). Enp3P4: segment length/width ratio = 2.0-2.4; inner spine/outer spine = 1.1; inner spine /length of segment = 1.0; outer spine /length of segment = 0.9. Lateral seta of Enp3P4 inserted at 69% of the total length of the segment. Setae of Enp3P4 long and slender; lateral seta reaching beyond apical margin of inner spine (arrowed in Fig. 3B).

*Leg 5* (Fig. 1C): One free segment subrectangular, 1.4–1.8 times as long as wide, bearing 1 inner spine and 2 setae; medial seta about 1.7 times longer than outer seta. Inner spine 1.2–1.6 times longer than outer seta and 0.5–0.8 times as long as median seta. Inner spine 2.0–2.2 times as long as segment length.

*Leg 6* (Fig. 2E): Represented by small, flat plate with 1 slender and long seta and 2 small spines. Outer seta notably long, 12 times longer than medial spine and 6 times longer than inner spine.

*Male*: Urosome 6-segmented, posterior margin of urosomites serrated (Figs 4, 7A). Caudal ramus rectangular, 2.8–4.0 times as long as wide; inner margin of caudal ramus naked. Dorsal seta (VII) 0.6 times as long as caudal ramus, and 1.1 times as long as outermost caudal seta (III). Length ratio of innermost caudal seta (VI)/outermost caudal seta (III) = 1.2. Lateral caudal seta (II) inserted at 70% of caudal rami length. All terminal caudal setae plumose.

*Antennule* (Fig. 7B): ornamentation per segment incomplete to described in details.

*Leg 5* (Fig. 7A): segment subrectangular in shape, 1.5 times longer than wide, bearing 1 inner spine and 2 setae; medial seta about 1.4 times longer than outer seta. Inner spine 0.8 times longer than outer seta and 0.6 times as long as medial seta.

*Leg 6* (Figs 4, 7A): Represented by one small, flat plate placed near lateral margin of genital somite with 1 strong, long inner spine and 2 unequal setae. Inner spine reaching medial length of fourth urosomite. Inner spine about 1.3–1.8 times longer than medial seta and about 1.4–2.0 times longer than outer seta.

**Remarks.** In the publication posterior to the description of *E. delachauxi* made by Kiefer (1926) he pointed out the taxonomic problems within the genus derived from improperly weighted characters used for the species determinations. He encouraged the exploration and use of additional structures to achieve a more accurate definition of species in order to establish consistent patterns both taxonomically and biogeographically. Since its description, *E. delachauxi* has been recorded in Mexico, Colombia and Peru (Harding 1955; Gaviria 1994; Del Río and Valdivia 1989; Rodríguez-Almaráz 2000; Suárez-Morales 2004; Elías-Gutiérrez et al. 2008), but none of the records includes drawings or descriptions of the specimens that might allow us to compare them with the type material and confirm these records. In the original description, the length/width proportion of the Enp3P4 (2.0–2.4) was stated as a distinguishing character of this species but it is shared with other species (v. gr. *E. prionophorus*, *E. leptacanthus*, *E. bondi*, *E. pseudoensifer*) related to *E. delachauxi*, thus making it less informative to separate species. Another character remarked by Kiefer (1925) is the ornamentation of the outer margin of the caudal rami, which in comparison to other species is weakly ornamented, usually bearing 4–6 spinules; yet a significant variation has been observed,

7–8 (our observations) to sometimes 10 or 17 spinules. In a recent revision of the *E. serrulatus*-complex, Alekseev and Defaye (2011) mentioned another particular feature of this species, namely the relative length of the lateral seta on Enp3P4 in comparison to the length of the apical outer spine (lateral seta is as long as or even longer than the inner spine), a characteristic that is unique in the American representatives of *Eucyclops*. As mentioned by Kiefer, records of species should be consistent both taxonomically and geographically; hence, the records of *E. delachauxi* from Mexico of this probably South American species could be assignable to a different species. Until recently, *E. delachauxi* has been identified by less reliable characters, as described above. The observations included in Kiefer's works (1925, 1926) about the ornamentation of caudal ramus were excluded by recent taxonomist and therefore many of the specimens recorded under the name of *E. delachauxi* could include records related to related species or even to species not yet described.

### ***Eucyclops prionophorus* Kiefer, 1931**

Figs 8–13

*Eucyclops* (s. str.) *prionophorus* Kiefer, 1931

*Eucyclops prionophorus*, Yeatman, in: Edmonson 1959, Smith and Fernando 1977, 1978, Harris 1978)

*Eucyclops prionophorus*, Einsle 1992

**Kiefer's description.** *The female:* Caudal rami slender, four times as long as wide, row of spinules on the outer margin, distal spinules are longer and proximal spinules are slender (Fig. 2). First antenna twelve-segmented, slightly shorter than the cephalothorax, with a narrow hyaline membrane along the margin of last three segments. Spine formula of exopods of four swimming legs is 3443. Fifth leg with one segment, bearing 3 elements, of which the inner spine at its insertion is twice as wide as both other setae. Seminal receptacle is similar to that in *E. serrulatus*. Length excluding caudal setae 0.94 mm.

*The male:* Spine of genital plate (P6) extremely long, longer than the genital segment, with two short, slender, plumose setae. Body length excluding caudal setae 0.8 mm.

**Distribution.** North America, close to New Heaven.

### **Description based on Kiefer's material.**

**Material examined.** Holotype. Adult ♀ collected 05.05.1929 from New Haven, USA. Specimen dissected (slide number SMNK01508). Additional material from San Bernardino, Paraguay (slides numbers SMNK03103, SMNK03104). Staatliches Museum für Naturkunde Karlsruhe, Germany.

*Female:* (Unless otherwise stated the character states are same in the holotype and in the Paraguay specimen) Average length excluding caudal setae 940 µm. Urosome 5-seg-

mented (Fig. 11A), relatively elongated; urosomal fringes smooth or slightly serrated, posterior margin of anal somite with 1 row of relatively long spinules. Genital double-somite symmetrical (Fig. 9A). Seminal receptacle typical of the *serrulatus*-group, with rounded lateral arms on posterior margin. Genital double-somite slightly wider than long (about 1.1 times). Anal somite with one row of hair-like spinules in each side of anal opening, anal operculum slightly rounded (Figs 10C, 11B). Length/width ratio of caudal ramus = 4.0–4.5; inner margin of caudal ramus naked in specimens from New Haven and with groups of small spinules in specimens from San Bernardino (see Fig 11A). Serra on outer margin with strong spinules covering 65–68% of lateral margin, spinules increasing in size distally (Figs 8A, 10C, 11B). Dorsal seta (VII) short, 0.4–0.6 times the length of caudal ramus, and 0.5–0.6 times as long as outermost caudal seta (III). Length ratio of innermost caudal seta (VI)/outermost caudal seta (III) = 1.0–1.1. Lateral caudal seta (II) inserted at 75–77% of caudal ramus. All terminal caudal setae plumose.

*Antennule* (Fig. 11C): 12-segmented. Armament per segment as follows (s = seta, ae = aesthetasc, sp = spine): **1**(6s), 2(4s), 3(2s), **4**(4s), **5**(1s), **6** (1s), 7(2s, with small projection on inner margin, arrowed in Fig. 11C), 8(3s), **9**(2s), 10(2s), **11**(2s), **12**(5s). Numbers in bold indicate segments with incomplete ornamentation.

*Antenna, mouthparts and Leg 2*: not observable in slides.

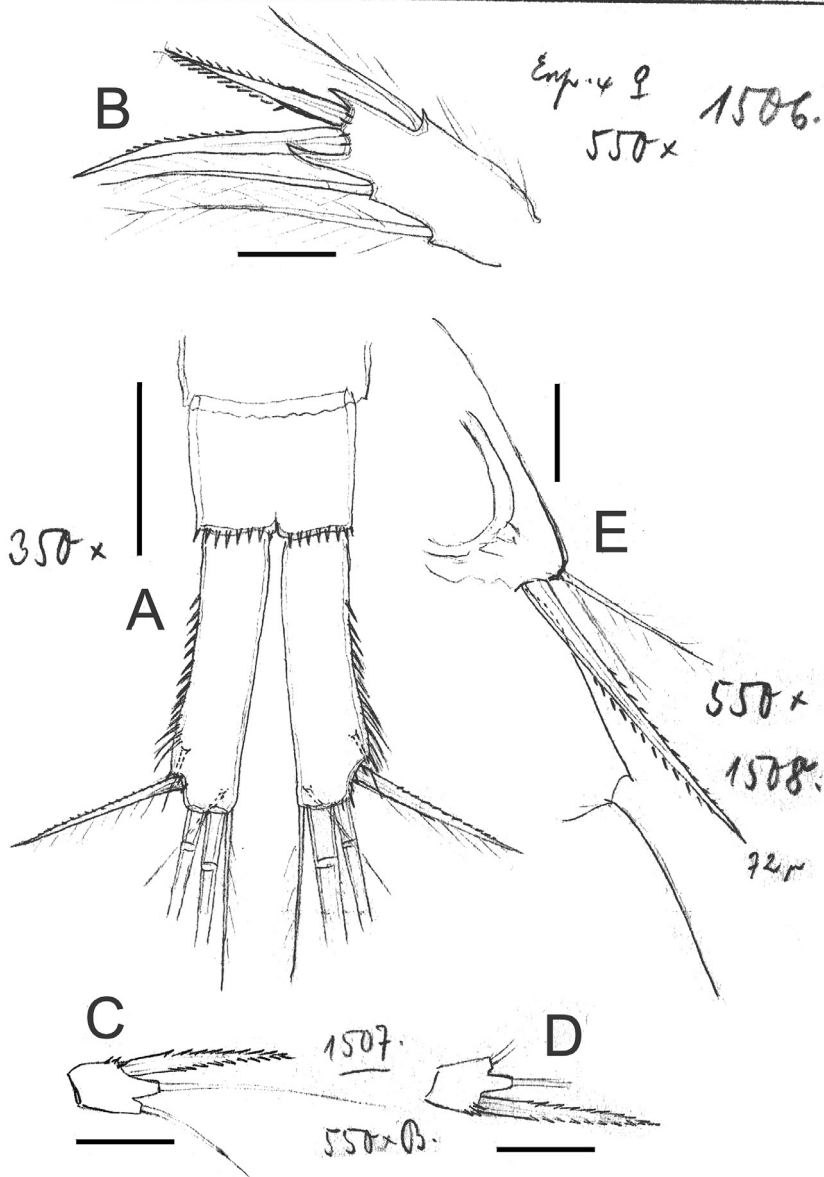
*P1-P4*: Endopods and exopods of all swimming legs 3-segmented. Armature formula of all swimming legs as in Table 1.

*Leg 1* (Fig. 12A): New Haven: Intercoxal sclerite without ornamentation and with 2 rounded chitinized projections. Coxa with strong biserially setulated inner coxal seta. Basipodal spine not reaching middle length of Enp 3; basipodal spine 0.6 times as long as total length of Enp. Third segment of Enp 1.5 times as long as wide, apical spine of Enp3 1.4 times longer than segment, apical most seta of Enp3 1.2 times longer than apical spine. Spines of Exp slightly elongated. San Bernardino: intercoxal sclerite not available. Basipodal spine reaching beyond middle length of Enp3; basipodal spine 0.75 times as long as total length of Enp. Third segment of Enp 1.2 times as long as wide, apical spine of Enp3 1.2 times longer than segment; apicalmost seta of Enp3 1.6 times longer than apical spine.

*Leg 3* (Fig. 12B): No ornamentation observed on intercoxal sclerite, distal margin with 2 rounded projections. Coxa with strong, biserially setulated inner coxal seta. Coxa with row of tiny spinules along outer margin. Enp3 1.7–1.8 times as long as wide, apical spine on Enp3 1.2 times as long as segment, Exp3 1.5–1.7 times as long as wide, apicalmost spine of Exp3 1.1 times as long as segment.

*Leg 4* (Fig. 12C–D): Intercoxal sclerite with rows I, II and III. Row I with 7 long spinules in each side and a small gap between. Row II with 6 spinules on middle margin. Row III divided in 3 sections, first one with 3 short spinules, middle section with 2 short spinules and third section with 2–3 short spinules (all observed in San Bernardino's specimens). Caudal coxal surface with spinule formula: A, B (4), C+D (6) (*sensu* Alekseev and Defaye 2011). Coxal spine with heteronomous setulation: with long hairs basally, and spinules distally; lateral edge of coxal spine with 3 spinules apically, proximal part naked. Enp3P4: segment length/width ratio = 2.0–2.5;

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 Art *Eucyclops prionophorus* n.sp. ♀ ♂

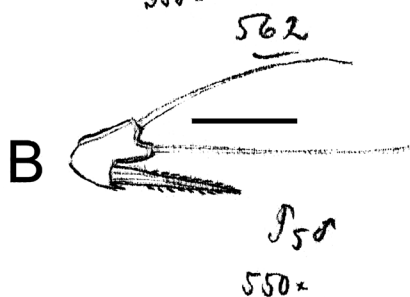
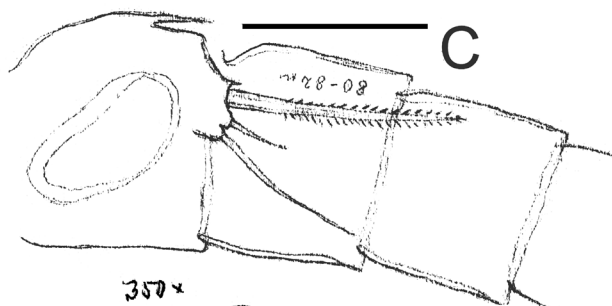
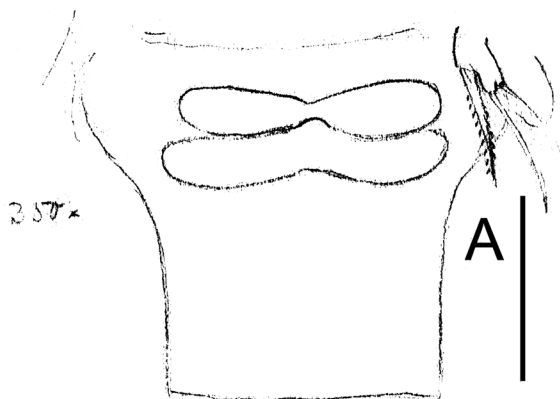


**Figure 8.** *Eucyclops prionophorus* Kiefer, 1931. Original drawings of F. Kiefer. **A** Female Holotype **B** female Paratype **A, C–E** from New Haven, U.S.A. **A** Caudal rami **B** Enp3P4 **C–D** P5 **E** P6. Scale bars: **A** = 50 μm; **B–E** = 20 μm.

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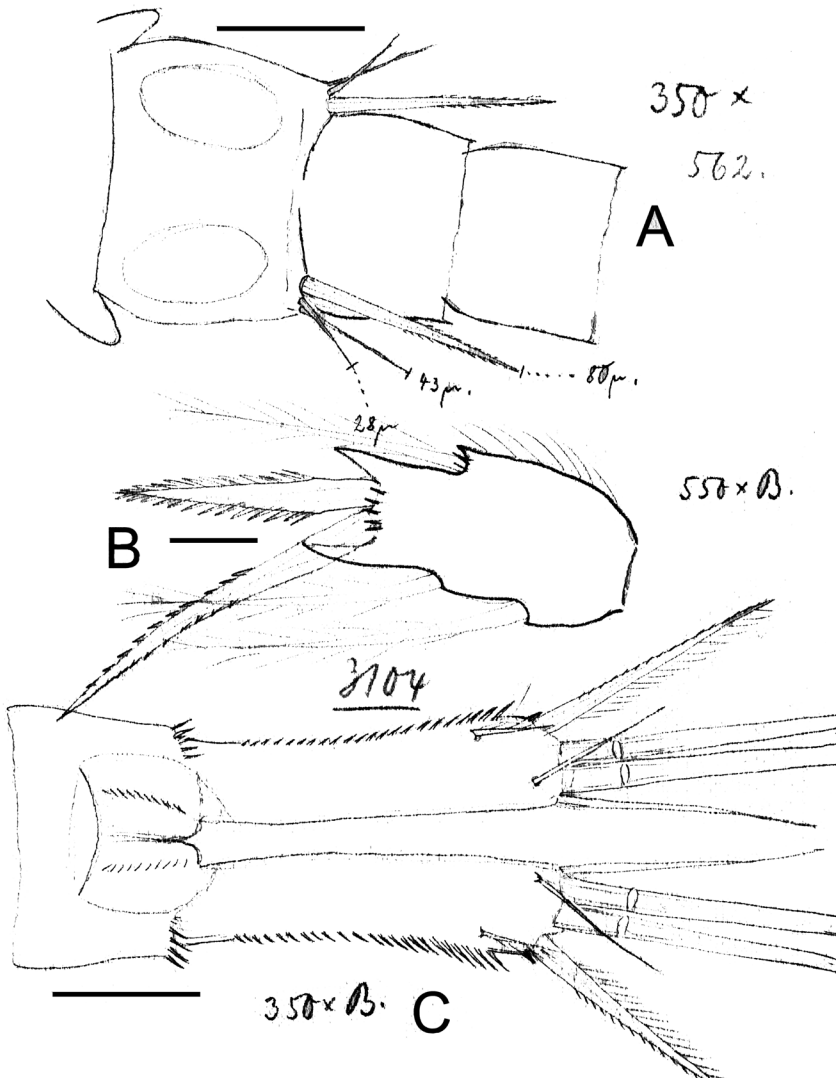


Fr = 138µm; 27.5µm  
Endco = 92µm; 60.9µm; 46.5µm; 88µm; (55µm) =  
Säge über den ganzen Rand  
besond. distal sehr kräftig!

**Figure 9.** *Eucyclops prionophorus* Kiefer, 1931. Original drawings of F. Kiefer. Female **A** Male **B–C** from San Bernardino, Paraguay. **A** Genital double-somite and P5 **B** P5 **C** P6. Scale bars: **A**, **C** = 50 µm, **B** = 20 µm.

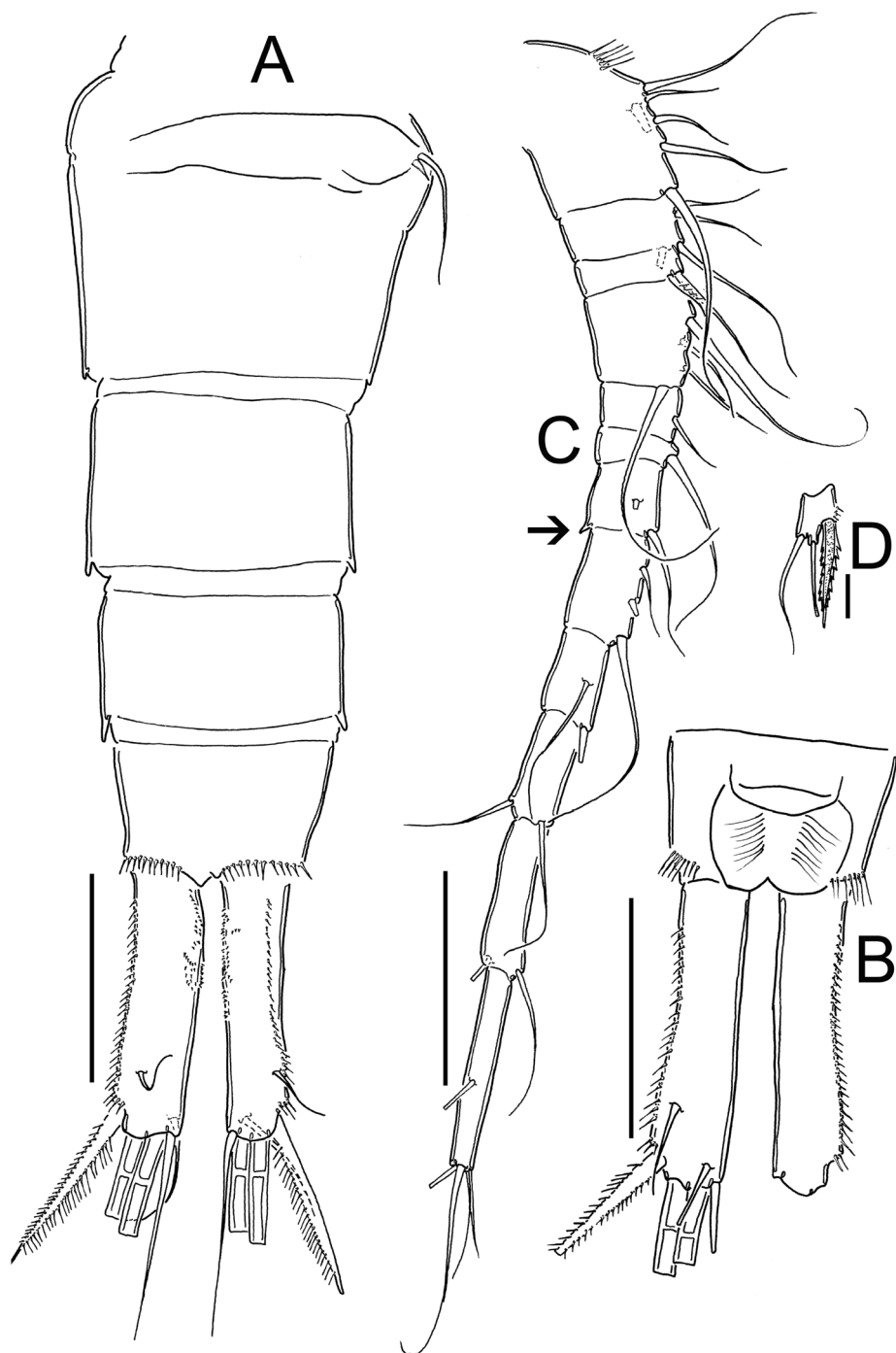
Paraguay, S. Bernardino

*Eucyclops prionophorus* Kiefer

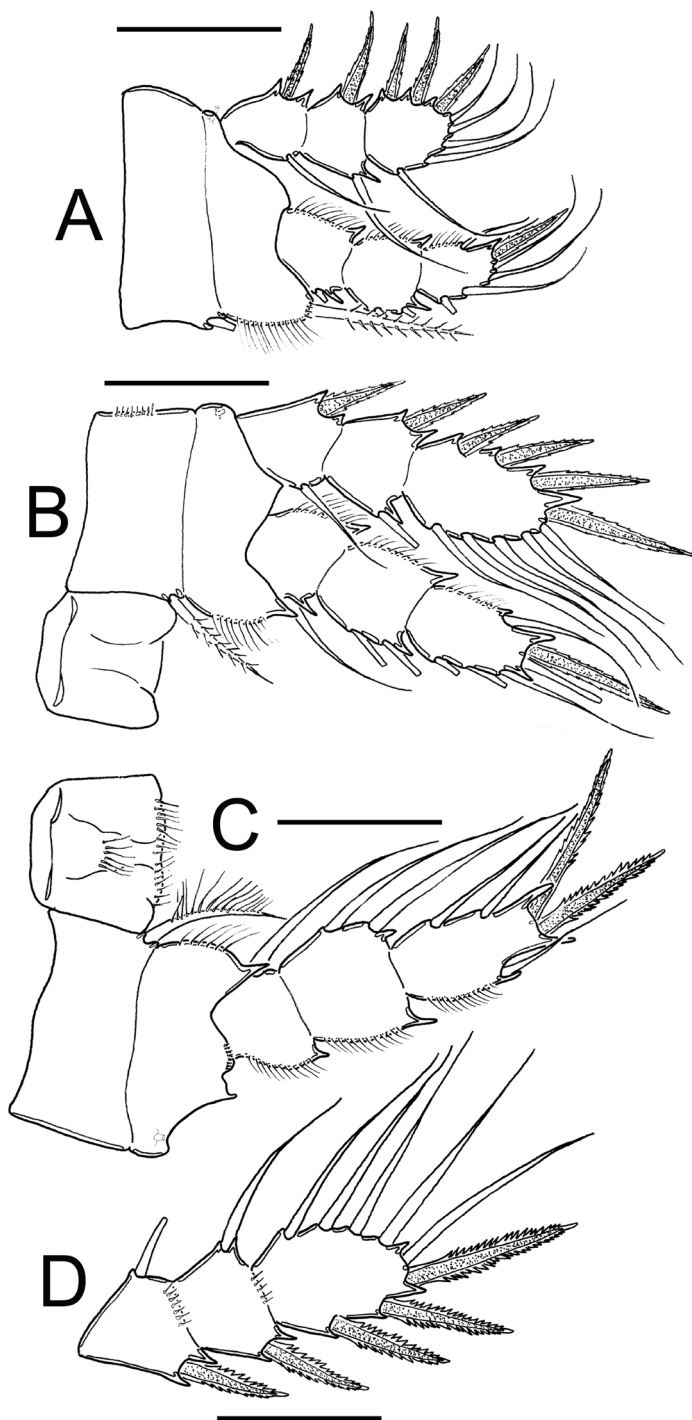


**Figure 10.** *Eucyclops prionophorus* Kiefer, 1931. Original drawings of F. Kiefer. Female **B–C** Male **A** from San Bernardino, Paraguay. **A** Genital somite and P6 **B** Enp3P4 **C** Anal somite and caudal rami. Scale bars: **A–C** = 50 μm.

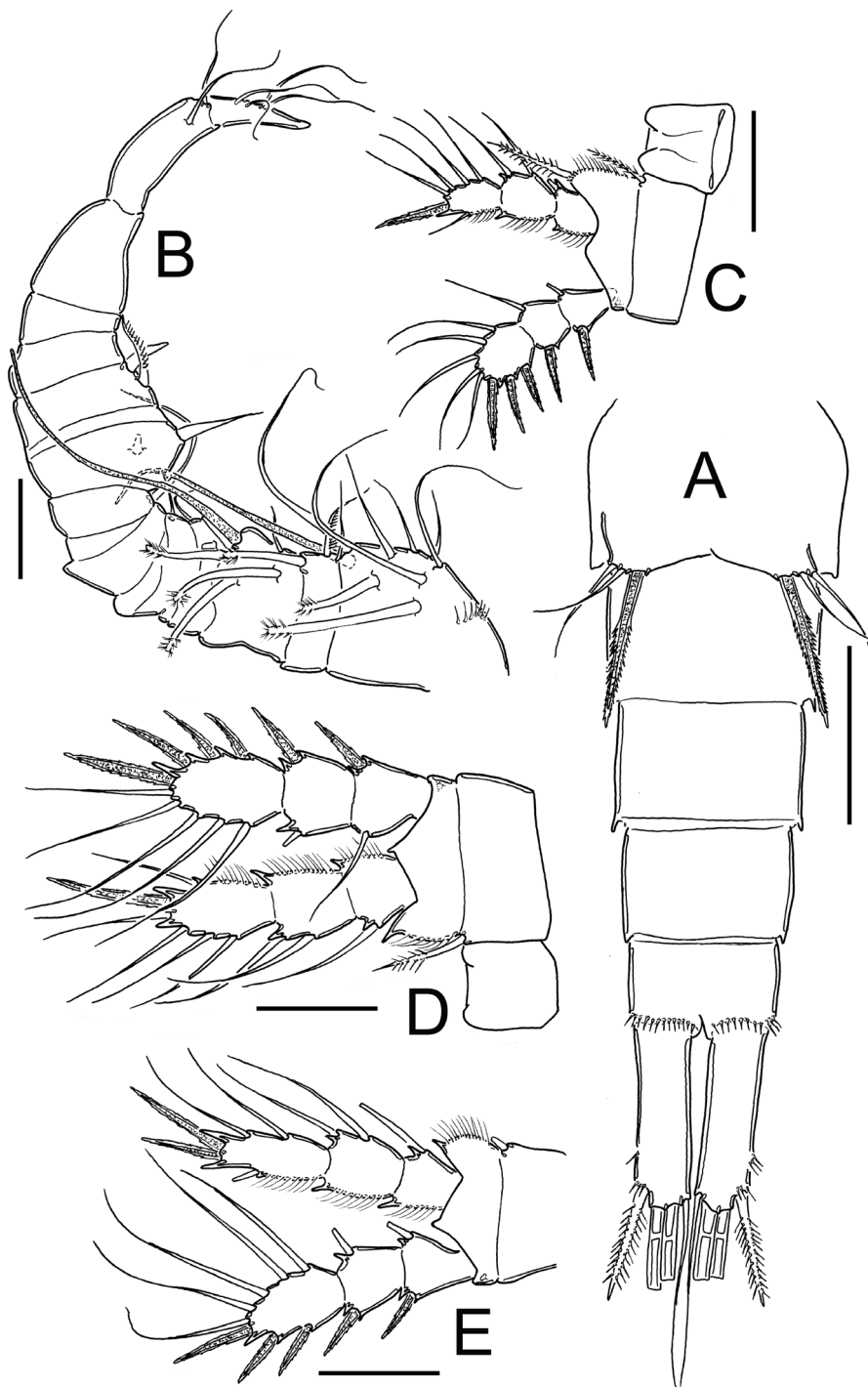




**Figure 11.** *Eucyclops prionophorus* Kiefer, 1931. Authors' drawings. Female from San Bernardino, Paraguay.  
**A** Urosome, dorsal view **B** Anal somite and caudal rami **C** Antennule **D** P5. Scale bars: **A–C** = 100  $\mu\text{m}$ ,  
**D** = 20  $\mu\text{m}$ .



**Figure 12.** *Eucyclops prionophorus* Kiefer, 1931. Authors' drawings. Female from San Bernardino, Paraguay.  
**A** P1 **B** P3 **C** P4 **D** Exp P4. Scale bars: A–D = 50  $\mu$ m.



**Figure 13.** *Eucyclops prionophorus* Kiefer, 1931. Authors' drawings. Male from San Bernardino, Paraguay.  
**A** Urosome, ventral view **B** Antennule **C** P1 **D** P3 **E** P4. Scale bars: **A** = 100  $\mu$ m, **B–E** = 50 $\mu$ m.

inner/outer spines = 1.1–1.5; inner spine/segment length = 1.0–1.5; outer spine/segment length = 0.8–1.1. Lateral seta of Enp3P4 inserted at 60–70% of the total length of segment. Modified setae present on Enp3P4 in specimens from Paraguay. Enp3 setae long in specimens from New Haven and Paraguay. Exp3 1.6–1.8 times as long as wide, apicalmost spines of Exp3 0.9–1.2 times as long as segment.

*Leg 5* (Figs 8C–D, 9A, 11D): Free segment subrectangular, 1.4–1.8 times longer than wide, bearing 1 inner spine and 2 setae; median seta longer than outer seta (1.0–1.7 times) and 1.3–1.6 times longer than inner spine. Inner spine 1.7–2.0 times as long as segment.

*Male*: Average length excluding caudal setae 800  $\mu\text{m}$ . Urosome 6-segmented, posterior margin of urosomites smooth. Caudal ramus 3.5 times as long as wide, inner margin naked, with a group of spinules present at insertion of lateral seta. Ratio of innermost caudal seta (VI)/outermost caudal seta (III) = 1.6. All terminal caudal setae plumose.

*Antennule*: 1-segmented (Fig. 13B), armament per segment as follows (s = seta, modified seta = ms, ae = aesthetasc, sp = spine): 1(6s + 2ms + 1ae); 2(42 + 1ms); 3(2s+3ms + 1ae); 4(1s); 5(1s); 6(0); 7(1s); 8(2s); 9(1s + 1sp); 10(0); 11(0); 12(0); 13(2s); 14 (4s).

*Leg 5*: Free segment subrectangular, 1.4 times longer than wide, bearing 1 inner spine and 2 setae; median seta longer than outer seta (about 1.3 times).

Inner spine 0.6 times longer than outer seta and 0.4 times as long as median seta.

*Leg 6* (Figs 8E, 9C, 10A, 13A): Represented by small, low plate near lateral margin of genital somite, armed with 1 strong and long inner spine and 2 unequal setae. Inner spine not reaching half length of fourth urosomite. Inner spine about 1.6–2.5 times longer than median seta and 1.2–1.8 times longer than outer seta.

**Remarks.** Since its description in 1931 from a material collected in the USA, *Eucyclops prionophorus* has been recorded from various habitats in the Americas including the Laurentian Great Lakes in Canada and the USA, the Chihuahuan Desert in Mexico, and water bodies in savannahs and deciduous forests in Argentina, Paraguay and Uruguay (Kiefer 1936; Czaika 1974, 1978; Robertson and Gannon 1981; Dussart and Fernando 1990; Einsle 1992; Reid and Marten 1995; Suárez-Morales and Reid 1998; Grimaldo-Ortega et al. 1998; Suárez-Morales 2004; Suárez-Morales et al. 2010; Mercado-Salas and Suárez-Morales 2012). In the description made by Kiefer (1931), the key characters of the species include the ornamentation on the outer margin of the caudal rami (spinules distally increasing in size), the remarkably strong (wide) spine of the fifth leg, and the extremely long spine on the sixth leg of the male. After Kiefer's contribution (1931), the most complete comparisons among populations of *E. prionophorus* were provided by Einsle (1992) based on American material from Kiefer's collection. In this paper, Einsle stated that the type material of the species was damaged and therefore it couldn't be used for the redescription of the species. Hence, he used the material from Paraguay identified by Kiefer as *E. prionophorus* to point out the main characteristics of the species, as follows: 1) dorsal caudal seta shorter than innermost and outermost caudal setae and shorter than caudal ramus; 2) basipodal seta of P1-reaching middle of Enp3P1; setae of exopodites of P3 and P4 transformed, spatulate; 4) setae on Enp3 P4 short (differing from Kiefer's description) and; 5) the

outer edge of P5 wider and longer than the central lobe. Our own observations on Kiefer's material from Paraguay, revealed that the main characteristic of *E. prionophorus* is the short dorsal caudal seta length being shorter than in any other closely related species (e.g. *E. bondi* and *E. conrowae*), but not as short as in *E. pseudoensifer* (Dussart 1984; Suárez-Morales and Walsh 2009). A remarkable feature found in the material from Paraguay is the ornamentation of the inner margin of the caudal rami, where we observed a group of tiny spinules that was never reported for this species (Fig. 11A). This character should be compared in other populations as well, in order to verify its diagnostic value: whether it is simple intraspecific variation or a unique species-specific character. Another structure that could be useful to distinguish this species from its congeners is the ornamentation of the intercoxal sclerite of the fourth leg: in *E. prionophorus* row I includes long and slender spinules (Fig. 12C), while in *E. bondi* and *E. conrowae* this row always consists of small and strong spinules, and in *E. pseudoensifer* row I consists of very long hairs. In our observations of the specimens identified as *E. prionophorus* from Mexico, we found a possible pattern in the ornamentation of the intercoxal sclerites of legs 3 and 4; in all the specimens possessing strong spinules in row I of P4, the intercoxal sclerite ornamentation of P3 also includes spinules, at least in one of the three rows of the plate. In case of the individuals possessing long hairs in row I of P4, the three rows of the P3 intercoxal sclerite always consist of long hairs. These observations will be discussed and compared in another manuscript about the Mexican fauna of *Eucyclops*. Records of *E. prionophorus* in the Americas appear to be well determined, at least those which include drawings of the caudal rami and the fourth leg, showing the characteristics remarked by Kiefer (1931, 1936) and Einsle (1992). Here we also present the first illustration of the male antennule (Fig. 13B) of this species; we found modified setae on segments 1, 2 and 3 and aesthetascs on segments 1 and 3; this pattern differs from the presented by Alekseev et al. (2006) for *E. serrulatus*, in which aesthetascs are reported only on segments 2, 3, 4, 6 and 10.

### ***Eucyclops bondi* Kiefer, 1934**

Figs 14–17

*Eucyclops* (s. str.) *Bondi* Kiefer, 1934

*Eucyclops* (s. str.) *Bondi* Kiefer, 1936

*Eucyclops bondi*, Smith and Fernando 1980; Reid 1992

### **Kiefer's description.**

*Female*: General aspect as the American *E. prionophorus*. Caudal rami 3.5 times longer than wide, with rami slightly divergent. Inner margin of caudal ramus naked, outer margin strongly ornamented with strong spinules. Proximal spines small but distal spines long (Fig. 4). Innermost apical seta longer than outermost seta; two middle setae show strongly heteronomous plumage.

Antennule only slightly longer than cephalothorax, bearing 12 segments, last three segments with a narrow hyaline membrane along margin.

Swimming legs normally segmented, with spines and setae. Third endopod of P4 two times longer than wide, inner spine longer than segment and even 1.5 times longer than the outer spine. The connecting plate of this leg is hairy on the free margin. Rudimentary leg (P5) with a slender inner spine, inner spine is at its insertion about twice as wide as one of the both setae. Seminal receptacle without special characteristics. Total length of animals, excluding apical setae of caudal ramus, 720–800  $\mu\text{m}$ .

*Male*: total length, excluding apical setae of caudal ramus, 580–600  $\mu\text{m}$ . As a main characteristic the reinforcement of genital somite (P6) should be considered. Of the three elements, the inner spine only measures 22–23  $\mu\text{m}$ , clearly differing from the similar North American species *E. prionophorus*, the outermost plumose seta is longer than the spine, the median seta is as long as the spine. In the male of *E. prionophorus* the inner spine is more than three times longer, 71  $\mu\text{m}$ .

### Description based on Kiefer's material.

**Material examined.** Holotype. Adult ♀ collected 16.02.1933 from Trou Caiman, Haiti, specimen dissected (slide reference numbers SMNK02079, SMNK02080). Additional material from Laguna Rincon, Haiti (slide reference numbers SMNK02393, SMNK02394). Staatliches Museum für Naturkunde Karlsruhe, Germany.

*Female*: Body length excluding caudal setae 720–800  $\mu\text{m}$ . Prosome expanded at first and second somite, symmetrical in dorsal view. Urosome 5-segmented (Figs 14C, 16A–B), relatively elongate. Urosomal fringes strongly serrated, posterior margin of anal somite with row of long spinules. Genital double-somite symmetrical. Seminal receptacle typical of *serrulatus*-group, with rounded lateral arms on posterior margin. Genital double-somite 1.1 times as long as wide. Anal somite with hair-like spinules in anal opening, anal operculum slightly rounded (Fig. 16A). Length/width ratio of caudal ramus = 3.5. Inner margin of caudal ramus naked, outer margin partially covered (53–57%) by strong spinules which increase in size distally (Figs 14C, 16B). Dorsal seta (VII) long: 0.8 times of caudal ramus length, and 1.26–1.4 times as long as outermost caudal seta (III). Length ratio of innermost caudal seta (VI)/outermost caudal seta (III) = 1.07–1.25. Lateral caudal seta (II) inserted at 77–80% of caudal rami. All terminal caudal setae plumose.

*Antennule* (Fig. 16C): 12-segmented, reaching second prosomite; three distal segments with narrow hyaline membrane. Armament per segment as follows (s = seta, ae = aesthetasc, sp = spine): 1(8s), 2(4s), **3(1s)**, 4(6s), **5(1s)**, 6 (1s+1sp), 7(1s), 8(3s), 9(2s+1ae), 10(2s), 11(3s), 12(8s). Numbers in bold indicate segments with incomplete ornamentation. Aesthetasc of ninth segment short, reaching posterior margin of segment.

*Antenna, Labrum and Mandible*: not observable in slides.

*Maxillule* (Fig. 16D): precoxal arthrite with naked surface, with 3 strong chitinized distal claws. Spiniform seta on frontal side and palp not observed.

*Maxilla* (Fig. 16E): praecoxa and coxa partially fused. Praecoxa with 2 armed setae on endite. Coxal surface naked, bearing 1 biserially plumose seta. Distal endite of



coxopodite well developed, with 2 apical setae, 1 strong and furnished with spinules and the other noticeably thicker and longer. Basal claw of basis with proximal row of spinules and 1 chitinized armed seta. Endopod 2-segmented, first segment with 1 seta, second with 2 setae.

*Maxilliped* (Fig. 16F): syncoxa naked, bearing 3 setae. Maxillipedal basis with 1 seta and no observable additional ornamentation. Endopod 2-segmented: Enp1 with 1 long, strong seta, Enp2 with 2 setae, proximal 1 chitinized and fused with segment, apical seta normal.

*P1–P4*: Endopod and exopods of all swimming legs three-segmented. Armature formula of all swimming legs as in Table 1.

*Leg 1* (Fig. 17A): Coxa with strong, biserially setulated inner coxal seta. Basipodal spine long, reaching apical margin of Enp3; basipodal spine as long as endopod. Third endopodal segment 1.5 times as long as wide, apical spine of Enp3 0.9 times longer than length of Enp3, apicalmost seta of Enp3 1.4 times longer than apical spine. Spines of all exopodal segments elongate.

*Leg 2* (Fig. 17B): Single group of small spinules in each side on anterior surface of intercoxal sclerite. Distal margin of intercoxal sclerite with 2 round chitinized projections. Coxa with strong, biserially setulated inner coxal seta. Enp3 1.9 times as long as wide, apical spine 1.2 times longer than length of Enp3, apicalmost seta of Enp3 1.4 times longer than apical spine.

*Leg 3* (Fig. 17C): Coxa with strong biserially setulated coxal seta. Enp3 2.2 times longer than wide, apical spine as long as Enp3, apicalmost seta of Enp3 as long as apical spine. Enp3 and Exp3 with modified setae on.

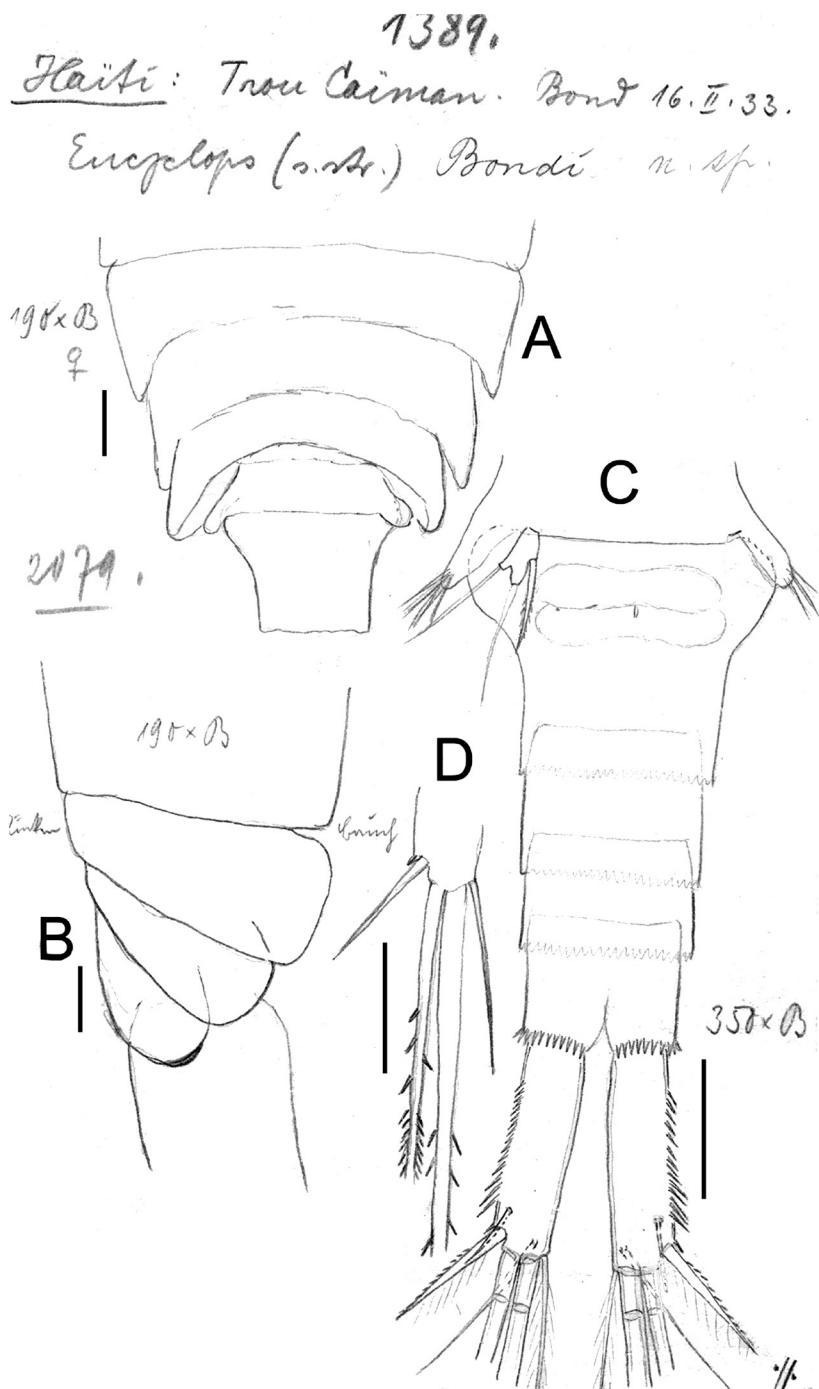
*Leg 4* (Figs 15A–B, 17D–F): Intercoxal sclerite with rows I, II and III. Row I with 7 strong spinules in each side and small gap in between. Row II with 16–18 spinules, row III with 14 strong spinules. Caudal coxal surface with spinule formula as: A, B (3), C+D (12), E (2), F, G (2), H, I. Inner spine of coxa with heteronomous setulation: basally with long hair-like setules, distally with spine-like setules; lateral edge of coxal spine naked. Enp3P4 length/width ratio 2.5; length ratio inner/outer spines of Enp3P4 = 1.6–1.8; length ratio inner spine in Enp3P4/Enp3P4 = 1.3; length ratio outer spines in Enp3P4/Enp3P4 = 0.7. Lateral seta in Enp3P4 inserted at 71% of segment length. Enp3 and Exp3 with normal setae.

*Leg 5* (Fig. 14C): Free segment subrectangular, 2 times longer than wide, with 1 inner spine and 2 setae; median seta as long as outer seta (1:1) but about 1.3 times longer than inner spine. Inner spine 1.6 times as long as segment.

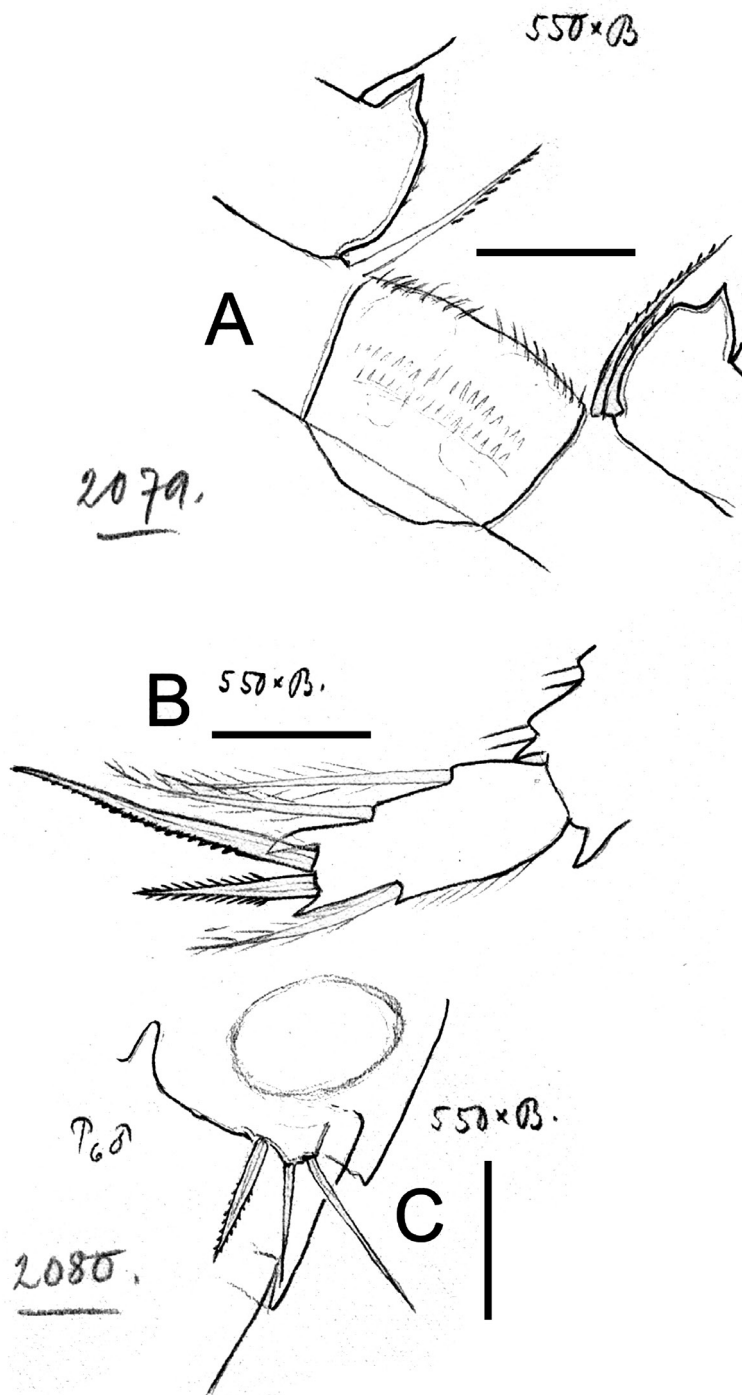
*Male*: Body length excluding caudal setae 580–600  $\mu\text{m}$ . Urosome 6-segmented, posterior margins of urosomites smooth. Caudal rami 2.6 times longer than wide; medial margin of caudal ramus naked, strong spines at insertion point of lateral caudal seta (II).

*Leg 6* (Fig. 15C): Represented by small, flat plate near lateral margin of genital double somite with 1 strong short inner spine and 2 unequal setae. Inner spine not reaching posterior margin of third urosomite. Inner spine about 0.7 times as long as outer seta and as long as median seta.

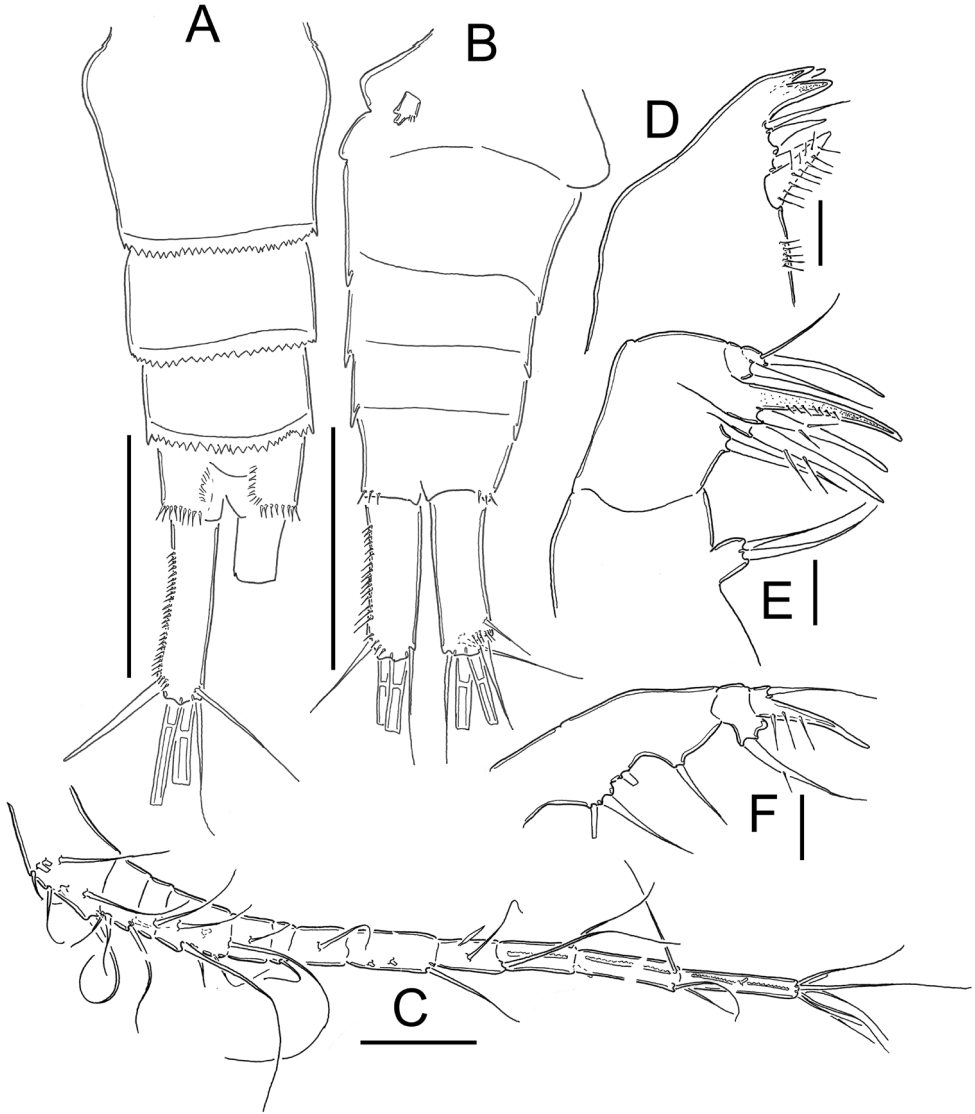




**Figure 14.** *Eucyclops bondi* Kiefer, 1934. Original drawings of F. Kiefer. Female Holotype from Trou Caiman, Haiti. **A** Prosome 2–5 and genital somite, dorsal view **B** Prosome 2–5, lateral view **C** Urosome, ventral view **D** Caudal setae of CR. Scale bars: **A–D** = 100  $\mu$ m.

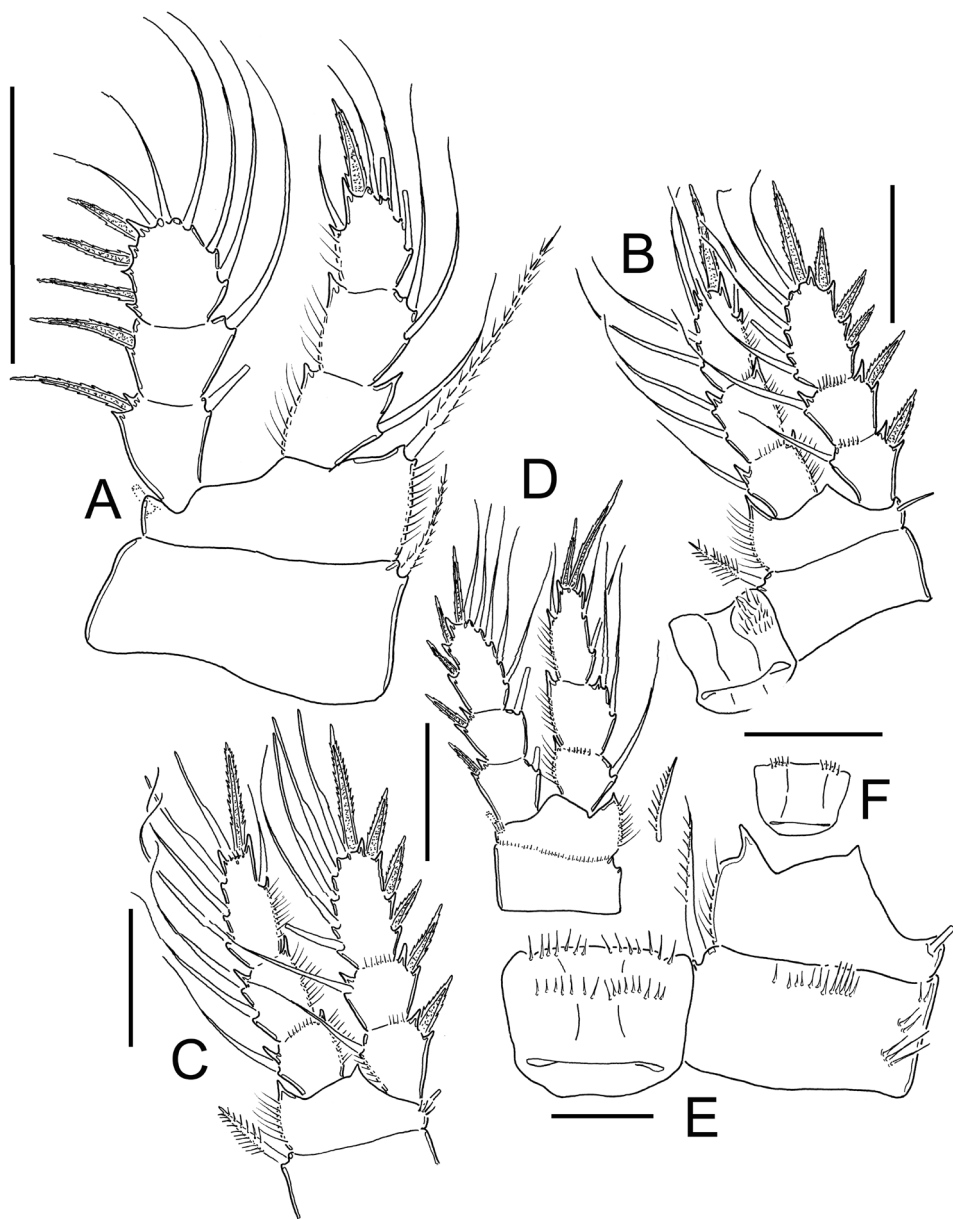


**Figure 15.** *Eucyclops bondi* Kiefer, 1934. Original drawings of F. Kiefer. Female Holotype **A–B** and male Paratype **C** from Trou Caiman, Haiti. **A** Intercoxal sclerite and coxal spines P4 **B** Enp3P4 **C** P6. Scale bars: A–C = 50  $\mu$ m.



**Figure 16.** *Eucyclops bondi* Kiefer, 1934. Authors' drawings. Female Holotype from Trou Caiman, Haiti. **A** Urosome, dorsal view **B** Urosome, ventral view **C** Antennule **D** Maxillule **E** Maxilla **F** Maxilliped. Scale bars: **A–B** = 100  $\mu\text{m}$ ; **C** = 50  $\mu\text{m}$ ; **D–F** = 20  $\mu\text{m}$ .

**Remarks.** After Kiefer's description (1934) of *E. bondi*, this species has been recorded from Colombia, Costa Rica, Cuba, Dominican Republic, Guatemala, Haiti, Mexico, Trinidad, and the USA (Florida) (Collado et al. 1984; Reid 1992; Suárez-Morales et al. 1996; Suárez-Morales and Reid 1998; Grimaldo-Ortega et al. 1998; Bruno et al. 2005; Dussart and Defaye 2006; Gaviria and Aranguren 2007; Elías-Gutiérrez et al. 2008; Mercado-Salas 2009; Suárez-Morales et al. 2010; Suárez-Mo-



**Figure 17.** *Eucyclops bondi* Kiefer, 1934. Authors' drawings. Female Holotype from Trou Caiman, Haiti. **A** P1 **B** P2 **C** P3 **D** P4 **E** P4, caudal surface **F** Intercoxal sclerite P4, frontal surface. Scale bars: **A–D**, **F** = 50 µm, **E** = 20µm.

rales and Walsh 2009; Mercado-Salas et al. 2012; Mercado-Salas and Suárez-Morales 2012). There are only a few records that include drawings of the main structures used in the identification of this species, thus allowing us to make some comparisons

and speculate about their status. The records of *E. bondi* from Costa Rica made by Collado et al. (1984) included drawings of both female and male specimens, and by comparing both sexes we conclude that the Costa- Rican records are not assignable to *E. bondi*. One of the main characteristics mentioned in Kiefer's description of this species is the particular shape and length of the three elements of the P6 in the males, where the inner spine is particularly short in comparison with the outer seta, a characteristic that separates this species from other congeners such as *E. delachauxi*, *E. prionophorus* and *E. pseudoensifer*. The specimens depicted in Collado et al. (1984) show an inner spine which is at least twice as long as the outer seta, thus diverging from *E. bondi*. The comparison of structures present in the males has been useful to separate species of other Eucyclopinae, especially in *Paracyclops* (Karaytug 1999, Karaytug and Boxshall 1999). So, the inclusion of male characters, such as the structure and armature of P6 and the presence of aesthetascs and modified setae on the male antennules appears to be a valuable tool in the separation of the species of *Eucyclops*. Such characters should be incorporated in the current taxonomy of the genus. In Mexico there are more than 70 records of *E. bondi* (Suárez-Morales et al. 1996; Grimaldo-Ortega et al. 1998; Suárez-Morales and Reid 1998; Elías-Gutiérrez et al. 2008; Mercado-Salas 2009; Suárez-Morales and Walsh 2009; Mercado-Salas and Suárez-Morales 2012; Gutiérrez-Aguirre and Cervantes-Martínez 2013). In order to clarify the taxonomic status of these specimens we reviewed most of the Mexican records and we can only confirm the presence of a similar form of the male of *E. bondi* in a single locality in the central state of Aguascalientes that we will discuss in a forthcoming paper about the Mexican fauna of *Eucyclops*. The remaining records should be revised and it is probable that many will have to be reassigned to different species. *Eucyclops tziscao*, a species from southeast Mexico that is closely related to *E. bondi*, was described recently; this could represent one of the species to which some of the Mexican records of *E. bondi* could be assigned (Gutiérrez-Aguirre et al. 2013). Other records of *E. bondi* from the Americas that included drawings, but only of the females, are by Reid (1992), Suárez-Morales et al. (1996), Grimaldo-Ortega et al. (1998), and Elías-Gutiérrez et al. (2008). We looked for the main characteristics of the species in the drawings and concluded that the only record safely assignable to *E. bondi* is the one by Reid (1992) from Florida, but we consider that the male should be reviewed in order to confirm the species. In our opinion, the other records (Suárez-Morales et al. 1996; Grimaldo-Ortega et al. 1998; Elías-Gutiérrez et al. 2008) do not belong to *E. bondi* because some important differences were found. For instance, the dorsal seta in *E. bondi* is always longer than the outermost caudal seta, while in all other records from Mexico this seta presents an opposite condition, a dorsal seta shorter than the outermost caudal seta. We also detected additional differences, such as the presence of modified setae on the endopod and exopod of the fourth swimming leg in Grimaldo-Ortega et al. (1998) and the presence of hair-like spinules on the distal margin of the intercoxal sclerite, while the true *E. bondi* has spines on its distal margin.

***Eucyclops leptacanthus* Kiefer, 1956**

Figs 18–21

*Eucyclops leptacanthus*, Kiefer 1956

*Eucyclops* cf. *leptacanthus*, Reid 1993

*Eucyclops leptacanthus*, Mercado-Salas 2009

**Kiefer's description.**

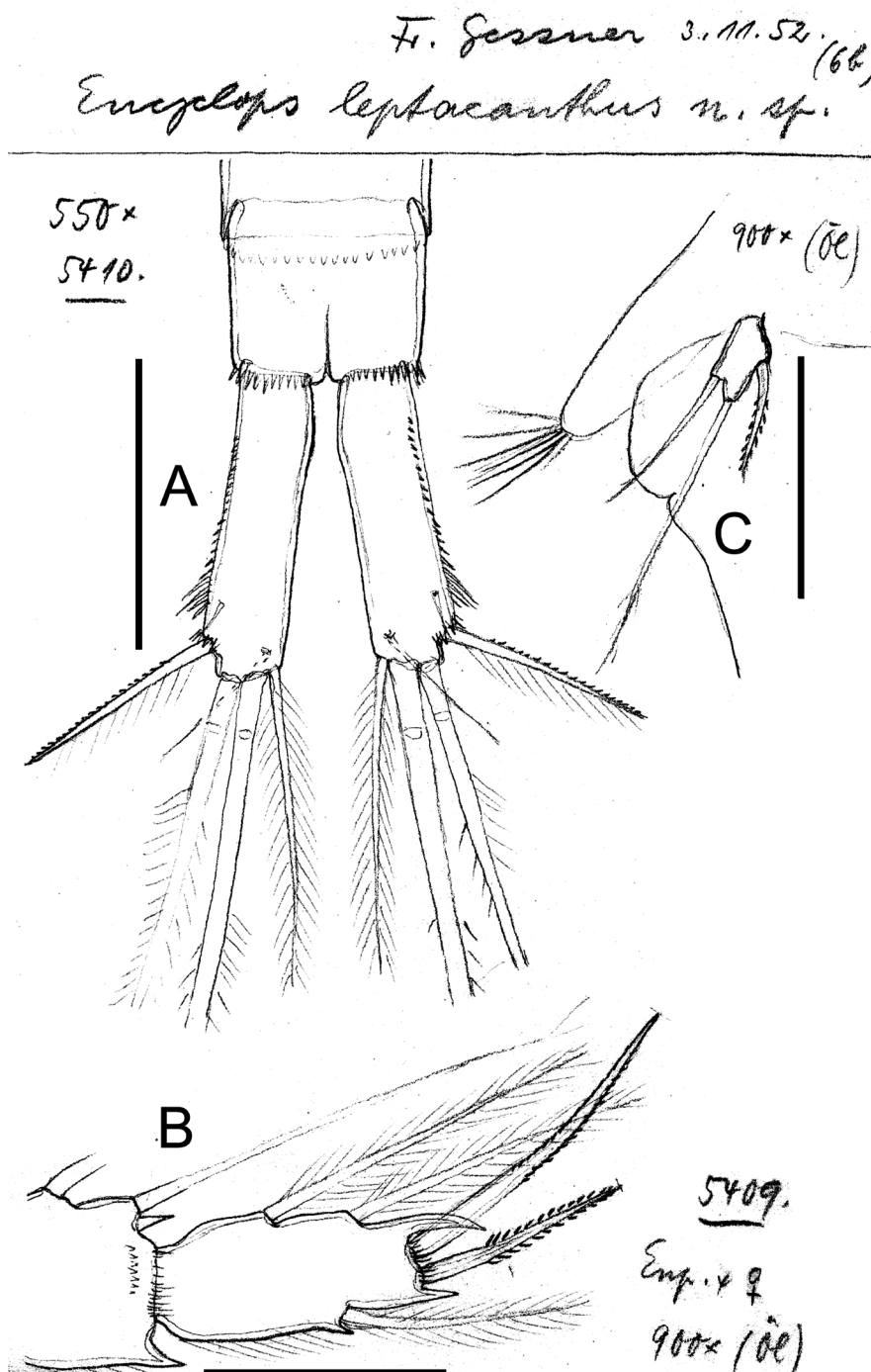
Total length of the single female found 0.76 mm, excluding caudal setae. The caudal ramus exactly four times as long as wide ( $82.5\mu$ :  $20.5\mu$ ). Position and shape of the two rami can be seen in Fig 25. Inner margin is naked, outer margin provided with a "serra", extending along almost the entire length of ramus, proximal spinules very small, very long spinules at the height of insertion of lateral seta, practically setiform. Measurements of setae of caudal rami from the innermost to outermost:  $80\mu$ ,  $356\mu$ ,  $198\mu$ ,  $60\mu$ , length of dorsal seta about  $45$ – $50\mu$ ; the ratio, based on the outermost terminal seta, is therefore 1.33: 5.93: 3.30: 1 (0.8). The two longest setae are quite weak and heteronomously plumose (Fig. 25).

Twelve-segmented antennules, margin of last three segments with a narrow hyaline membrane, margin of membrane finely denticulated (Fig. 26). Segmentation and setation of the swimming legs as usual, the final segment of the Enp of fourth leg with a length/width:  $44.5\mu$ :  $20.5\mu$  = 2.17. Inner apical spine about  $55\mu$ – $56\mu$ , notably longer than the length of segment and significantly longer than the outer spine which measures  $35\mu$  (Fig. 28). Segment of rudimentary leg elongated and bearing small and slender inner spine (Fig. 29). The seminal receptacle was not perceptible.

The male has not yet been found.

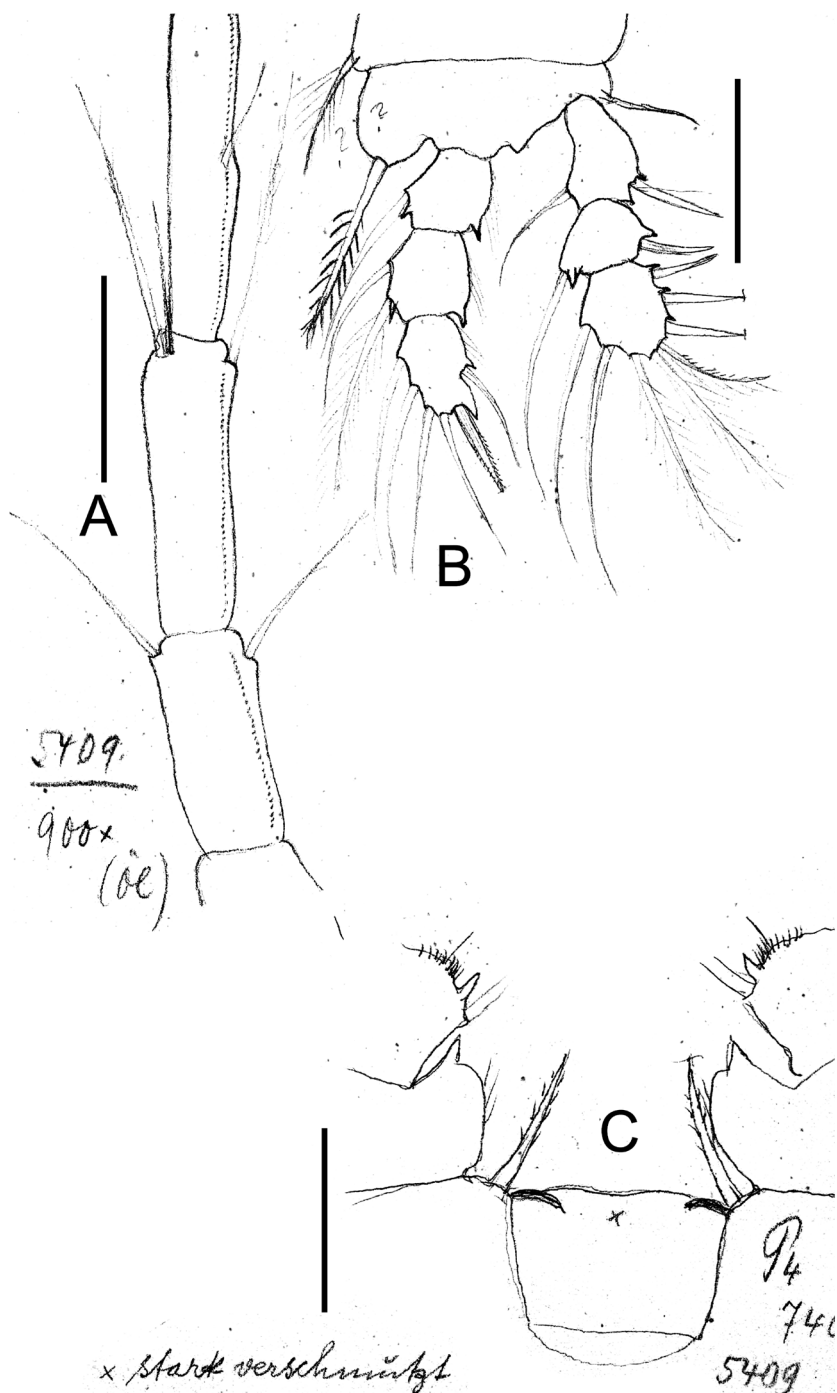
**Systematic position.** in the complex genus *Eucyclops*, where many forms exist that are similar to the single female specimen found here, a new species can only be established when the new form is distinguished by unique characteristics. The specimen of *Eucyclops* herein described possesses a well-developed *serra* on the caudal rami, a rudimentary leg with a slender inner spine, long apical spines on the last segment of endopod of fourth leg, as well as a finely denticulate hyaline membrane on the three last segments of the antennule, a combination of characters that I have not seen in any of the known *Eucyclops* species. For this reason I considered it as a new species and named as *Eucyclops leptacanthus* because of its slender spines on the fifth and fourth legs.

In the sample 10e I did find another *Eucyclops*-female. The hyaline membrane on the last segments of the antennules is equally finely denticulate; the *serra* on the caudal rami is not particularly remarkable, the inner spine of rudimentary leg is thicker, and the apical spine of the last segment of the endopodite of the fourth leg is wider than that in the above described species. This specimen must remain undetermined because of the few characters that could be seen. The same holds true in the two *Eucyclops* males from sample 11.

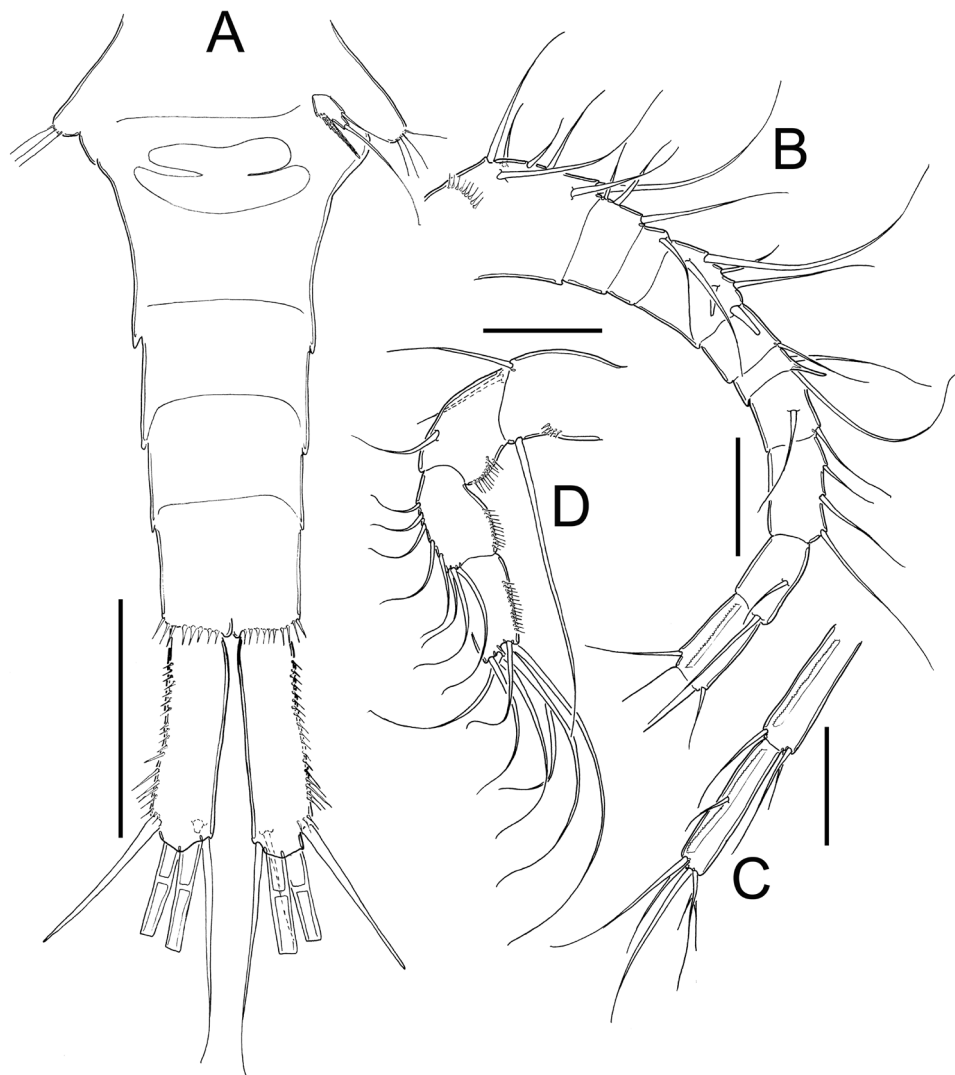


**Figure 18.** *Eucyclops leptacanthus* Kiefer, 1956. Original drawings of F. Kiefer. Female Holotype (two preparations same specimen) from Lake Orinoco, Venezuela. **A** Caudal rami **B** Enp3P4 **C** P5. Scale bars: A = 100  $\mu$ m; B–C = 50  $\mu$ m.





**Figure 19.** *Eucyclops leptacanthus* Kiefer, 1956. Original drawings of F. Kiefer. Holotype (two preparations same specimen) from Lake Orinoco, Venezuela. **A** Last segments of antennule **B** P1 **C** Intercoxal sclerite P4. Scale bars: **A–C** = 50  $\mu$ m.

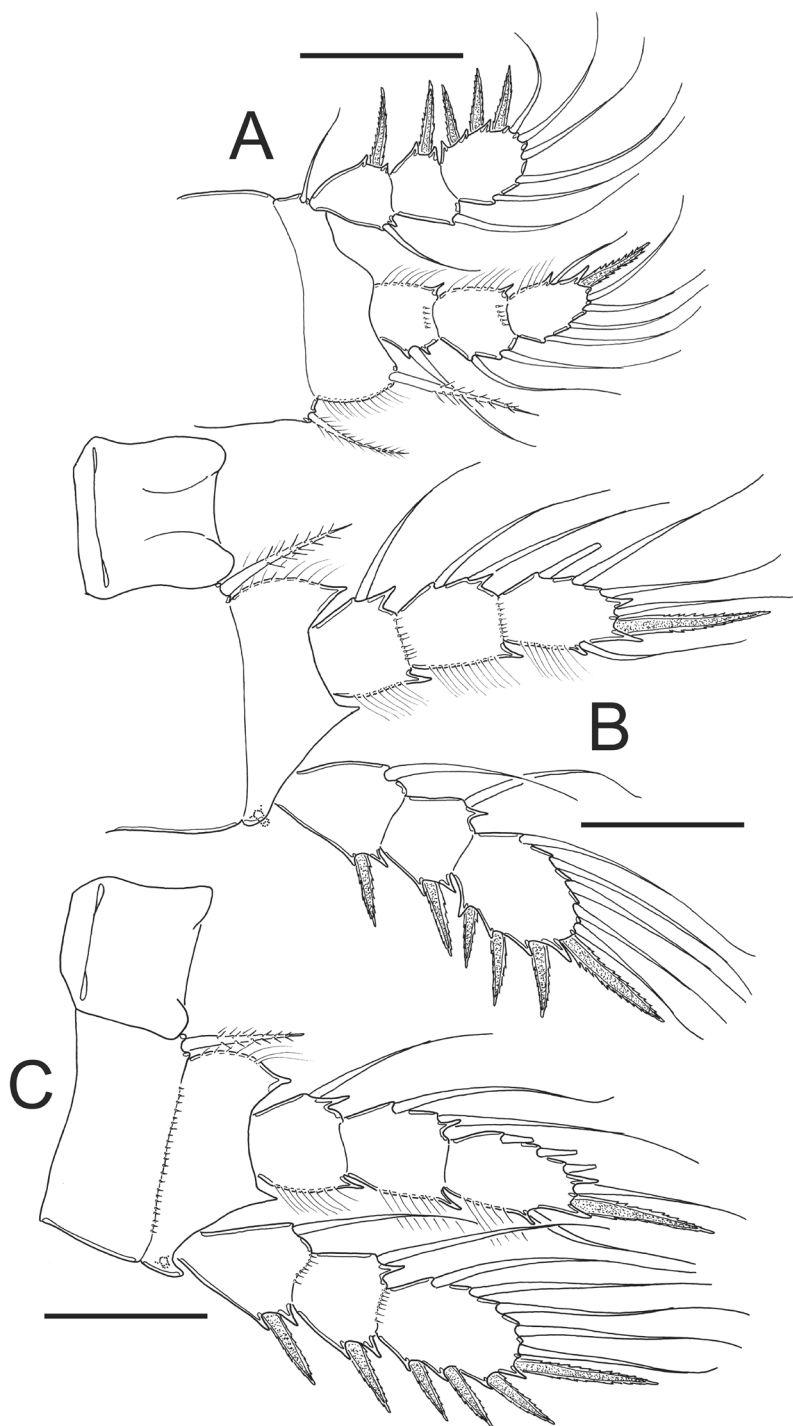


**Figure 20.** *Eucyclops leptacanthus* Kiefer, 1956. Authors' drawings. Female Holotype from Lake Orinoco, Venezuela. **A** Urosome, ventral view **B** Antennule, segments 1–10 **C** Antennule, segments 11–12 **D** Antenna. Scale bars: **A** = 100 µm, **B–D** = 50µm.

#### Description based on Kiefer's material.

**Material examined.** Holotype. Adult ♀ collected 03.11.1952 from Lake Orinoco, Barrancas, Venezuela (slides reference numbers SMNK05409, SMNK05410). Staatliches Museum für Naturkunde Karlsruhe, Germany.

*Female:* Body length of holotype, excluding caudal setae, 760 µm. Urosome 5-segmented (Fig. 20A): relatively elongate; urosomal fringes smooth or weakly serrated. Genital double-somite symmetrical. Seminal receptacle typical of *serrulatus*-group,



**Figure 21.** *Eucyclops leptacanthus* Kiefer, 1956. Authors' drawings. Female Holotype from Lake Orinoco, Venezuela. **A** P1 **B** P2 **C** P3. Scale bars: A–C = 50  $\mu$ m.

with rounded, lateral arms in posterior margin. Genital double somite about 1.3 times longer than wide. Length/width ratio of caudal ramus = 3.9–4.0; inner margin of caudal ramus naked; outer margin with strong spinules covering 63–64% of segment length, spinules distally increase in size (Figs 18A, 20A). Dorsal seta (VII) short, 0.5 times of length of caudal ramus, and 0.7 times as long as outermost caudal seta (III). Ratio of innermost caudal seta (VI)/outermost caudal seta (III) = 1.3–1.4. Lateral caudal seta (II) inserted at 74% of caudal rami. All terminal caudal setae plumose.

*Antennule* (Figs 19A, 20B–C): 12-segmented. Armament per segment as follows (s = seta, ae = aesthetasc, sp = spine): **1**(7s), **2**(3s), **3**(1s), 4(6s), **5**(1s), 6 (1s+1sp), 7(2s), 8(3s), **9**(2s), 10(2s), 11(3s), **12**(7s). Numbers in boldface indicate segments with incomplete ornamentation.

*Antenna* (Fig. 20D): Basis (2s + Exp), 3-segmented End (1s, 8s and 7s). Only row N17 was observable on basis of the holotype.

*Mouthparts*: not observable in the slide.

*P1–P4*: Endopods and exopods of all swimming legs three-segmented. Armature formula of all swimming legs as in Table 1.

*Leg 1* (Figs 19B, 21A): Coxa with strong, biserially setulated inner coxal seta. Basipodal spine not reaching middle of Enp3; and 0.7 times as long as endopodal ramus. Enp3 1.4–1.7 times as long as wide, apical spine of Enp3 as long as segment Enp3 (1:1), apicalmost seta of Enp3 1.5–1.8 times longer than apical spine.

*Leg 2* (Fig. 21B): No ornamentation observed on intercoxal sclerite, distal margin with 2 rounded projections. Coxa with strong, biserially setulated inner coxal seta. Enp3 1.6 times longer than wide, apical spine on Enp3 1.3 times as long as segment, Exp3 2.2 times as long as wide, apical spines of Exp3 0.9 times as long as segment. No modified setae were observed.

*Leg 3* (Fig. 21C): No cuticular ornamentation was observed on intercoxal sclerite, distal margin with 2 rounded projections. Coxa with strong, biserially setulated inner coxal seta. Enp3 2.0 times longer than wide, apical spine on Enp3 1.1 times as long as segment, apical seta of Enp3 1.2 times as long as apical spine. Exp3 1.9 times as long as wide, apical spine of Exp3 as long as segment (1:1). No modified setae observed.

*Leg. 4* (Figs 18B, 19C): Intercoxal sclerite could not be clearly observed. Inner coxal spine with heteronomous setulation: basally with long hairs yet distally with spinules; lateral edge of inner coxal spine with 2 apical spine-like setules, proximal surface naked. Length/width ratio Enp3P4 = 2.3; length ratio inner/outer spines of Enp3P4 = 1.5; length ratio inner spine of Enp3P4/Enp3P4 = 1.3; length ratio outer spine of Enp3P4/Enp3P4 = 0.8–0.9. Lateral seta of Enp3P4 inserted at 67–70% of total length of segment. No modified setae were observed.

*Leg 5* (Figs 18C, 20A): Free segment subrectangular, 1.8 times as long as wide bearing 1 inner spine and 2 setae; median seta longer than outer seta (about 1.8 times) and inner spine (about 2.6 times). Inner spine noticeably slender, 1.3 times as long as segment.

**Remarks.** *Eucyclops leptacanthus* is another species described by Kiefer (1956) that has been recorded from Mexico. Additional American records are from Costa

Rica, Venezuela and Brazil (Rocha and Botelho 1998; Gutiérrez-Aguirre and Suárez-Morales 2001; Suárez-Morales 2004; Elías-Gutiérrez et al. 2008; Mercado-Salas 2009). This species is distinguished from the American congeners by the possession of a very slender spine on the female fifth leg and unmodified setae on P1–P4, the setae and spines of P1–P4 are relatively longer and narrower than in other species. Another characteristic of *E. leptacanthus* is the remarkably long innermost caudal seta, it is 1.3–1.4 times longer than outermost caudal seta and as long or slightly shorter than length of caudal ramus. In addition, the basipodal seta is distinctive in this species; when compared to some related species, it is short, reaching the proximal margin of P1 Enp3 whereas this seta reaches at least the middle of this segment in most American species of *Eucyclops*. A character that we couldn't examine in the type material was the ornamentation of the P4 intercoxal sclerite because, as Kiefer stated on his drawings (Fig. 19C), the structure was very dirty. Nonetheless, we did note that differing from other species the plate was expanded horizontally, clearly wider than long. From the drawings presented by Collado et al. (1984), the Costa Rican specimens seem to agree with Kiefer's description, but some differences have been detected. The fifth leg presents an outer seta that is only slightly shorter than the median seta, while in Kiefer's description the outer seta is clearly shorter than the median seta. Also, the individuals from Costa Rica have short setae on Enp3 of P4, whereas these setae are long and slender in the type material (as mentioned above). The rest of the records from America did not include drawings that would allow further comparisons.

## Discussion

Among the 108 species and subspecies currently known in the genus *Eucyclops*, 28 are distributed in the Americas, most of the records in the continent are from surveys in the Eastern United States, Mexico, Argentina and Brazil (Reid 1985; Suárez-Morales 2004; Bruno et al. 2005; Frisch and Threlkeld 2005; Alekseev et al. 2006; Gaviria and Aranguren 2007; Elías-Gutiérrez et al. 2008; Suárez-Morales and Walsh 2009; Mercado-Salas 2009; Suárez-Morales et al. 2010; De los Ríos et al. 2010; Mercado-Salas et al. 2012). Due to its diversification in different geographic regions and the taxonomical problems within the genus, it is likely that the fauna of *Eucyclops* in the Americas has been underestimated. Our analysis of the records of four of the 28 species recorded in the Americas revealed that many published records of these species are actually not assignable to these species and should be compared and re-checked using upgraded descriptive standards in order to clarify their taxonomic and biogeographic status. In addition, if we consider that about 40% of the records in the continent have been assigned to taxonomically complex and widely distributed taxa such as *E. serrulatus*, *E. agilis*, and *E. speratus*, we can have a general idea about how the diversity of the genus is underestimated in the Americas.

## Acknowledgments

We gratefully acknowledge the support and confidence from Dr. Hans Walter Mittmann, Staatliches Museum Für Naturkunde, Karlsruhe, Germany in allowing us to examine the type material of the species included in the present work. He also granted permission to include the unpublished original drawings by F. Kiefer in this work. We also acknowledge the help, time and patience of Jörg Pertzel and Gerald Islebe in translating the original descriptions of the species from German to English. This work is part of the first author's (NFM-S) Doctoral Thesis developed at El Colegio de la Frontera Sur (ECOSUR). This contribution was supported by CONACyT project 133404-Investigación Científica Básica 2009. The comments and suggestions of two anonymous reviewers and the ZooKeys editor of Copepoda are deeply appreciated.

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# Two new species of yellow-shouldered bats, genus *Sturnira* Gray, 1842 (Chiroptera, Phyllostomidae) from Costa Rica, Panama and western Ecuador

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Academic editor: D. Reeder | Received 11 February 2014 | Accepted 2 April 2014 | Published 15 April 2014

<http://zoobank.org/55362CF7-837E-4183-A879-5A1D14FF2A9E>

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**Citation:** Velazco PM, Patterson BD (2014) Two new species of yellow-shouldered bats, genus *Sturnira* Gray, 1842 (Chiroptera, Phyllostomidae) from Costa Rica, Panama and western Ecuador. ZooKeys 402: 43–66. doi: 10.3897/zookeys.402.7228

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## Abstract

Two new species of yellow-shouldered bats *Sturnira* Gray, 1842 (Chiroptera, Phyllostomidae) from Central America and western South America are described using molecular and morphological data. The two new species, which occur in Costa Rica and Panama and in western Ecuador, were previously confused with *S. ludovici*, and *S. lilium* and *S. luisi*, respectively. *Sturnira* now includes 22 described species, making it the most speciose genus in the Neotropical family Phyllostomidae.

## Keywords

Neotropics, Stenodermatinae, *Sturnira bakeri*, *Sturnira burtonlimi*, Systematics, Taxonomy

## Introduction

The genus *Sturnira* Gray, 1842 (Phyllostomidae, Stenodermatinae) includes at least 23 monophyletic clades of frugivorous bats that are all endemic to the Neotropics. Their collective geographic range extends from Mexico and Lesser Antilles to northern Argentina (Velazco and Patterson 2013). The genus includes small to large (10–68 g) bats found primarily in tropical lowland and montane forest from sea level to at least 3,600 m, but the greatest diversity in the genus occurs on the forested slopes of the Andes where at least 11 species occur (Koopman 1978, Gardner 2008, Velazco and Patterson 2013).

Like other phyllostomid genera (i.e., *Carollia* [Solari and Baker 2006, Pacheco et al. 2004, Velazco 2013] and *Platyrrhinus* [Velazco 2005, Velazco and Patterson 2008, Velazco et al. 2010]), the diversity of *Sturnira* has grown substantially from recent revisionary studies (Iudica 2000, McCarthy et al. 2006, Velazco and Patterson 2013). Only 14 species were recognized in *Sturnira* in the last world checklist (Simmons 2005), but since then, three new species have been described, *S. koopmanhilli* McCarthy et al., 2006, *S. perla* Jarrín-V & Kunz, 2011, and *S. soriano* Sánchez-Hernández et al., 2005. In addition, a molecular phylogeny of the genus (Velazco and Patterson 2013) uncovered three lineages that do not correspond to any of the species described to date—these were referenced as *Sturnira* new species 1, 2, and 3 (sensu Velazco and Patterson 2013). The first of these new taxa, *S. new species 1*, occurs in Costa Rica and Panama and belongs to a clade that also includes *S. hondurensis*, *S. ludovici*, and *S. oporaphilum*. The second, *S. new species 2*, occurs in western Ecuador and is the sister species of *S. parvidens*. The third, *S. new species 3*, is one of the most widely distributed species in the genus. Found in eastern Ecuador, eastern Peru, Venezuela, Guyana, Suriname, French Guiana, and Trinidad and Tobago, it belongs to a clade that also includes *S. angeli*, *S. luisi*, and *S. paulsoni* and has long been confused with *S. lilium*. Here we describe two—*S. new species 1* and 2—of the three new species uncovered by the analyses of Velazco and Patterson (2013).

## Methods

Guided by the phylogenetic studies of Velazco and Patterson (2013), we describe in this report *Sturnira* new species 1 and 2 (sensu Velazco and Patterson 2013), and compare them to the most closely related and sympatric species. External and osteological characters examined were based on, but not restricted to, those defined by Pacheco and Patterson (1992) and Iudica (2000). We follow Miller (1907) in assigning homology for the premolars: 1st upper premolar (P3), 2nd upper premolar (P4), 1st lower premolar (p2), 2nd lower premolar (p4).

The specimens examined by this study and tissues used by the study of Velazco and Patterson (2013) are deposited in the following Recent mammal collections:

AMNH	American Museum of Natural History, New York, New York.
CM	Carnegie Museum of Natural History, Pittsburgh, Pennsylvania

<b>FMNH</b>	Field Museum of Natural History, Chicago, Illinois
<b>LSUMZ</b>	Museum of Natural Science, Louisiana State University, Baton Rouge, Louisiana
<b>MSB</b>	Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico
<b>MUSM</b>	Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima, Peru
<b>MVZ</b>	Museum of Vertebrate Zoology, University of California, Berkeley, California
<b>QCAZ</b>	Museo de Zoología of the Pontificia Universidad Católica del Ecuador, Quito, Ecuador
<b>ROM</b>	Royal Ontario Museum, Toronto, Ontario, Canada
<b>TTU (TK)</b>	Museum of Texas Tech University, Lubbock, Texas
<b>USNM</b>	National Museum of Natural History (formerly the U.S. National Museum), Smithsonian Institution, Washington, D.C.

We examined 62 adult specimens of *Sturnira* representing 8 species of *Sturnira*: 3 specimens of *S. bakeri*, 8 of *S. hondurensis*, 3 of *S. burtonlimi*, 3 of *S. ludovici*, 8 of *S. luisi*, 7 of *S. mordax*, 11 of *S. oporaphilum*, and 19 of *S. parvidens* (see Appendix for complete specimen data). All linear measurements are given in millimeters (mm), weights in grams (g). Standard external measurements (total length, hind foot length, ear length) are those recorded on the specimen labels. We used digital calipers to take one external and 11 craniodental measurements to the nearest 0.01 mm on each specimen (Figure 1). Descriptive statistics (mean and observed range) were calculated for all samples. The craniodental, mandibular, and external measurements used in this study were:

**Forearm length (FA):** Distance from the elbow (tip of the olecranon process) to the wrist (including the carpals). This measurement was made with the wing at least partially folded.

**Greatest length of skull (GLS):** Distance from the posteriormost point on the occiput to the anteriormost point on the premaxilla (excluding the incisors).

**Condylolincisive length (CIL):** Distance between a line connecting the posteriormost margins of the occipital condyles and the anteriormost point on the upper incisors.

**Condyllocanine length (CCL):** Distance between a line connecting the posteriormost margins of the occipital condyles and a line connecting the anteriormost surface of the upper canines.

**Postorbital breadth (PB):** Least breadth at the postorbital constriction.

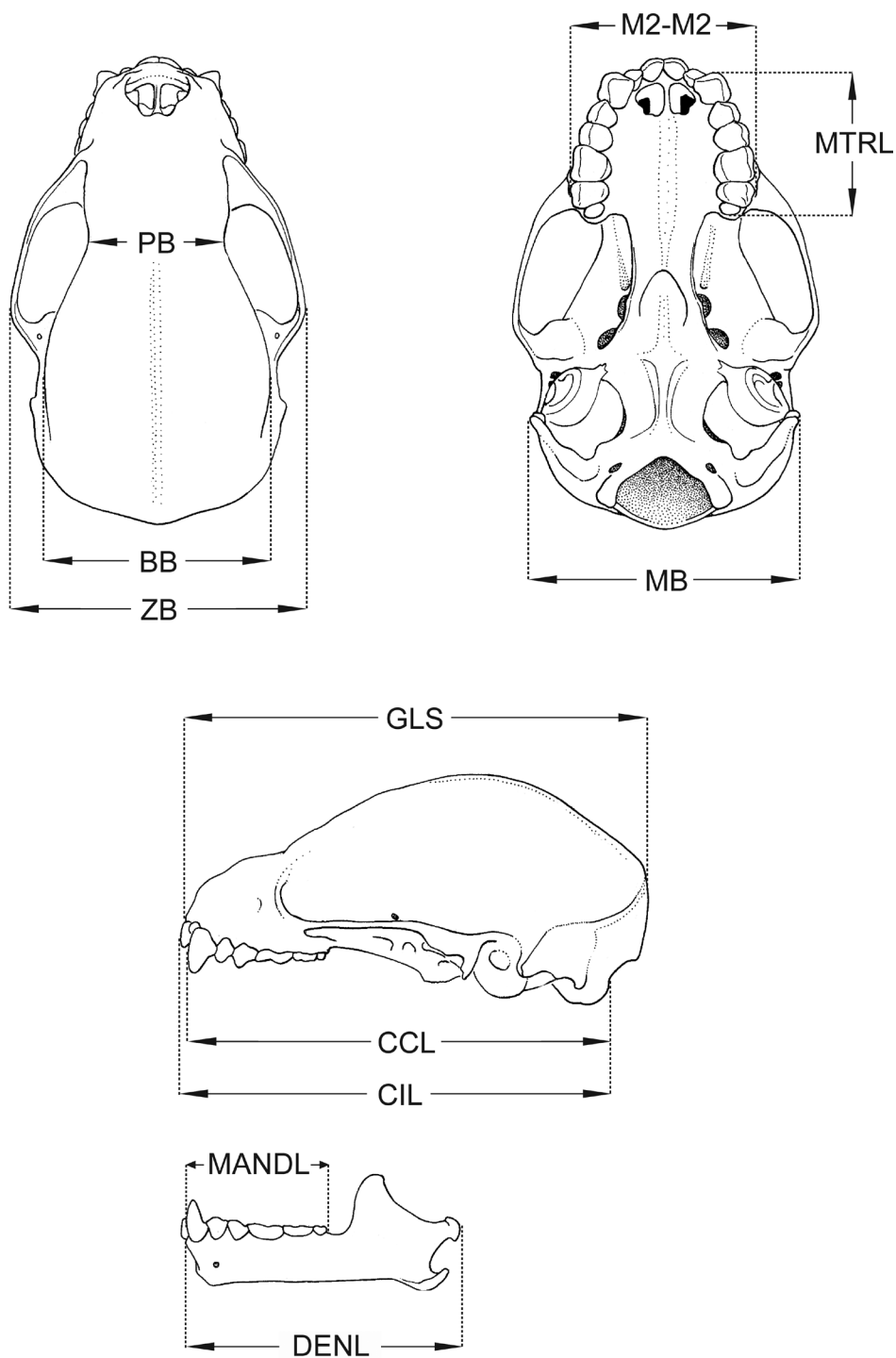
**Braincase breadth (BB):** Greatest breadth of the globular part of the braincase, excluding mastoid and paraoccipital processes.

**Mastoid breadth (MB):** Greatest breadth across the mastoid region.

**Zygomatic breadth (ZB):** Greatest breadth across the zygomatic arches.

**Maxillary toothrow length (MTRL):** Distance from the anteriormost surface of the upper canine to the posteriormost surface of the crown of M3.

**Width at M2 (M2–M2):** Greatest width of palate across labial margins of the alveoli of M2s.



**Figure 1.** Dorsal and ventral views of the cranium and lateral view of the cranium and mandible illustrating the measurements used in the description. For definitions of abbreviations see Methods.



**Dentary length (DENL):** Distance from midpoint of condyle to the anteriormost point of the dentary.

**Mandibular tooththrow length (MANDL):** Distance from the anteriormost surface of the lower canine to the posteriormost surface of m3.

## Taxonomy

**Family Phyllostomidae Gray, 1825**

**Subfamily Stenodermatinae Gervais, 1856**

**Genus *Sturnira* Gray, 1842**

***Sturnira bakeri* sp. n.**

<http://zoobank.org/1F5CCFAE-60C4-41F4-B0E9-904683866863>

[http://species-id.net/wiki/Sturnira\\_bakeri](http://species-id.net/wiki/Sturnira_bakeri)

Baker's Yellow-shouldered Bat

**Synonymy.** *Sturnira lilium*: Carrera et al. 2010:18 (part)

*Sturnira luisi*: Carrera et al. 2010:18 (part)

*S[turnira]*. new species 2: Velazco and Patterson 2013: 687

**Holotype.** Adult female, deposited at the Museo de Zoología of the Pontificia Universidad Católica del Ecuador (QCAZ 14635), collected on 16 July 2004 by J. Sebastián Tello (original field number JST 487). The body is preserved in alcohol with the skull removed and cleaned. The body and skull are in good condition. Frozen tissues are deposited at Texas Tech University (TK 135127).

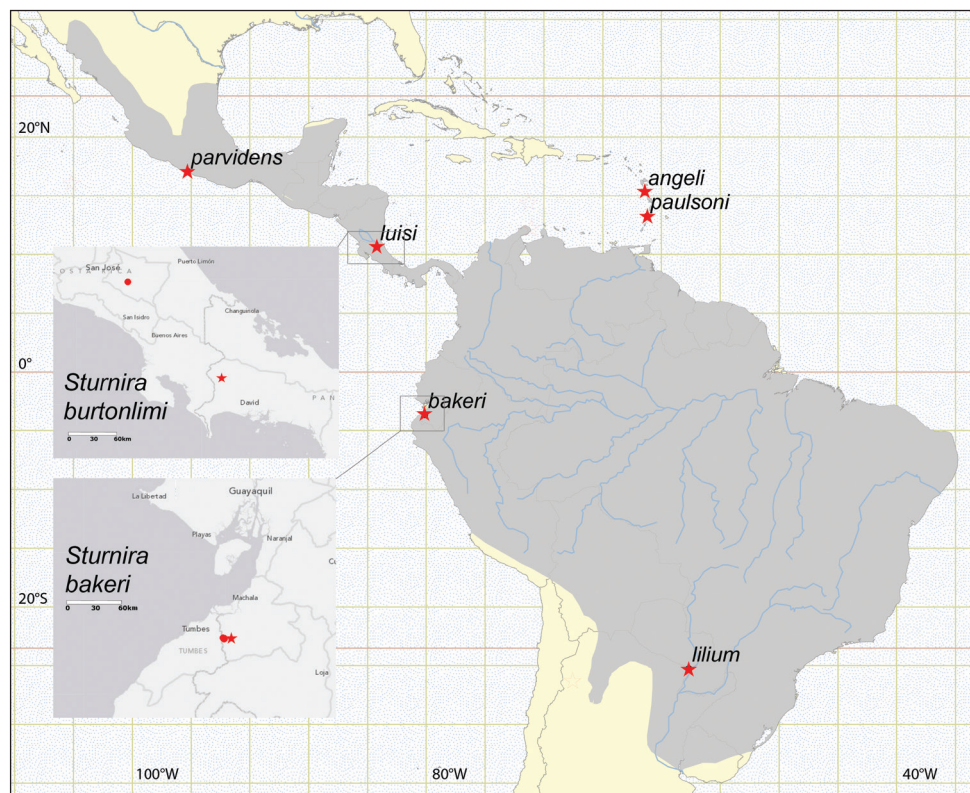
**Type locality.** Palmale, Reserva Militar Arenillas, El Oro, Ecuador, approximately 3°40'27.4"S, 80°06'20"W, 49 m (Figure 2).

**Paratypes.** An adult female (QCAZ 9737) caught by Peter A. Larsen (original field number PAL 92) and an adult male (QCAZ 9739) caught by Peter A. Larsen (original field number PAL 93), both collected on 16 July 2004 at Quebrada Seca, Fuerte Militar Arenillas (7.1 km W and 12.5 km S of the Military Base), El Oro, Ecuador, approximately 3°39'24.1"S, 80°10'56.2"W, 43 m (Figure 2). Both paratypes are preserved in alcohol. Frozen tissues are deposited at Texas Tech University (TK 135040 and TK 135051 respectively).

**Distribution.** *Sturnira bakeri* is known from only the two localities in southwestern Ecuador represented by the hypodigm (Figure 2, Appendix). Their proximity to the Peruvian border opens the possibility that *S. bakeri* is also present in northwestern Peru.

**Etymology.** The name *bakeri* honors our friend Dr. Robert J. Baker, who has made enormous contributions to our understanding of bats, particularly to the evolution of Neotropical phyllostomids. Robert's numerous contributions, both to the literature and to scientific discourse, and his productive and generous mentoring of students make him a professional paragon for each of us.

**Measurements.** External and craniodental measurements are presented in Table 1.



**Figure 2.** Map of Central and South America, showing the combined distribution range of species formerly ascribed to *Sturnira lilium* (gray tone) and the type localities (stars) of species in the *S. lilium* complex. The localities where *S. burtonlimi* (top inset) and *Sturnira bakeri* (bottom inset) occur are also shown; type localities are represented by a star and paratypes with circles. Note that *S. burtonlimi* and *S. luisi* occur in sympatry.

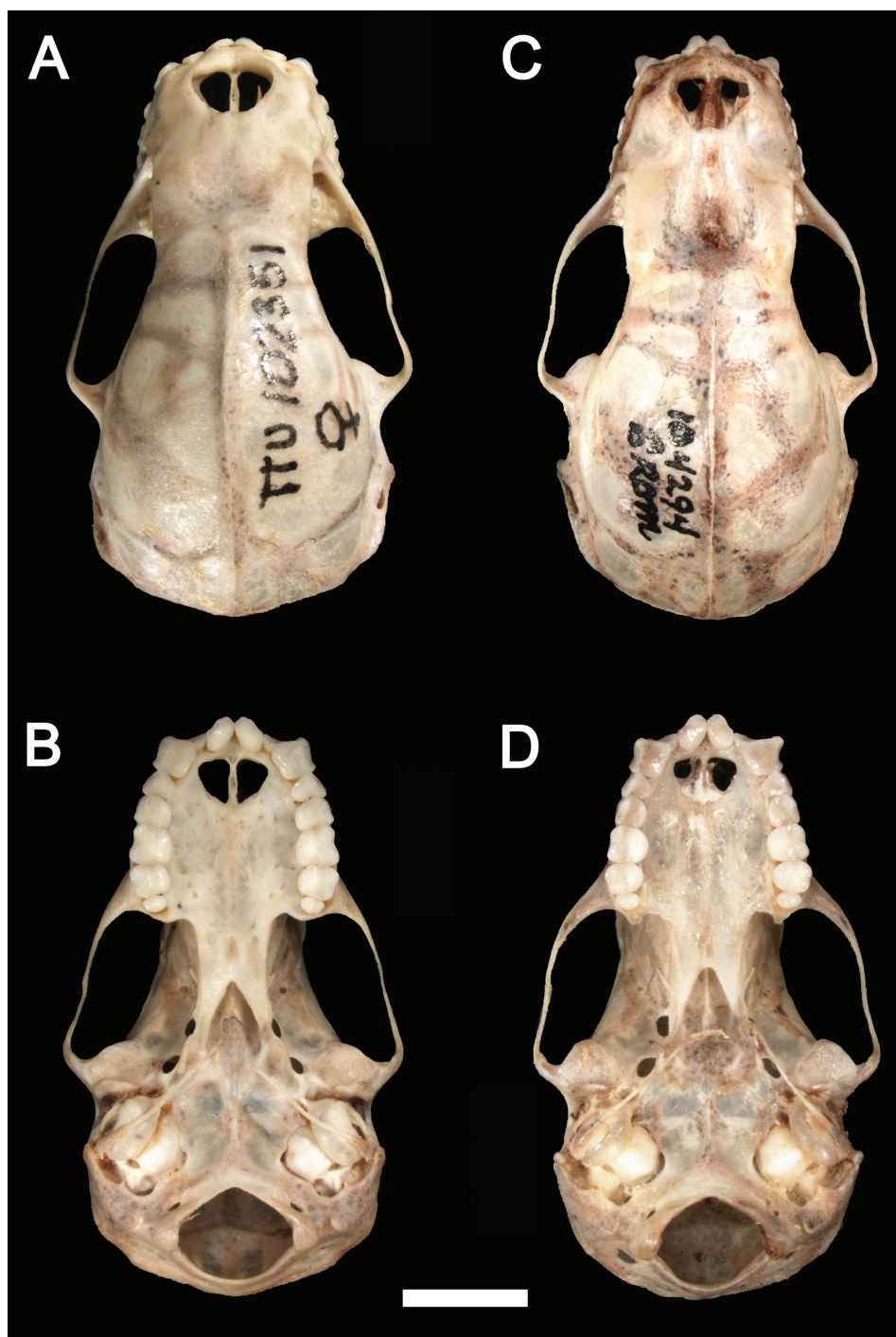
**Diagnosis and description.** *Sturnira bakeri* is a medium-size yellow-shouldered bat (FA 43.0–45.0 mm; GLS 22.7 mm; CIL 21.1 mm; Table 1) with a slender rostrum and a globular braincase (Figures 3–4). The dorsal fur is pale brown. Dorsal hairs are tetracolored with a short, whitish base (approximately 10% of the length of each hair), a long, pale brown band (approximately 40% of each hair), a long, pale gray band (approximately 40% of each hair), and a short dark brown terminal band (approximately 10% of each hair). The ventral fur is pale gray. Ventral hairs are tricolored with a short, pale gray base (approximately 10% of each hair), a long, pale brown subterminal band (approximately 45% of each hair), and a long, pale gray terminal band (approximately 45% of each hair). The fur is short and woolly, approximately 5 mm long between the shoulders and 5 mm on the chest. The proximal portion of the forearm (roughly 50% of the shaft just distal to the elbow) is sparsely furred with short hairs. The wing membranes are dark brown. The dorsal surfaces of the femur, tibia, and feet are densely covered with long hairs. The IV metacarpal is shorter than the III metacarpal.

**Table 1.** Measurements (mm) and weights (g) of the type series of *Sturnira bakeri* and *S. burtonlimi*.

	<i>Sturnira bakeri</i>			<i>Sturnira burtonlimi</i>	
	Holotype QCAZ 14635 ♀	Paratype QCAZ 9737 ♀	Paratype QCAZ 9739 ♂	Holotype ROM 104294 ♂	Paratype ROM 104295 ♂
Greatest length of skull	22.7	–	–	22.7	22.8
Condylolincisive length	21.1	–	–	21.5	20.8
Condyllocanine length	20.3	–	–	20.6	20.0
Braincase breadth	10.4	–	–	10.5	10.4
Zygomatic breadth	13.5	–	–	13.6	13.5
Postorbital breadth	5.9	–	–	6.5	6.3
Mastoid breadth	11.9	–	–	12.1	11.8
Maxillary toothrow length	6.9	–	–	6.8	6.6
Width at M2	8.3	–	–	8.2	8.1
Dentary length	15.0	–	–	14.9	14.6
Mandibular toothrow length	7.7	–	–	7.6	7.4
Forearm length	45.0	44.0	43.0	44.0	44.0
Total length	65	64	63	72	70
Hind foot length	14	12	14	14	14
Ear length	14	17	15	15	15
Weight	18.7	19.0	21.0	19.0	19.0

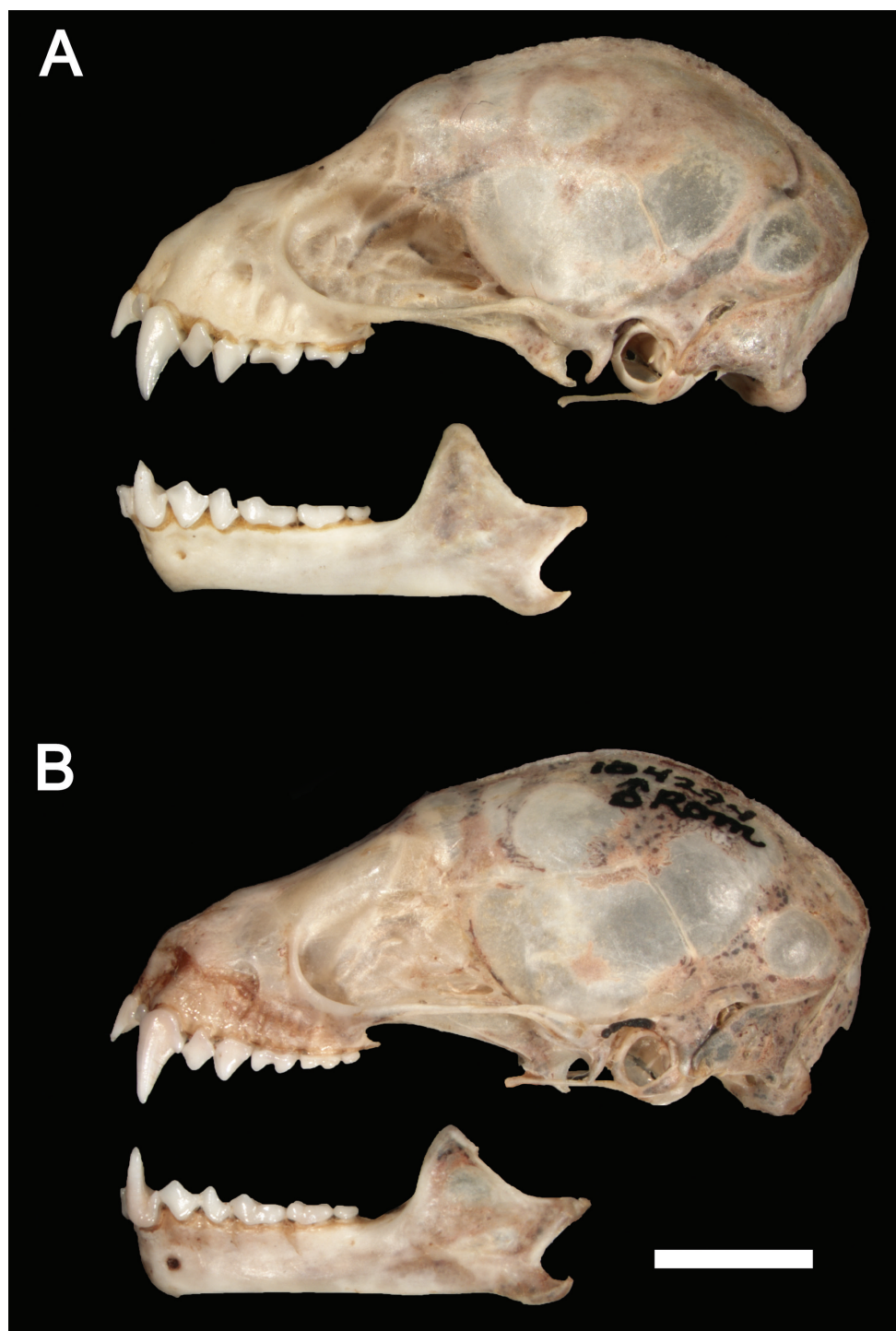
The skull of *Sturnira bakeri* has a globular braincase with a slender rostrum and well-developed sagittal crest (Figures 3–4). The basisphenoid pits are shallow and divided by a low midline septum. The sphenorbital fissure is oval (Figure 5). The anterior process of the glenoid fossa is absent (Figure 6). The clinoid processes are well developed (Figure 7), and the proximal end of the stylohyoid is expanded.

Like most species of *Sturnira*, *S. bakeri* has a dental formula of I2/2, C1/1, P2/2, M3/3 = 32 teeth. The upper inner incisor (I1) is bicuspidate with a small lateral cusp (Figure 8). The I1 is procumbent and is at least twice the height of the I2. Anteroposterior length of P3 is less than that of P4, and crown height of P3 is slightly less than that of P4. P4 has a small distal cusp. The anteroposterior length of M1 is larger than that of M2. The paracones of M1 and M2 are shorter than their metacones. The direction of the premetacrista of M1 is oblique to the upper alveolar plane. The M3 is ovoid in shape and has two labial cones (cusps). The first and second lower incisors (i1 and i2) are tricuspidate and are subequal in height. The lower canine covers 25% of the occlusal area of i2. The lower canines are laterally divergent, shafts are slanted outward. Anteroposterior length of p2 exceeds that of p4, and crown height of p2 is slightly more than that of p4. The protoconid, hypoconid, metaconid, and entoconid are present in m1 and m2. The paraconid is present and well developed in m1 but absent in m2. The lingual cuspids (metaconid and entoconid) of m1 and m2 are well defined and separated by a deep notch (Figure 9). The m3 is small and only poorly defined, but its protoconid, metaconid, and entoconid are visible.



**Figure 3.** Dorsal (A) and ventral (B) views of the cranium of *Sturnira bakeri* (QCAZ 14635 ♀) from El Oro, Ecuador. Dorsal (C) and ventral (D) views of the cranium of *S. burtonlimi* (ROM 104294 ♂) from Chiriquí, Panama. Scale bar = 5 mm.





**Figure 4.** Lateral views of the cranium and mandible of **A** *Sturnira bakeri* (QCAZ 14635 ♀). Lateral views of the cranium and mandible of **B** *S. burtonlimi* (ROM 104294 ♂). Scale bar = 5 mm.

**Table 2.** Measurements (mm) of six species of *Sturnira*.

	<i>S. hondurensis</i> <sup>a</sup>	<i>S. ludovici</i> <sup>b</sup>	<i>S. luisi</i> <sup>c</sup>	<i>S. mordax</i> <sup>d</sup>	<i>S. oporaphilum</i> <sup>e</sup>	<i>S. parvidens</i> <sup>f</sup>
FA	45.4 (44.8–46.0) 5	45.6, 45.2, 46.9	46.0, 45.0	44.4, 45.4	47.0 (45.0–48.0) 6	39.9 (38.0–41.0) 12
GLS	23.1 (21.8–24.2) 5	24.4, 23.6, 23.8	23.0, 22.2	21.7, 24.5	23.4 (22.6–24.1) 7	21.2 (20.8–21.8) 9
CIL	21.3 (20.6–22.5) 5	22.7, 22.2, 23.0	–, 20.5	–, 22.5	21.4 (20.9–22.0) 7	19.3 (19.0–19.9) 9
CCL	20.5 (19.6–21.5) 5	21.7, 20.9, 21.7	20.9, 19.7	–, 21.4	20.7 (20.0–21.4) 7	18.6 (18.3–19.2) 9
BB	10.2 (10.1–10.4) 5	10.7, 10.8, 10.5	10.3, 9.9	10.1, 10.5	10.5 (10.5–10.6) 7	10.0 (9.8–10.2) 9
ZB	13.2 (12.5–13.6) 5	14.0, 14.1, 13.5	14.2, 13.7	–, 12.8	13.9 (13.6–14.7) 7	13.0 (12.5–13.4) 9
PB	5.9 (5.7–6.0) 5	6.3, 6.0, 6.0	5.9, 5.9	6.1, 6.1	6.1 (5.8–6.5) 7	5.5 (5.0–5.7) 9
MB	11.8 (11.5–12.0) 5	12.3, 12.1, 12.6	12.0, 11.6	10.6, 11.8	12.2 (11.9–12.4) 7	11.5 (11.2–12.0) 9
MTRL	6.7 (6.5–7.0) 5	7.0, 6.9, 6.9	6.9, 6.8	–, 7.0	6.9 (6.6–7.2) 7	6.2 (6.1–6.4) 9
M2–M2	8.0 (7.5–8.2) 5	8.4, 8.4, 8.3	8.3, 8.1	7.3, 7.5	8.2 (7.8–8.6) 7	7.7 (7.5–8.0) 9
DENL	14.9 (14.4–15.2) 5	15.8, 15.5, 15.5	15.6, 15.0	14.2, 15.5	15.1 (14.8–15.5) 7	13.7 (13.5–14.0) 9
MANDL	7.4 (7.2–7.8) 5	7.9, 7.8, 7.8	7.8, 7.8	7.2, 7.9	7.9 (7.4–8.5) 7	7.1 (6.7–7.4) 9

<sup>a</sup> Summary statistics (mean, observed range in parentheses, and sample size) for measurements of AMNH 126811 (Holotype, ♀); ROM 101366 ♀, ROM 101474 ♀; TTU 83675 ♀, TTU 104945 ♀.

<sup>b</sup> Measurements of AMNH 67328 (Holotype, ♂); TTU 102457 ♀, TTU 102461 ♂.

<sup>c</sup> Measurements of ROM 104204 ♂, ROM 105807 ♂.

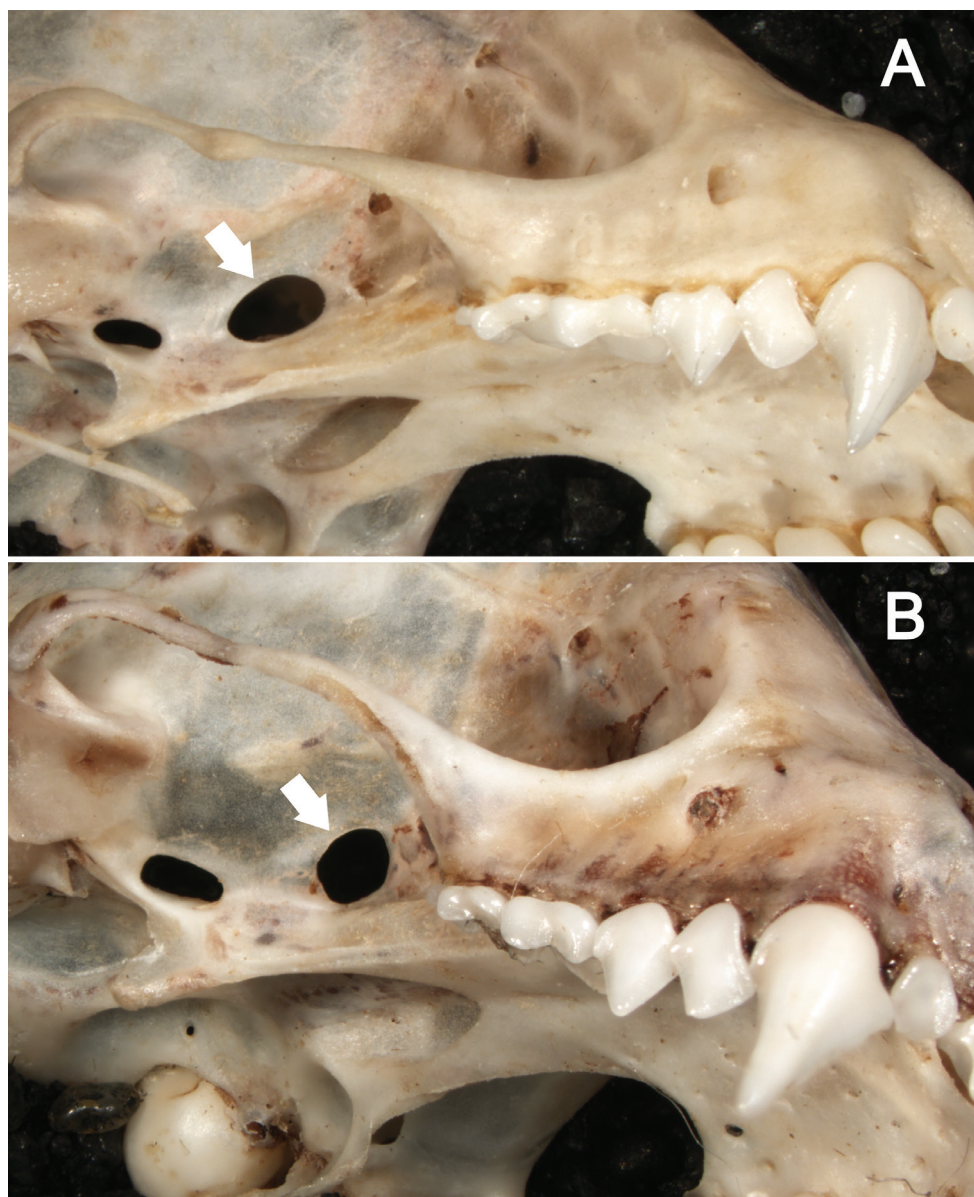
<sup>d</sup> Measurements of AMNH 142485 ♀; FMNH 124092 ♂.

<sup>e</sup> Summary statistics (mean, observed range in parentheses, and sample size) for measurements of AMNH 263462 ♀, AMNH 263463 ♀, AMNH 263465 ♂, AMNH 264660 ♂; FMNH 128926 ♀, FMNH 174843 ♂; MUSM 39230 ♂.

<sup>f</sup> Summary statistics (mean, observed range in parentheses, and sample size) for measurements of ROM 96276 ♀, ROM 97412 ♀, ROM 99284 ♂; TTU 44789 ♀, TTU 61103 ♂, TTU 62410 ♀, TTU 62411 ♂, TTU 84422 ♀, TTU 84608 ♀, TTU 104285 ♀, TTU 104631 ♀, TTU 105076 ♂.

**Comparisons.** Comparisons were made with sister species (*S. parvidens*) (Velazco and Patterson 2013) and with other species of the genus (*S. ludovici*, *S. luisi*, and *S. parvidens*) that occur in sympatry with *S. bakeri*. External and craniodental measurements for *S. bakeri* and the compared species are provided in Tables 1 and 2. *Sturnira bakeri* can be easily distinguished from *S. parvidens* by its longer forearm and longer greatest length of skull (Tables 1–2). *Sturnira bakeri*, *S. ludovici*, and *S. luisi* overlap somewhat in size (Tables 1–2) but are unambiguously distinguished by pelage and craniodental characteristics.

Externally, the dorsal pelage between the shoulders of *S. bakeri*, *S. luisi*, and *S. parvidens* is short (4.0–6.0 mm) whereas it is long (10 mm) in *S. ludovici*. Individual dorsal hairs are tetracolored in *S. bakeri* and *S. ludovici* whereas they are bicolored in *S. luisi* and *S. parvidens*. The overall appearance of the dorsal pelage is pale brown in *S. bakeri* and *S. luisi*, whereas it is dark brown in *S. ludovici* and reddish in *S. parvidens*. Ventrally the hairs are short (4.0–6.0 mm) and tricolored in *S. bakeri*, *S. ludovici*, and *S. parvidens*, but short (4.0–6.0 mm) and bicolored in *S. luisi*. The ventral fur is pale gray in *S. bakeri*, whereas it is dark gray in *S. luisi*, dark brown in *S. ludovici*, and reddish in *S. parvidens*. Shoulder glands (epaulettes) are conspicuous in *S. bakeri*, *S. ludovici*, *S. luisi*, and *S. parvidens*. The trailing edge of the uropatagium is covered by



**Figure 5.** Ventrolateral views of the right orbital region in *Sturnira bakeri* (A, QCAZ 14635 ♀) and *S. luisi* (B, ROM 104204 ♂) illustrating taxonomic differences in the shape of the sphenorbital fissure. In *S. bakeri*, the sphenorbital fissure is oval (arrow). In *S. luisi*, however, the sphenorbital fissure is semicircular (arrow).

short hairs (4.0–5.0 mm) in *S. bakeri*, *S. luisi*, and *S. parvidens*, whereas the uropatagium is covered by long hairs (7.0–9.0 mm) in *S. ludovici*. The proximal portion of the forearm (roughly 50% of the shaft just distal to the elbow) is sparsely furred with short hairs in *S. bakeri* and *S. luisi*, whereas it is well furred with short hair in *S. ludovici*



and *S. parvidens*. The dorsal surfaces of the femur and tibia are densely covered with long hairs in *S. bakeri*, whereas they are densely covered with short hairs in *S. ludovici*, sparsely covered with long hairs in *S. parvidens*, and sparsely covered with short hairs in *S. luisi*. The dorsal surfaces of the feet are densely covered with long hairs in *S. bakeri* and *S. parvidens*, whereas they are densely covered with short hairs in *S. ludovici* or sparsely covered with short hairs in *S. luisi*. The IV metacarpal is shorter than the III metacarpal in *S. bakeri* and *S. parvidens*, whereas the IV metacarpal is equal to the III metacarpal in *S. ludovici* and *S. luisi*.

Cranially, the rostrum of *Sturnira bakeri*, *S. ludovici*, and *S. luisi* is slender, whereas it is broad in *S. parvidens*. The zygomatic arches are straight in *S. bakeri* and *S. luisi*, whereas they are bowed outward in *S. ludovici* and *S. parvidens*. The basisphenoid pits are shallow and divided by a low midline septum in *S. bakeri* and *S. ludovici*, whereas they are shallow and divided by a high septum in *S. luisi* and deep and divided by a high septum in *S. parvidens*. The sphenorbital fissure is oval in *S. bakeri*, *S. ludovici*, and *S. parvidens*, whereas it is subcircular in *S. luisi* (Figure 5). The anterior process of the glenoid fossa is absent in *S. bakeri*, whereas it is well developed in *S. luisi* and *S. parvidens* (Figure 6). Some specimens of *S. ludovici* lack the anterior process of the glenoid fossa (TTU 102461) while in others (TTU 102457) it is well developed. The clinoid processes are present and well developed in *S. bakeri* and *S. ludovici*, whereas they are absent in *S. luisi* (Figure 7). Some specimens of *S. parvidens* lack clinoid processes (ROM 97412; TTU 84608) while others (ROM 99284) possess them. The proximal end of the stylohyoid is expanded in *S. bakeri*, *S. ludovici*, and *S. parvidens*, whereas it is narrow in *S. luisi*.

Dentally, two labial cusps are present in M3 in *S. bakeri*, *S. luisi* and *S. parvidens*, whereas only one labial cusp is present *S. ludovici*. The i1 and i2 are tricuspidate in *S. bakeri*, *S. luisi*, and *S. parvidens*, whereas they are bicuspidate in *S. ludovici*. The metaconid and entoconid of m1 and m2 are well defined and separated by a deep notch in *S. bakeri*, *S. luisi*, and *S. parvidens*, whereas they are poorly defined and are not separated by a deep notch in *S. ludovici* (Figure 9).

**Natural history.** The area surrounding the Fuerte Militar Arenillas is relatively xeric and surrounded by primary dry forest, secondary forest, and plantations of crops (Carrera et al. 2010). No other information is available.

### ***Sturnira burtonlimi* sp. n.**

<http://zoobank.org/309E2CD7-7E93-4E46-89A9-C6EF685FE5C5>

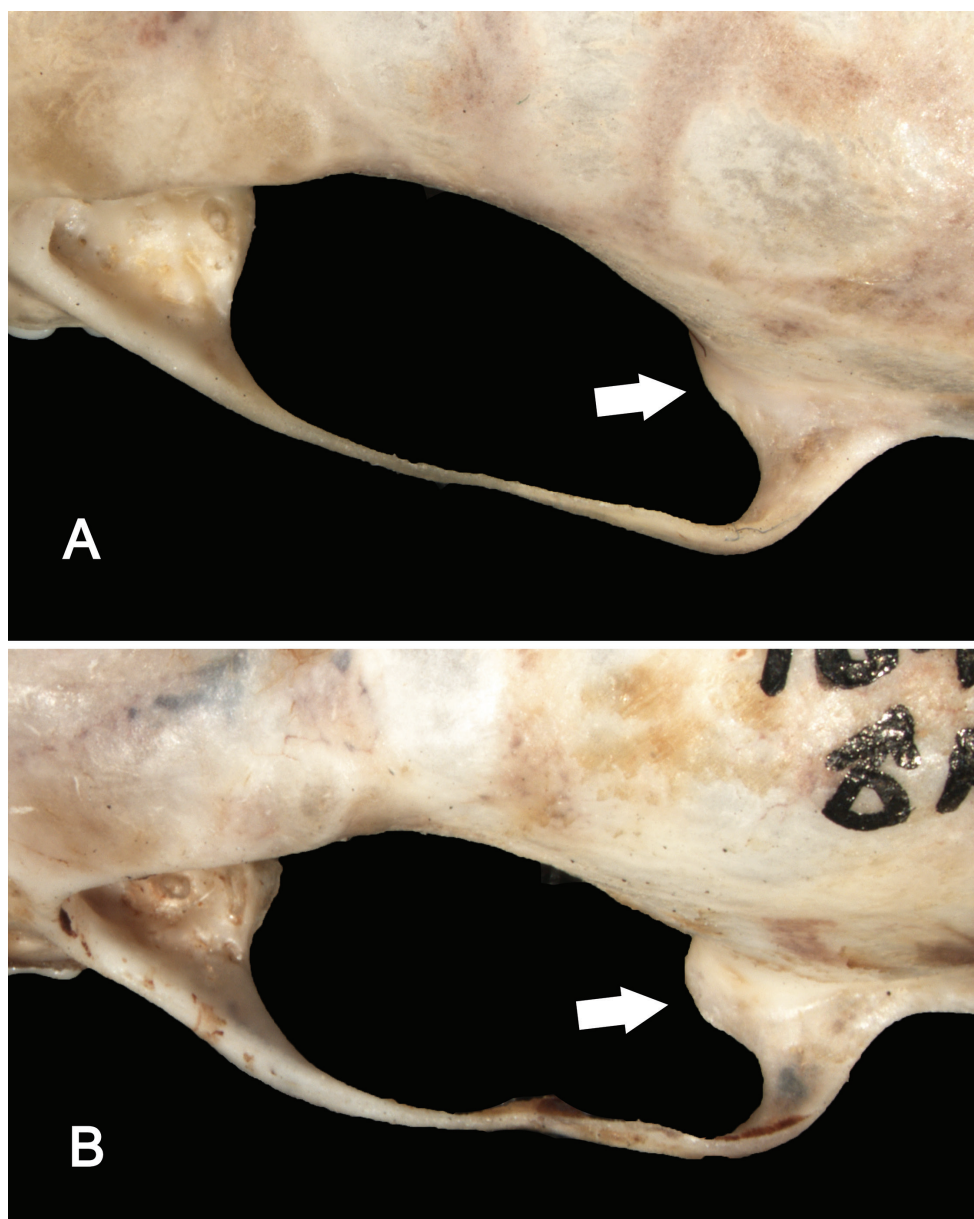
[http://species-id.net/wiki/Sturnira\\_burtonlimi](http://species-id.net/wiki/Sturnira_burtonlimi)

Burton's Yellow-shouldered Bat

**Synonymy.** *Sturnira ludovici*: Clare et al. 2011:9 (part)

*S[turnira]*. new species 1: Velazco and Patterson 2013:687

**Holotype.** Adult male, deposited at the Royal Ontario Museum (ROM 104294), collected on 7 March 1995 by Burton K. Lim and Eamon O'Toole (original field



**Figure 6.** Dorsal view of the left zygomatic arches in *Sturnira bakeri* (**A**, QCAZ 14635 ♀) and *S. luisi* (**B**, ROM 104204 ♂) illustrating taxonomic differences in the development of the glenoid fossa. In *S. bakeri* the anterior process of the glenoid fossa is absent (arrow). In *S. luisi*, however, the anterior process of the glenoid fossa is well developed (arrow).

number F 38144). Prepared as dry skin, skull, and skeleton. The skin, skull, and skeleton are in good condition. Frozen tissues are deposited at the Royal Ontario Museum (F 38144).

**Type locality.** Ojo de Agua, 2 km N of Santa Clara, Chiriquí, Panama, approximately 8°42'N, 82°45'W, 1500m (Figure 2).

**Paratype.** The skin, skull, and carcass of an adult male (ROM 104295) caught on 7 March 1995 at the type locality by Burton K. Lim and Eamon O'Toole (original field number F 38145).

**Additional specimens.** Besides the specimens from the type series from Panama, Velazco and Patterson (2013) reported an additional record of *S. burtonlimi* (referred as *S. new species 1*) from the Cartago province in Costa Rica (MVZ 174432 ♂; Appendix) based on DNA sequence data. We did not include this specimen as part of the type series because it was not available for examination, therefore the diagnostic morphological characteristics of *S. burtonlimi* could not be confirmed in this specimen.

**Distribution.** The new species is known from only two localities, one in Costa Rica and the other in Panama (Figure 2, Appendix).

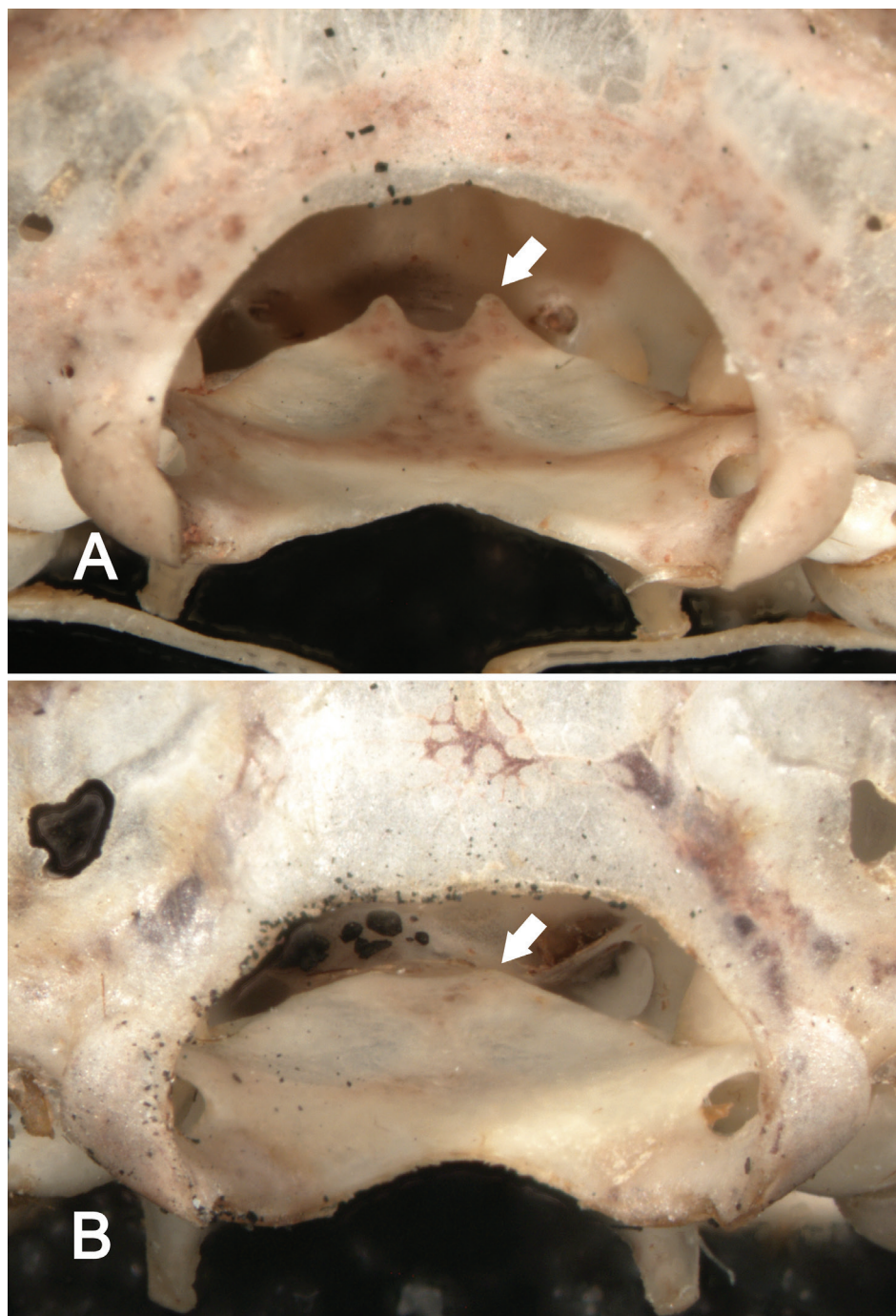
**Etymology.** The name *burtonlimi* honors our friend Dr. Burton K. Lim, who collected the type series of this species and has made many other important collections throughout the Neotropics and beyond. Burton is a tireless fieldworker whose research has contributed much to our understanding of the diversity, relationships, and biogeography of tropical mammals.

**Measurements.** External and craniodental measurements are presented in Table 1.

**Diagnosis and description.** *Sturnira burtonlimi* is a medium-sized yellow-shouldered bat (FA 44.0 mm; GLS 22.7–22.8 mm; CIL 20.8–21.5 mm; Table 1) with a broad rostrum and a globular braincase (Figures 3–4). The dorsal fur is dark brown. Dorsal hairs are tetracolored with a short, pale gray base (approximately 10% of the length of each hair), a long, dark grey band (approximately 40% of each hair), a long, pale gray band (approximately 40% of each hair), and short dark brown terminal band (approximately 10% of each hair). The ventral fur is dark brown. Ventral hairs are tricolored with a short, pale gray base (approximately 10% of each hair), a long, dark brown subterminal band (approximately 45% of each hair), and a long, gray terminal band (approximately 45% of each hair). The fur is long and woolly, approximately 7 mm long between the shoulders and 5 mm on the chest. The proximal portion of the forearm (roughly 50% of the shaft just distal to the elbow) is densely furred with short hairs. The wing membranes of *S. burtonlimi* are dark brown. The dorsal surfaces of the femur and tibia are densely covered with long hairs. The dorsal surfaces of the feet are densely covered with short hairs. The IV metacarpal is shorter than the III metacarpal.

The skull of *Sturnira burtonlimi* has a globular braincase with a broad rostrum and a well-developed sagittal crest (Figures 3–4). The basisphenoid pits are shallow and divided by a low midline septum. The sphenorbital fissure is subcircular. The anterior process of the glenoid fossa is well developed, as are the clinoid processes. The proximal end of the stylohyoid is expanded.

Like most species of *Sturnira*, *S. burtonlimi* has a dental formula of I2/2, C1/1, P2/2, M3/3 = 32 teeth. The upper inner incisor (I1) is unicuspidate and has a small lateral cusp (Figure 8). The I1 is procumbent and is at least twice the height of the I2. Anteroposterior length of P3 is less than that of P4, and crown height of P3 is slightly



**Figure 7.** Posterior views of the basioccipital (view through the foramen magnum) in *Sturnira bakeri* (A, QCAZ 14635 ♀) and *S. luisi* (B, ROM 104204 ♂) illustrating taxonomic differences in the degree of development of the clinoid processes. In *S. bakeri* the clinoid processes are well developed (arrow). In *S. luisi*, however, the clinoid processes are absent (arrow).



less than that of P4. Both P3 and P4 possess a small distal cusp. Anteroposterior length of M1 is longer than M2. The paracone and metacone of M1 and M2 are subequal in height. The direction of the premetacrista of M1 is perpendicular to the upper alveolar plane. The M3 is ovoid in shape and has only one labial cone (cusp). The first and second lower incisors (i1 and i2) are bicuspidate. The i1 and i2 are subequal in height. The lower canine covers half the occlusal surface of i2. The lower canines are laterally divergent, their shafts slanted outward. Anteroposterior length of p2 is more than that of p4, and crown height of p2 is slightly more than that of p4. The protoconid, hypoconid, metaconid, and entoconid are present in m1 and m2. The paraconid is present and well developed in m1. Paraconid is absent in m2. The lingual cuspids (metaconid and entoconid) of m1 and m2 are poorly defined and are not separated by a deep notch (Figure 9). The m3 is small and only poorly defined protoconid, metaconid, and entoconid are evident.

**Comparisons.** *Sturnira burtonlimi* was compared with the closely related species *S. hondurensis*, *S. ludovici*, and *S. oporaphilum* (Velazco and Patterson 2013) and with other sympatric species of the genus (*S. luisi*, *S. mordax*, and *S. parvidens*). External and craniodental measurements for *S. burtonlimi* and the compared species are provided in Tables 1 and 2. *Sturnira burtonlimi* can be easily distinguished from *S. ludovici* by its shorter forearm and shorter greatest length of skull and from *S. parvidens* by its longer forearm and longer greatest length of skull (Tables 1–2). *Sturnira burtonlimi*, *S. hondurensis*, *S. luisi*, *S. mordax*, and *S. oporaphilum* overlap somewhat in size (Tables 1–2) but can be unambiguously distinguished based on pelage and craniodental characteristics.

Externally, the dorsal pelage between the shoulders of *S. burtonlimi*, *S. hondurensis*, *S. ludovici*, *S. mordax*, and *S. oporaphilum* is long (7.0–10 mm) and tetracolored, whereas it is short (4.0–6.0 mm) and bicolored in *S. luisi* and *S. parvidens*. The overall appearance of the dorsal pelage is dark brown in *S. burtonlimi*, *S. hondurensis*, *S. ludovici*, *S. mordax*, and *S. oporaphilum*, whereas it is pale brown in *S. luisi* and reddish in *S. parvidens*. Ventrally the hairs are short (4.0–6.0 mm) and tricolored in *S. burtonlimi*, *S. ludovici*, *S. mordax*, *S. oporaphilum*, and *S. parvidens*; but short (4.0–6.0 mm) and bicolored in *S. luisi*, and long (8.0 mm) and monocolored in *S. hondurensis*. The ventral fur is dark gray in *S. burtonlimi*, *S. luisi*, and *S. oporaphilum*, whereas it is pale gray in *S. hondurensis*, dark brown in *S. ludovici*, *S. mordax*, and reddish in *S. parvidens*. Shoulder glands (epaulettes) are conspicuous in *S. burtonlimi*, *S. ludovici*, *S. luisi*, and *S. parvidens*, whereas they are absent in *S. hondurensis*, *S. mordax*, and *S. oporaphilum*. The trailing edge of the uropatagium is covered by long hairs (7.0–9.0 mm) in *S. burtonlimi*, *S. hondurensis*, *S. ludovici*, and *S. oporaphilum*, whereas the uropatagium is covered by short hairs (4.0–5.0 mm) in *S. luisi*, *S. mordax*, and *S. parvidens*. The proximal portion of the forearm (roughly 50% of the shaft just distal to the elbow) is well furred with short hair in *S. burtonlimi*, *S. ludovici*, and *S. parvidens*, whereas it is well furred with long hair in *S. hondurensis*, *S. mordax*, and *S. oporaphilum*, and sparsely furred with short hairs in *S. luisi*. The dorsal surfaces of the femur and tibia are densely covered with long hairs in *S. burtonlimi* and *S. hondurensis*, whereas they are densely



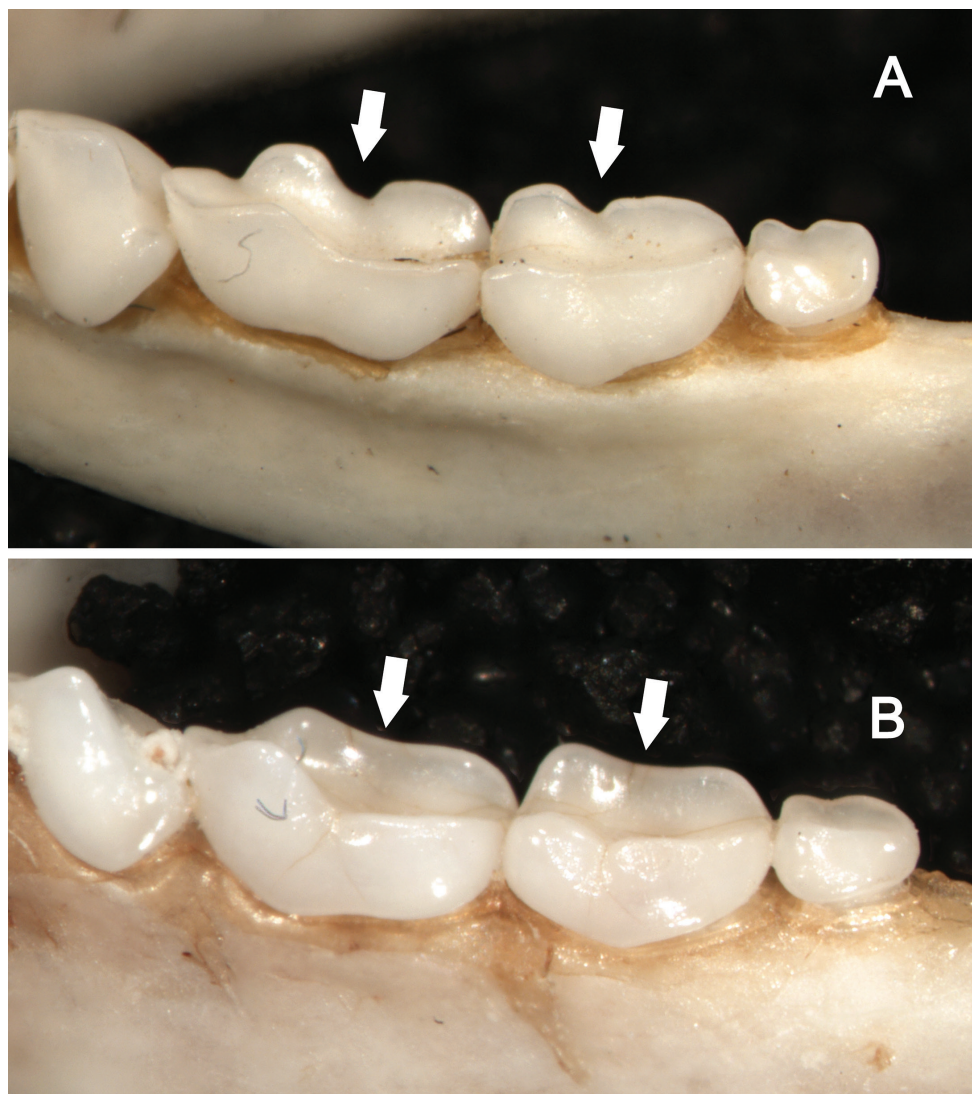
**Figure 8.** Anterior views of the upper incisors and canines in *Sturnira bakeri* (A, QCAZ 14635 ♀) and *S. burtonlimi* (B, ROM 104294 ♂) illustrating taxonomic differences in the number of cusps of the upper inner incisor (I1). In *S. bakeri* the I1 is bicuspidate. In *S. burtonlimi*, however, the I1 is unicuspidate.

covered with short hairs in *S. ludovici*, sparsely covered with long hairs in *S. mordax*, *S. oporaphilum*, and *S. parvidens*, and sparsely covered with short hairs in *S. luisi*. The dorsal surfaces of the feet are densely covered with short hairs in *S. burtonlimi* and *S. ludovici*, whereas they are densely covered with long hairs in *S. hondurensis*, *S. oporaphilum*, and *S. parvidens*, sparsely covered with long hairs in *S. mordax*, and sparsely covered with short hairs in *S. luisi*. The IV metacarpal is shorter than the III metacarpal in *S. burtonlimi*, *S. hondurensis*, and *S. parvidens*, whereas the IV metacarpal is equal to the III metacarpal in *S. ludovici*, *S. luisi*, *S. mordax*, and *S. oporaphilum*.

Cranially, the rostrum of *Sturnira burtonlimi*, *S. oporaphilum*, and *S. parvidens* is broad, whereas it is slender in *S. hondurensis*, *S. ludovici*, *S. luisi*, and *S. mordax*. The basisphenoid pits are shallow and divided by a low midline septum in *S. burtonlimi*, *S. ludovici*, *S. mordax*, and *S. oporaphilum*, whereas they are shallow divided by a high septum in *S. luisi* and deep divided by a high septum in *S. hondurensis* and *S. parvidens* (Figure 3). The sphenorbital fissure is subcircular in *S. burtonlimi*, *S. hondurensis*, *S. luisi*, *S. mordax*, and *S. oporaphilum*, whereas it is oval in *S. ludovici* and *S. parvidens*. The anterior process of the glenoid fossa is well developed in *S. burtonlimi*, *S. hondurensis*, *S. luisi*, and *S. parvidens*, whereas it is absent or poorly developed in *S. mordax* and *S. oporaphilum*. Some specimens of *S. ludovici* (TTU 102461) lack the anterior process of the glenoid fossa while others (TTU 102457) present a well-developed anterior process of the glenoid fossa. The clinoid processes are well developed in *S. burtonlimi* and *S. ludovici*, whereas they are weak in *S. oporaphilum* and absent in *S. hondurensis*, *S. luisi*, and *S. mordax*. Clinoid processes are present in some specimens of *S. parvidens* (ROM 99284), while they are lacking in others (ROM 97412; TTU 84608). The proximal end of the stylohyoid is expanded in *S. burtonlimi*, *S. ludovici*, *S. oporaphilum*, and *S. parvidens*, whereas it is narrow in *S. hondurensis*, *S. luisi*, and *S. mordax*.

Dentally, the upper inner incisor (I1) is unicuspidate in *S. burtonlimi* and *S. hondurensis*, whereas it is bicuspidate in *S. ludovici*, *S. luisi*, *S. mordax*, *S. oporaphilum*, and *S. parvidens* (Figure 8). A small distal cusp is present on P3 in *S. burtonlimi* and *S. oporaphilum*, whereas this cusp is absent in *S. hondurensis*, *S. ludovici*, *S. luisi*, *S. mordax*, and *S. parvidens*. The direction of the premetacrista of M1 is perpendicular to the upper alveolar plane in *S. burtonlimi*, whereas the premetacrista is oblique to the upper alveolar plane in *S. hondurensis*, *S. ludovici*, *S. luisi*, *S. mordax*, *S. oporaphilum*, and *S. parvidens*. One labial cusp is present in M3 in *S. burtonlimi*, *S. hondurensis*, *S. ludovici*, and *S. oporaphilum*, whereas two labial cusps are present in *S. luisi* and *S. parvidens*. The i1 and i2 are bicuspidate in *S. burtonlimi*, *S. hondurensis*, *S. ludovici*, *S. mordax*, and *S. oporaphilum*, whereas they are tricuspidate in *S. luisi* and *S. parvidens*. The lower canines are laterally divergent, shafts slanted outward, in *S. burtonlimi*, *S. ludovici*, *S. luisi*, and *S. parvidens*, whereas they are not laterally divergent in *S. hondurensis*, *S. mordax*, and *S. oporaphilum*. The metaconid and entoconid of m1 and m2 are poorly defined and are not separated by a deep notch in *S. burtonlimi*, *S. hondurensis*, *S. ludovici*, *S. mordax*, and *S. oporaphilum*, whereas the metaconid and entoconid of m1 and m2 are well defined and separated by a deep notch in *S. luisi* and *S. parvidens* (Figure 9).





**Figure 9.** Dorsolateral views of the left mandibular toothrows in *Sturnira bakeri* (**A**, QCAZ 14635 ♀) and *S. burtonlimi* (**B**, ROM 104294 ♂), illustrating taxonomic differences in the shape of the metaconid and entoconid of m1 and m2. In *S. bakeri*, the metaconid and entoconid of m1 and m2 are well defined and separated by a deep notch (arrows). In *S. burtonlimi*, however, the metaconid and entoconid of m1 and m2 are poorly defined and are not separated by a deep notch (arrows).

**Natural history.** *Sturnira burtonlimi* has been documented from an elevational range of 1290 to 1500 m and was taken in premontane forest near coffee fields. All known specimens are males. Testes of the type series specimens measured  $5 \times 3$  mm (ROM 104294) and  $7 \times 5$  mm (ROM 104295).

## Discussion

From the time of its description in 1810, *Sturnira lilium* was thought to be one of the most widespread species of phyllostomid bats, ranging from northern Mexico to northern Argentina and into the Lesser Antilles. Six subspecies have been recognized (Gannon et al. 1989, Gardner 2008): *S. l. lilium* Geoffroy St.-Hilaire, 1810 over much of South America east of the Andes; *S. l. parvidens* Goldman, 1917 over much of Central America and Pacific slopes of Colombia and Ecuador; and four subspecies restricted to the Lesser Antilles: *S. l. angeli* de la Torre, 1966; *S. l. luciae* Jones & Phillips, 1976; *S. l. paulsoni* de la Torre & Schwartz, 1966; and *S. l. zygomaticus* Jones & Phillips, 1976. Multilocus molecular analyses of the genus (Velazco and Patterson 2013) showed *S. lilium* to be a paraphyletic complex of six species, including two that lacked names. Their analyses suggested that four of the six erstwhile subspecies of *S. lilium* should be elevated to specific rank, namely *S. angeli*, *S. lilium*, *S. parvidens*, and *S. paulsoni*. The other two subspecies were considered junior synonyms: *zygomaticus* of *S. angeli* (which was also shown to include “*S. thomasi*”); and *luciae* of *S. paulsoni* (Figure 2).

With the descriptions of two additional species in the *lilium* complex (*S. bakeri* in this report and “*S. new species 3*” of Velazco and Patterson (2013), to be described elsewhere), the distribution of *S. lilium* has been radically altered. *Sturnira lilium* is actually restricted to the Brazilian Shield portions of Brazil, Bolivia, Paraguay, and Argentina. However, most reports on the ecology, distribution, morphology, behavior, and parasites of *S. lilium* are based on different species (e.g., Wenzel and Tipton 1966, Wenzel 1976, Contreras Vega and Cadena 2000, Evelyn and Stiles 2003, Lobova et al. 2009, Medina and Lopez 2010, Jarrín-V and Kunz 2011, Jarrín-V and Clare 2013, Frank et al. 2014, Melaun et al. 2014). The largely allopatric distributions of forms in this species complex should aid efforts to allocate these observations to the correct species.

In a similar manner, Velazco and Patterson (2013) found that *Sturnira ludovici* and *S. oporaphilum* were sister species and related to two unrecognized species. Their sister species is here named *S. burtonlimi*. All three species are then sister to a Central American taxon long considered a subspecies of *S. ludovici* (Simmons 2005), which should be recognized as *S. hondurensis* as suggested by Gardner (2008).

According to the timetree analysis of Velazco and Patterson (2013), these newly described species arose after the final emergence of the Panamanian landbridge during the Pliocene. Both *S. burtonlimi*, a Central American form, and *S. bakeri*, a South American form, have their closest living relative on the opposite side of the Panamanian isthmus: *S. burtonlimi* is sister to *S. ludovici* + *S. oporaphilum*, and *S. bakeri* is sister to *S. parvidens*. Both of these divergence events were dated to the Late Pliocene or Early Pleistocene.

## Acknowledgments

The following curators and collection staff graciously provided access to specimens under their care: Neil Duncan, Nancy B. Simmons, and Eileen Westwig (AMNH); Suzanne

McLaren and John R. Wible (CM); John D. Phelps (FMNH); Robert T. Brumfield, Donna Dittmann, and Mark S. Hafner (LSUMZ); Joseph A. Cook and Jonathan L. Dunnum (MSB); Víctor Pacheco (MUSM); James L. Patton (MVZ); Santiago Burneo and Alejandra Camacho (QCAZ); Burton K. Lim (ROM); Robert J. Baker and Heath J. Garner (TTU); Alfred L. Gardner and Suzanne C. Peurach (USGS-PWRC / USNM). Sergio Solari and two anonymous reviewers read early drafts of this manuscript and made helpful suggestions for its improvement. PMV was supported by NSF grant DEB 0949859 to Nancy B. Simmons.

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## Appendix

Specimens of *Sturnira* used in this study. See Methods for collection acronyms. Individuals marked with an asterisk were used only in the molecular analyses.

- Sturnira bakeri* new species (3).— ECUADOR: *El Oro*: Reserva Militar Arenillas, Palmares (QCAZ 14635 [holotype]); Fuerte Militar Arenillas (7.1 km W and 12.5 km S of the Military Base), Quebrada Seca (QCAZ 9737, 9739).
- Sturnira burtonlimi* new species (3).— COSTA RICA: *Cartago*: Colima Tapanti, 1.6 km S Tapanti, Bridge over río Grande de Orosi (MVZ 174432\*). PANAMA: *Chiriquí*: Ojo de Agua, 2 km N Santa Clara (ROM 104294 [holotype], 104295).
- Sturnira hondurensis* (8).— EL SALVADOR: *Santa Ana*: Los Planes (ROM 101474); Parque Nacional Montecristo, Bosque Nebuloso (ROM 101366). GUATEMALA: *El Progreso*: 3 km W Pinalon, Reserva de Biosfera Sierra de las Minas, Municipalidad San Agustín Acasaguastlan (MVZ 223393\*). *Huehuetenango*: 2.5 km S, 2.75 km W San Mateo Ixtatan (MVZ 223172\*); Finca Ixcansan, 10.3 km (by road) E of Yalambojoch on road to Río Seco, Sierra de los Cuchumatanes (MVZ 223178\*). HONDURAS: *Francisco Morazán*: La Tigra Parque Nacional (TTU 83675). *La Paz*: La Cruz Grande (AMNH 126811 [holotype]). MEXICO: *San Luis Potosí*: 1.5 mi W Las Abritas (TTU 104945).
- Sturnira ludovici* (3).— ECUADOR: *El Oro*: Jardín Botánico Moro Moro (límite con la Reserva Jocotoco) (TTU 102457, 102461). *Pichincha*: W side Pichincha near Gualea (AMNH 67328 [holotype]).
- Sturnira luisi* (8).— ECUADOR: *Esmeraldas*: 2 km S of Alto Tambo (ROM 105807); terrenos aledaños de La Comuna San Francisco de Bogota (TTU 103217\*). PANAMA: *Bocas del Toro*: Isla Popa, S Shore, 1 km E Sumwood Channel (USNM 579052\*); Isla San Cristóbal, Bocatorito (USNM 449721\*); Península Valiente, Bahía Azul, Pigeon Key Trail (USNM 578239\*). *Canal Zone*: Gamboa (ROM 104204). *Chiriquí*: Santa Clara (TTU 39136\*). *Darién*: Caña (LSUMZ 25478\*).
- Sturnira mordax* (7).— COSTA RICA: *Alajuela*: 4.2 km SE Cariblanco (CM 92486–92488\*; TJM 6741\*). *Cartago*: Refugio Nacional Tapanti, Sombrilla de Pobre Trail at Quebrada Segunda Trail, 0.2 km N park headquarters (MVZ 174439\*). *Puntarenas*: Cañas Gordas, Las Vueltas (AMNH 142485); Finca Las Cruces, 2 km S San Vito (FMNH 124092).
- Sturnira oporaphilum* (11).— BOLIVIA: *La Paz*: 3 km S of Irupana (AMNH 263462–263463, 263465); Chijchipa (AMNH 264660). ECUADOR: *Tungurahua*: La Estancia (TTU 84970\*). PERU: *Amazonas*: Luya, Río Utcubamba, 11 km by road



NW Pedro Ruiz (FMNH 128925\*). *Cajamarca*: Chota Querocoto, Monte Ribereño (MUSM 39428\*); Santa Cruz, Río Zaña, 2 km N Monte Seco (FMNH 128926). *Cuzco*: Paucartambo, Consuelo, 15.9 km SW Pilcopata (FMNH 174843). *Madre de Dios*: Manu, Maskoitania, 13.4 km NNW Atalaya, left bank Río Alto Madre de Dios (FMNH 174844\*). *San Martín*: Moyobamba, Area de Conservación Municipal Mishquiyacu Rumiyacu-Almendra, Orquidiario Waqanki (MUSM 39230). *Sturnira parvidens* (19).— COSTA RICA: *Puntarenas*: 5 km S, 6 km W Esparza (LSUMZ 28341\*). EL SALVADOR: *La Paz*: 1 mi N La Herradura (TTU 62410). *Santa Ana*: Cemetery, 2 mi S Santa Ana (TTU 62411). GUATEMALA: *El Peten*: Tikal (ROM 99284). HONDURAS: *Atlántida*: Lancetilla Botanical Garden (TTU 84422). *Comayagua*: Parque Nacional Cerro Azul, Meambar (TTU 104285). *Copán*: 5 km NW Santa Rosa de Copan (TTU 84608). *Valle*: 8.5 mi SSW San Lorenzo (TTU 61103). MEXICO: *Campeche*: 3.7 km SE of Chekubul (ROM 96276). *Chiapas*: 25 km S, 3 km N Ocozocoautla (TTU 104631). *Quintana Roo*: 6 km S of Majahual (ROM 97412). *Sonora*: 12 mi E (by road) Alamos, Rio Cuchujaqui (MSB 53756\*, 53759\*, 53760\*); 3 mi S, 2.8 mi W Alamos, La Aduana, Santo Domingo (MSB 53758\*). *Tamaulipas*: 2 mi W Calabazas, Río Sabinas (TTU 44789). *Veracruz*: La Mancha Field Station (MSB 82216\*, 82218\*); Paso del Patal [=Panal?] (TTU 105076).

# A taxonomic review of the *Neoserica* (sensu lato) *septemlamellata* group (Coleoptera, Scarabaeidae, Sericini)

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|| <http://zoobank.org/AF657935-9B32-4F91-B25D-46203C82EB51>

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Academic editor: A. Frolov | Received 24 February 2014 | Accepted 28 March 2014 | Published 15 April 2014

<http://zoobank.org/B0ED94FB-951A-4063-BEED-7BF5F4E85C39>

**Citation:** Ahrens D, Liu W-G, Fabrizi S, Bai M, Yang X-K (2014) A taxonomic review of the *Neoserica* (sensu lato) *septemlamellata* group (Coleoptera, Scarabaeidae, Sericini). ZooKeys 402: 67–102. doi: 10.3897/zookeys.402.7360

## Abstract

In the present paper the species belonging to the *Neoserica* (sensu lato) *septemlamellata* group, that included so far only four known species, are revised. Here we describe eleven new species originating mainly from Indochina and Southern China: *N. daweishanica* sp. n., *N. gaoligongshanica* sp. n., *N. guangpingensis* sp. n., *N. igori* sp. n., *N. jiulongensis* sp. n., *N. plurilamellata* sp. n., *N. weishanica* sp. n., *N. yanzigouensis* sp. n. (China) *N. sapaensis* sp. n. (China, Vietnam), *N. bansongchana* sp. n., *N. takakuwai* sp. n. (Laos). The lectotypes of *Neoserica septemlamellata* Brenske, 1898 and *N. septemfoliata* Moser, 1915 are designated. Keys to the species and species groups are given, the genitalia of all species and their habitus are illustrated and distribution maps are included.

## Keywords

Beetles, chafers, *Neoserica*, China, Laos, Vietnam, Thailand, new species



## Introduction

The genus *Neoserica* Brenske, 1897 is with ca. 200 taxa one of the most species rich groups of Sericini. Since the redefinition of the genus (Pope 1960, Ahrens 2003) many other species so far grouped under *Neoserica* and being not directly related to the type species *Neoserica ursina* (Brenske, 1894) (i.e. *Neoserica* (sensu stricto) group; Ahrens 2003) are grouped preliminarily as *Neoserica* sensu lato (e.g. Ahrens 2004), a collective group that was identified to be neither related to *Neoserica* sensu stricto (Ahrens 2003) nor being monophyletic (Ahrens and Vogler 2008). They all await taxonomic revision based on which their relationships and classification can be subsequently established more rigorously.

In the current study we investigate the taxonomy of the representatives closely related to the species *Neoserica septemlamellata* Brenske, 1898, described originally from Myanmar. According to our present knowledge the species group is distributed from the eastern Himalaya to southern China and Indochina being mainly restricted to the higher elevated regions. The species of this group are characterised by a more or less distinctly tridentate protibia, by an antennal club composed of seven antennomeres in males and by a metafemur with a continuously serrated line adjacent to the anterior margin. However, all these features are likely to be homoplastic since they do occur also in other genera (e.g. in *Trioserica* Moser, 1922, *Nepaloserica* Frey, 1965, and *Lasioserica* Brenske, 1896, respectively). So far only four species were known to belong to this group, *N. septemlamellata* Brenske, 1898, *N. septemfoliata* Moser, 1915 as well as the recently described taxa *N. changrae* Ahrens, 2004 and *N. crenatolineata* Ahrens & Fabrizi, 2009. Here, eleven new species are described originating mainly from Indochina and Southern China.

## Material and methods

The terminology and methods used for measurements, specimen dissection and genital preparation follow AHRENS (2004). Data from specimens examined are cited in the text with original label contents given in quotation marks verbatim, multiple labels are separated by a “/”. Male genitalia were glued to a small pointed card and photographed in both lateral and dorsal view using a stereomicroscope Leica M125 with a Leica DC420C digital camera. In the automontage software as implemented in Leica Application Suite (V3.3.0) a number of single focussed images were combined in order to obtain an entirely focussed image. The resulting images were subsequently digitally edited.

Abbreviations used in the text for collection depositories are as follows:

<b>CNAR</b>	Collection A. Naplov, Riga, Lettland;
<b>CPPB</b>	Collection P. Pacholátko, Brno, Czech Republic;
<b>HBUM</b>	Museum of Hebei University, Baoding, Hebei, China;
<b>ISNB</b>	Institut Royal des Sciences naturelles de Belgique, Brüssel, Belgium;

<b>IZAS</b>	Institute of Zoology, Chinese Academy of Sciences, Beijing, China;
<b>MNHN</b>	Museum national d'Histoire naturelle, Paris, France;
<b>NKU</b>	Nankai University, Tianjin, China;
<b>NMPC</b>	National Museum (Natural History), Prague, Czech Republic;
<b>ZFMK</b>	Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn, Germany;
<b>ZMHB</b>	Museum für Naturkunde Berlin, Germany;
<b>ZSM</b>	Zoologische Staatssammlung, München, Germany.

### Key to species groups of *Neoserica* (*sensu lato*)

- 1 Hypomeron not carinate..... *Tetraserica* Ahrens, 2004
- 1' Hypomeron carinate ..... 2
- 2 Antennal club in female composed of 3 antennomeres .....  
..... *Neoserica vulpes* group, *N. lubrica* group,  
*N. pilosula* group, *N. calva* group, *Anomalophylla* Reitter, 1887, *Gynaecoserica* Brenske, 1896, *Leuroserica* Arrow, 1946, *Sericania* Motschulsky, 1860, *Calloserica* Brenske, 1894, *Lasioserica* Brenske, 1896, *Gastroserica* Brenske, 1897, *Neoserica* (s.str.) Brenske, 1894, *Trioserica* Moser, 1922, *Microserica* Brenske, 1894, *Oxyserica* Brenske, 1900, other *Neoserica* (s.l.)
- 2' Antennal club in female composed of more than 3 antennomeres..... 3
- 3 Metatibia slender and long..... 4
- 3' Metatibia short and wide .....  
... *Neoserica* (s. l.) *uniformis* group & *N. multifoliata* group (from Indochina)
- 4 Antennal club of males with 7 antennomeres ..... 5
- 4' Antennal club of males with 7, 6 or less antennomeres ..... 6
- 5 Metafemur with a continuously serrated line adjacent to the anterior margin of metafemur. Protibia more or less distinctly tridentate .....  
..... *Neoserica septemlamellata* group
- 5' Metafemur without a continuously serrated line adjacent to the anterior margin of metafemur. Protibia always distinctly bidentate..... *Nepaloserica* Frey, 1965
- 6 Basis of labroclypeus dull. Antennal club of males with 6 or 7 antennomeres... 7
- 6' Antennal club of males with 5 or 4 antennomeres..... 8
- 7 Angle between basis of hypomeron and that of pronotum strongly rounded, angle of surfaces of hypomeron and pronotum basally blunt. Hypomeron basally strongly produced ventrally and transversely sulcate.....  
..... *Lepidoserica* Nikolaev, 1979
- 7' Angle between basis of hypomeron and that of pronotum sharp, angle of surfaces of hypomeron and pronotum sharp. Hypomeron basally not produced ventrally and not sulcate ..... *Neoserica abnormis* group
- 8 Body surface strongly shiny. Body small: 5,7–6,6 mm .....  
..... *Neoserica speciosa* group
- 8' Body surface dull. Body larger 8 mm ..... *Chrysoserica* Brenske, 1897

***Neoserica septemlamellata* group - key to species (♂♂)**

- 1 Pronotum and elytra with dense, erect, long setae.....**2**
- 1' Pronotum and elytra nearly glabrous, without dense, erect, long setae .....**4**
- 2 Left paramere basally extremely wide, without basal lobe.... ***N. changrae* Ahrens**
- 2' Left paramere basally narrow, with a well developed basal lobe.....**3**
- 3 Antennal club strongly reflexed and three times as long as the remaining antennomeres combined..... ***N. weishanica* sp. n.**
- 3' Antennal club moderately reflexed and 2.5 times as long as the remaining antennomeres combined.....***N. septemlamellata* Brenske**
- 4 Elytra shiny.....**5**
- 4' Elytra dull.....**9**
- 5 Pronotum not or only weakly narrowed towards base .....**6**
- 5' Pronotum strongly narrowed towards base, and concavely sinuate before posterior angles. Phallobasis at apex ventrally produced.....***N. plurilamellata* sp. n.**
- 6 Pronotum dull on disc.....**7**
- 6' Pronotum completely shiny .....**8**
- 7 Phallobasis at apex ventrally not produced. Left paramere apically not widened. Basal tooth of protibia indistinct .....***N. gaoligongshanica* sp. n.**
- 7' Phallobasis at apex ventrally produced. Left paramere apically abruptly widened. Basal tooth of protibia distinct ..... ***N. jiulongensis* sp. n.**
- 8 Left paramere (dorsal view) not widened basally (lateral view), at apex without ventral tooth..... ***N. septemfoliata* Moser**
- 8' Left paramere (dorsal view) strongly widened basally (lateral view), at apex with a sharp ventral tooth ..... ***N. dawuishanica* sp. n.**
- 9 Antennal club shorter, 1.5 to 2 times as long as remaining antennomeres combined.....**10**
- 9' Antennal club longer, 2.5 to 3 times as long as remaining antennomeres combined ..... **12**
- 10 Basal lobe of left paramere directed medially. Basal tooth of protibia distinct...**11**
- 10' Basal lobe of left paramere directed basally. Basal tooth of protibia indistinct ...  
..... ***N. yanzigouensis* sp. n.**
- 11 Right paramere narrow, nearly straight interiorly .... ***N. bansongchana* sp. n.**
- 11' Right paramere wide, deeply sinuate interiorly at middle. ***N. guangpingensis* sp. n.**
- 12 Parameres without any lobes, compact..... **13**
- 12' Parameres with lobes..... **14**
- 13 Left paramere without triangular tooth laterally before apex....***N. sapaensis* sp. n.**
- 13' Left paramere with a triangular tooth laterally before apex.....***N. igori* sp. n.**
- 14 Basal lobe of left paramere directed distally, with a large convex distal lobe; right paramere with a small basal lobe. Protibia indistinctly tridentate, basal tooth small..... ***N. crenatolineata* Ahrens & Fabrizi**
- 14' Basal lobe of left paramere directed medially, with a narrow and long distal lobe; right paramere without basal lobe. Protibia distinctly tridentate.....  
..... ***N. takakuwai* sp. n.**

## Systematics

### *Neoserica* (s.l.) *septemlamellata* Brenske, 1898

[http://species-id.net/wiki/Neoserica\\_septemlamellata](http://species-id.net/wiki/Neoserica_septemlamellata)

Figs 1A–D, 6

*Neoserica septemlamellata* Brenske, 1898: 349.

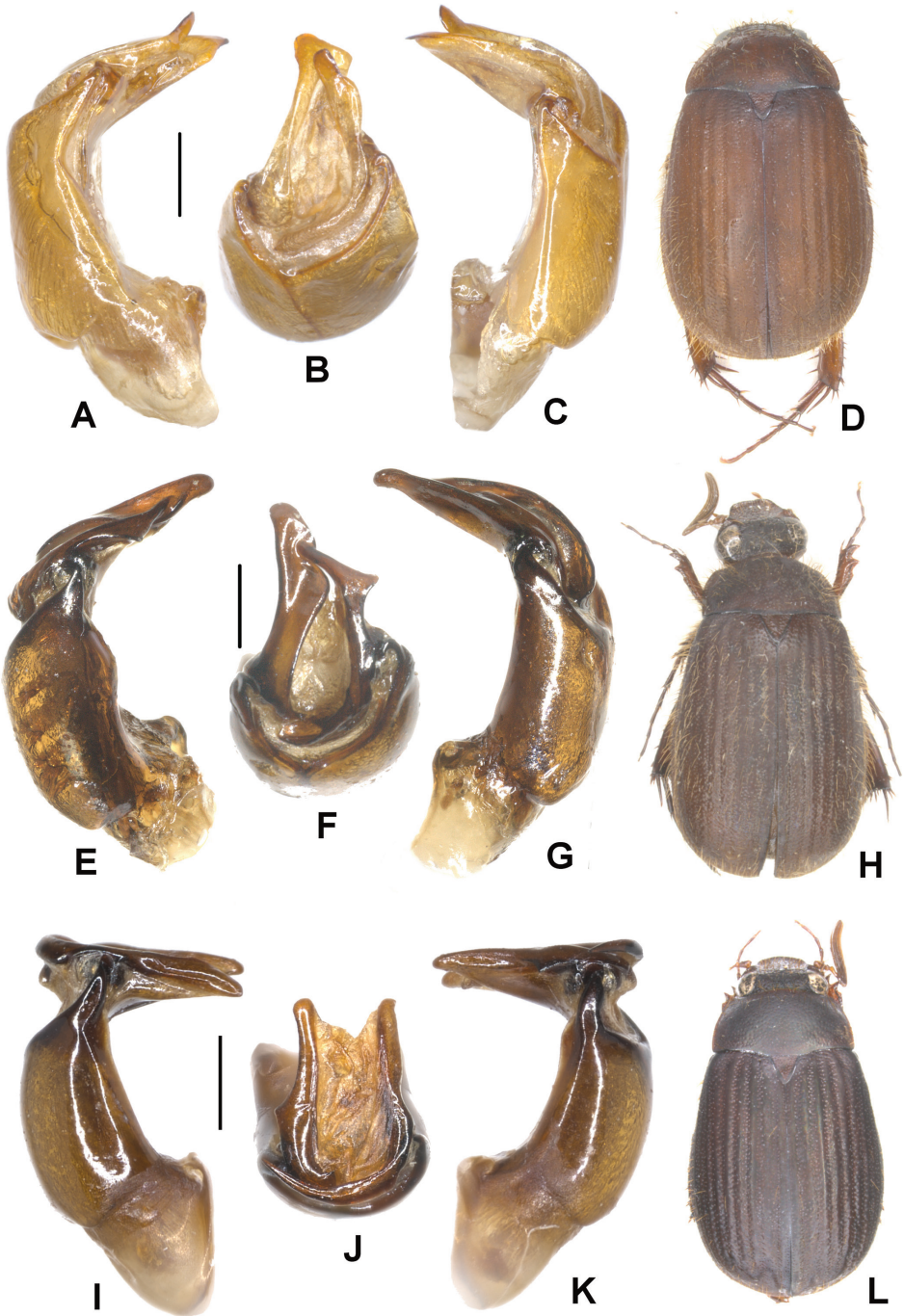
*Aserica septemlamellata*: Arrow 1946a: 14.

**Type material examined.** Lectotype (here designated): 1 ♂ „Hte Birmanie Mines des Rubies 1200m 2300m Doherty 1890/ 7-lamellata type Brsk./ Museum Paris ex. Coll. R. Oberthür/ Type” (MNHN).

**Additional material examined.** 9 ex. „N-Thailand 20.–27.III.1990 Doi Ithang lg. Malicky” (ZSM), 7 ex. „N-Thailand 27.III.–3.IV.1990 Doi Ithanon lg. Malicky” (ZSM), 1 ex. „N-Thailand 14.–28.VIII.1990 Doi Ithanon lg. Malicky” (ZSM), 2 ex. „N-Thailand 10.–12.IV.1990 Doi Ithanon lg. Malicky” (ZSM), 1 ex. „N-Thailand 20.II.–6.III.1990 Doi Ithanon lg. Malicky” (ZSM), 9 ex. „N-Thailand 13.–20.III.1990 Doi Ithanon lg. Malicky” (ZSM), 3 ex. „NE-Laos: Hua Phan prov., Ban Saleui, Phou Pan (Mt.) - 20°12'N, 104°01'E; 14.iv.–15.v.2012; 1300–1900m; leg. C. Holzschuh Ankauf ZFMK Bonn 2012/13” (ZFMK), 16 ex. “Laos-NE Hua Phan prov., 20°12'N, 104°01'E, Phu Phan Mt., 1500–1900m, 17.5.–3.6.2007, leg. Vit Kuban” (ZFMK), 6 ex. “Laos-NE Hua Phan prov., 20°12'N, 104°01'E, Phu Phan Mt., 1500–1900m, 17.5.–3.6.2007, leg. C. Holzschuh” (ZFMK), 43 ex. “Laos-NE, Houa Phan prov., 20°13'09–19"N, 103°59'54"-104°00'03"E, 1480–1510m Phou Pane Mt., 22.IV.–14.V.2008 Vit Kuban leg. (NMPC), 1 ♂ “Mengzhe, Xishuangbanna, Yunnan, 23.VI.1958, 1700m, leg. Wang Shuyong” (IZAS).

**Redescription.** Length: 8.3 mm, length of elytra: 6.2 mm, width: 5.2 mm. Body oblong, reddish brown, antennal club yellowish brown, labroclypeus shiny, dorsal surface dull, with dense and erect setae.

Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex and strongly convergent anteriorly, anterior angles strongly rounded, anteriorly not sinuate medially, margins weakly reflexed; surface flat and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture indistinctly incised, slightly elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with a few minute, superficial punctures and a few long setae. Frons dull, behind frontoclypeal suture shiny, with coarse and fine, dense punctures, densely covered with erect setae. Eyes moderately large, ratio diameter/interocular width: 0.64. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 2.5 times as long as remaining antennomeres combined; antennomere 4 subequal to half length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.



**Figure 1.** **A–D** *Neoserica septemlamellata* Brenske (Thailand: Doi Ithanon) **E–H** *N. weishanica* Ahrens, Liu & Fabrizi sp. n. (holotype) **I–L** *N. takakuwai* Ahrens, Liu & Fabrizi sp. n. (holotype) **A, E, I** Aedeagus, left side lateral view **C, G, K** Aedeagus, right side lateral view **B, F, J** parameres, dorsal view **D, H, L** Habitus. Scale: 0.5 mm.



Pronotum subrectangular, widest shortly before base, lateral margins evenly convex and moderately convergent anteriorly, slightly narrowed basally, anterior angles sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, with long erect setae; setae of anterior and lateral border more robust and sparse; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, with coarse, dense punctures and a few short setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and evenly densely punctate, third interval with punctures concentrated along striae, with dense, erect and long setae; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.48. Pygidium strongly convex and dull, coarsely and densely punctate, with a narrow smooth midline, evenly covered with long erect setae.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and sparsely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/2.9, dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one shortly behind middle, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, coarsely and densely punctate, in apical half punctures less dense, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth blunt; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 1A–C.

**Remarks.** The species was so far known only from Myanmar. Here it is first time recorded from Thailand and China. We designate here a lectotype for the species, since in the original description it is not mentioned on how many specimens it was based.

***Neoserica* (s.l.) *weishanica* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/3336E93D-3093-4A31-A341-77C9B1A3C32B>

[http://species-id.net/wiki/Neoserica\\_weishanica](http://species-id.net/wiki/Neoserica_weishanica)

Figs 1E–H, 6

**Type material examined.** Holotype ♂ “Yunnan 1800–500m 25.10N 100.21E Weishan mts. 22.–25.6.92 David Kral lgt.” (ZFMK).

**Description.** Length: 9.7 mm, length of elytra: 6.2 mm, width: 5.2 mm. Body oblong, reddish brown, antennal club yellowish brown, labroclypeus shiny, dorsal surface dull, with dense and erect setae.

Labroclypeus subtrapezoidal, slightly wider than long, widest at base, lateral margins weakly convex and strongly convergent anteriorly, anterior angles moderately rounded, anteriorly weakly sinuate medially, margins weakly reflexed; surface flat and shiny, basis without dull tomentum, punctation very dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with minute, dense punctures and a few long setae. Frons dull, behind frontoclypeal suture shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes large, ratio diameter/interocular width: 0.8. Antenna with ten antennomeres, club with seven antennomeres, strongly reflexed, three times as long as remaining antennomeres combined; antennomere 4 subequal to half length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum subrectangular, widest at base, lateral margins in basal half straight and subparallel, convex and moderately convergent in anterior half, anterior angles moderately sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, with long erect setae; setae of anterior and lateral border more robust and sparse; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, with coarse, dense punctures and a few short setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and evenly densely punctate, third interval with punctures concentrated along striae, with dense, erect and long setae; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface dull, coarsely and densely punctate, metasternum densely setose; metacoxa glabrous, with numerous long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.41. Pygidium weakly convex and dull, coarsely and densely punctate, with a narrow smooth midline, evenly covered with long erect setae.



Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and moderately densely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/2.8, dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one at two thirds, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length and ending at apex of metatibia; lateral face longitudinally convex, coarsely and densely punctate, in apical half punctures less dense, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, laterally not carinate, dorsally with a few coarse punctures each bearing a robust short seta at posterior part of basal two tarsomeres; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth blunt; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 1E–G. Female unknown.

**Diagnosis.** The new species is in genital and external morphology very similar to *N. septemlamellata*. It differs by the significantly longer and strongly reflexed club (male) and the dorsal punctures on meso- and metatarsomeres as well as by shape of parameres: the left paramere (both species share the long basal lobe directed mesally) has at middle a sharp triangular tooth laterally, the basal lobe is flat in cross section, the right paramere is not widened at apex showing, however, a blunt median extension a third before the apex.

**Etymology.** The new species is named according to its type locality, Weishan mountains.

***Neoserica* (s.l.) *takakuwai* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/44F563D7-9321-4EF0-970C-B8C3954DA463>

[http://species-id.net/wiki/Neoserica\\_takakuwai](http://species-id.net/wiki/Neoserica_takakuwai)

Figs 1I–L, 7

**Type material examined.** Holotype ♂ “Mt. Phu Pan, Xam Neua, Houapan, N. Laos, 19–21.V.2005 Takakuwa, M. leg.” (ZFMK). Paratypes: 1 ♂ “Laos-NE Hua Phan prov., 20°12'N, 104°01'E, Phu Phan Mt., 1500–1900m, 17.5.–3.6.2007, leg. Vit Kuban” (NMPC), 2 ♂♂ “Laos-NE Hua Phan prov., 20°12'N, 104°01'E, Phu Phan Mt., 1500–1900m, 17.5.–3.6.2007, leg. C. Holzschuh” (ZFMK), 3 ♂♂ “Laos-NE,

Houa Phan prov., 20°13'09–19"N, 103°59'54"–104°00'03"E, 1480–1510m Phou Pane Mt., 22.IV.–14.V.2008 Vit Kuban leg." (ZFMK), 1 ♂, 1 ♀ "Laos-NE, Houa Phan prov., 20°13'09–19"N, 103°59'54"–104°00'03"E, 1480–1510m Phou Pane Mt., 22.4.–14.5.2008 Vit Kuban leg." (ZFMK).

**Description.** Length: 8.5 mm, length of elytra: 5.8 mm, width: 4.9 mm. Body oblong, dark brown, ventral surface and legs reddish brown, antennal club yellowish brown, dorsal surface dull, nearly glabrous except a few long setae on head.

Labroclypeus short and trapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight and strongly convergent anteriorly, anterior angles strongly rounded, anterior margin very weakly sinuate medially, margins moderately reflexed; surface flat and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with minute punctures and a few long setae. Frons dull, anterior quarter shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes large, ratio diameter/interocular width: 0.74. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 2.5 times as long as remaining antennomeres combined; antennomere 4 slightly longer than half of club length, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum moderately transverse, subrectangular, widest at base, lateral margins evenly weakly convex and moderately convergent towards moderately sharp and distinctly produced anterior angles, posterior angles blunt, slightly rounded at tip; anterior margin moderately convexly produced medially, with a broadly incomplete marginal line medially; surface densely and moderately coarsely punctate, only with minute setae; setae of anterior and lateral border fine and dense; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with fine, dense punctures also on midline, with minute setae.

Elytra oblong, widest at posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures concentrated along striae, odd intervals with single long erect setae, otherwise punctures only with very minute setae; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.56. Pygidium moderately convex and dull, coarsely and densely punctate, without impunctate midline, with dense, long, erect and minute setae on apical half.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and moderately densely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/2.9; dorsal margin sharply carinate, with three groups of robust spines, basal group shortly before middle, median one at two thirds, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being convergent with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, finely and moderately densely punctate, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust, nearly equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth distinct; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 11–K.

**Diagnosis.** The new species is in shape of parameres somewhat similar to *N. weishanica* sp. n., but it differs by having the parameres straight, lacking an external blunt tooth to the left paramere, and a median internal extension to the right one.

**Etymology.** The new species is named after the first collector of this species, M. Takakuwa.

**Variation.** Length: 8.5–9.3 mm, length of elytra: 5.8–7.5 mm, width: 4.9–5.8 mm. Female: Antennal club composed of five antennomeres, slightly longer than remaining antennomeres combined, first joint of club a quarter of length of club, 5th antennomere slightly transversely produced; eyes slightly smaller than in male (ratio diameter/interocular width: 0.56).

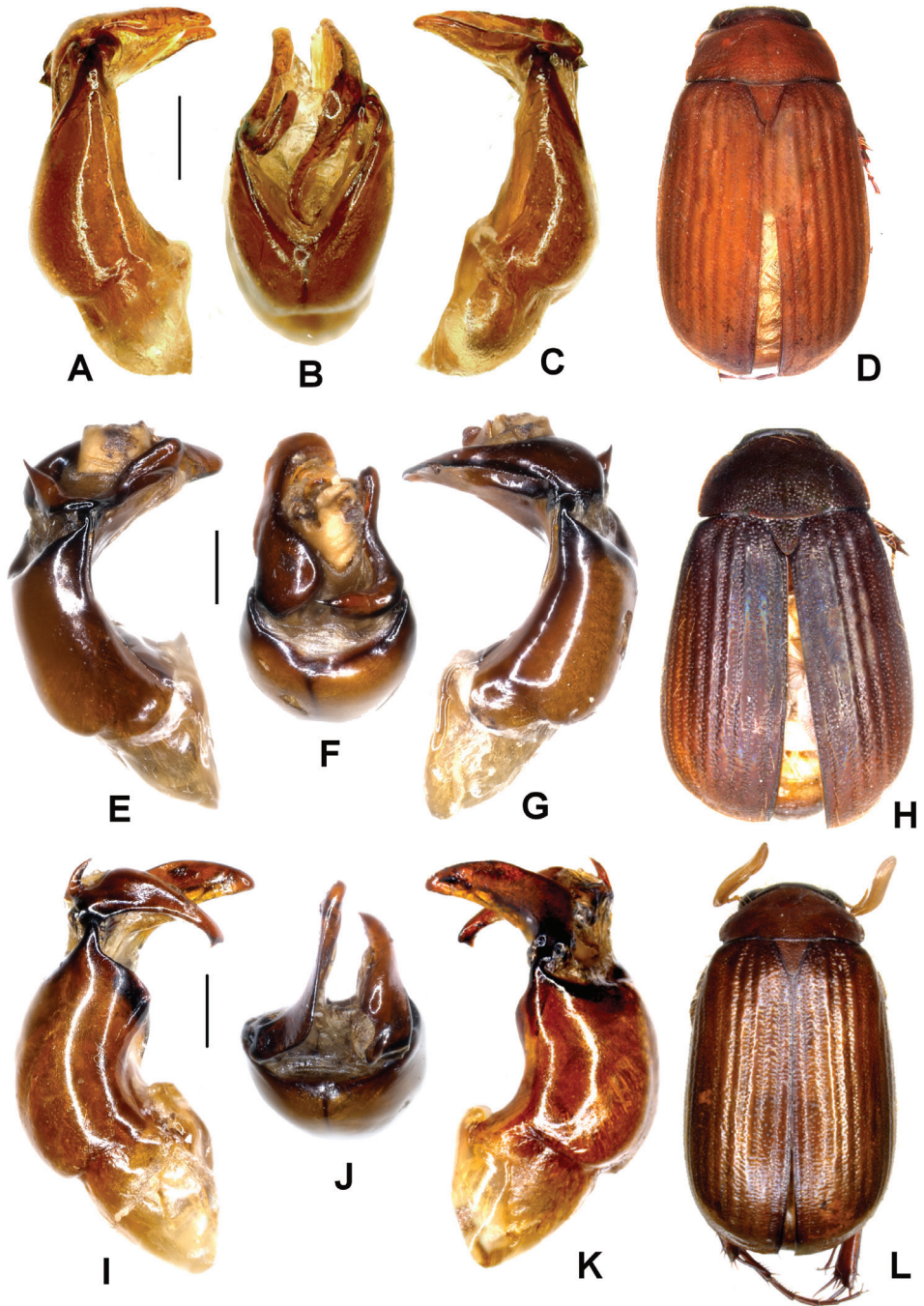
***Neoserica* (s.l.) *yanzigouensis* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/8271DC13-1B45-4F80-ADDF-10CE14EA67DE>

[http://species-id.net/wiki/Neoserica\\_yanzigouensis](http://species-id.net/wiki/Neoserica_yanzigouensis)

Figs 2A–D, 7

**Type material examined.** Holotype ♂ “Yanzigou, Xinxing, Luding, Sichuan, 7.VIII.2004, 1560m, leg. Bai Ming, Wan Xia” (IZAS). Paratypes. 1 ♂ “Yanzigou, Xinxing, Luding, Sichuan, 7.VIII.2004, 1560m, leg. Bai Ming, Wan Xia” (IZAS), 6 ♂♂ “Yanzigou, Xinxing, Luding, Sichuan, 7.VIII.2004, 1500m, leg. Zhang Yong” (IZAS, ZFMK), 2 ♂♂ “Yanzigou, Xinxing, Luding, Sichuan, 7.VIII.2004, 1560m, leg. Bai Ming” (IZAS).



**Figure 2.** **A–D** *Neoserica yanzigouensis* Ahrens, Liu & Fabrizi sp. n. (holotype) **E–H** *N. guangpingensis* Ahrens, Liu & Fabrizi sp. n. (holotype) **I–L** *N. plurilamellata* Ahrens, Liu & Fabrizi sp. n. (holotype) **A, E, I** Aedeagus, left side lateral view **C, G, K** Aedeagus, right side lateral view **B, F, J** parameres, dorsal view **D, H, L** Habitus. Scale: 0.5 mm.

**Description.** Length: 8.2 mm, length of elytra: 6.4 mm, width: 4.6 mm. Body oblong, dark reddish brown, antennal club yellowish brown, dorsal surface dull, nearly glabrous except a few long setae on head.

Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight and strongly convergent anteriorly, anterior angles strongly rounded, anterior margin weakly sinuate medially, margins moderately reflexed; surface flat and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length =  $1/3$  of ocular diameter) and wide, with minute punctures and a few long setae. Frons dull, anterior quarter shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes large, ratio diameter/interocular width: 0.74. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, twice as long as remaining antennomeres combined; antennomere 4 subequal to half length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum moderately transverse, subrectangular, widest at base, lateral margins weakly convex and moderately convergent towards moderately sharp and distinctly produced anterior angles, posterior angles blunt, slightly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border fine and sparse; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with fine, dense punctures and minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures concentrated along striae, with minute setae, odd intervals with a few erect setae (partially lacking on disc); epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100 $\times$ ).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.41. Pygidium strongly convex and dull, coarsely and densely punctate, with a narrow smooth midline, with dense, long erect setae and minute setae on apical half.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and moderately densely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/3.2; dorsal margin sharply carinate, with three groups



of spines, basal group shortly before middle, median one shortly behind middle, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, finely and moderately densely punctate, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, but basal tooth rather indistinct; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 2A–C. Female unknown.

**Diagnosis.** The new species is similar to *N. takakuwai* sp. n. in external morphology. It may be distinguished by its more reddish brown colour, by the slightly shorter antennal club being twice as long as remaining antennomeres combined, as well as by the basal lobe of the left paramere directed basally (and not medially as in *N. takakuwai* sp. n.).

**Etymology.** The new species is named after its type locality, Yanzigou.

**Variation.** Length: 8.2–9.6 mm, length of elytra: 6.4–7.1 mm, width: 4.6–5.2 mm.

***Neoserica* (s.l.) *guangpingensis* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/17E90087-D9C9-41EC-8EF7-593A14006B5A>

[http://species-id.net/wiki/Neoserica\\_guangpingensis](http://species-id.net/wiki/Neoserica_guangpingensis)

Figs 2E–H, 7

**Type material examined.** Holotype: ♂ “839462 *Neoserica* spYU09\_2 China S. Murzin 29.07.2009 Guang Ping, 34km N Jihong Yunnan Pr. Xichuanbanna 1200m” (ZFMK).

**Description.** Length: 8.8 mm, length of elytra: 6.5 mm, width: 5.2 mm. Body oblong, dark brown, antennal club yellowish brown, dorsal surface dull, except a few long setae on head and sides of elytra nearly glabrous.

Labroclypeus subtrapezoidal, considerably wider than long, widest at base, lateral margins moderately convex and strongly convergent anteriorly, anterior angles strongly rounded, anterior margin weakly sinuate medially, margins moderately reflexed; surface convexly elevated medially and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus short (length = 1/4 of ocular diameter) and wide, with fine, moderately dense punctures and a few long setae. Frons in posterior quarter dull, otherwise moderately shiny, with coarse and fine, dense punctures, densely covered with long erect setae being partly bent posteriorly. Eyes



moderately large, ratio diameter/interocular width: 0.61. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, twice as long as remaining antennomeres combined; antennomere 4 subequal to half of length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum transverse, widest shortly before base, lateral margins evenly convex and moderately convergent anteriorly, anterior angles moderately sharp and distinctly produced, posterior angles strongly rounded; anterior margin moderately convexly produced medially, with a medially widely incomplete marginal line; surface densely and coarsely punctate, only with minute setae, and a few long erect setae on anterior sides; setae of lateral border fine and moderately dense, those of anterior margin numerous and in part widely displaced from margin; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with fine, dense punctures, on midline impunctate, with minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures mainly concentrated along striae, with minute setae, odd intervals on sides and apical declivity with a few erect setae (lacking on disc); epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border broadly membranous, with a fine fringe of microtrichomes (visible at 100 $\times$ ).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.62. Pygidium strongly convex and dull, coarsely and densely punctate, with a narrow smooth midline, with dense and long erect setae and minute setae.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and moderately densely punctate between rows, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and little widened and smooth, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and short, widest at apex, ratio of width/length: 1/2.6; dorsal margin sharply carinate, with three groups of spines, basal group at the middle, median one at two thirds, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length and ending shortly before metatibial apex; lateral face longitudinally convex, coarsely and moderately densely punctate, with a few robust setae, in apical half punctures less dense, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust, nearly equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral

carina immediately beside it, first metatarsomere as long as following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, distinctly tridentate; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 2E–G.

**Diagnosis.** *Neoserica guangpingensis* sp. n. differs from very similar *N. takakuwai* sp. n. by the wide right paramere being deeply and concavely sinuate internally.

**Etymology.** The new species is named according to its type locality Guang Ping (China).

***Neoserica* (s.l.) *plurilamellata* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/DA6AA1B1-AFE0-4BAB-8104-2FC24EBB4EFF>

[http://species-id.net/wiki/Neoserica\\_plurilamellata](http://species-id.net/wiki/Neoserica_plurilamellata)

Figs 2I–L, 7

**Type material examined.** Holotype: ♂ “China, N.Yunnan, env. Xiaguan, 2400m, 29.vii.2002, leg. S. Murzin, I. Shokhin/ Coll. P. Pacholátko Brno Merhautova 68 Czech Republic/ 858 Sericini: Asia spec.” (CPPB). Paratype: 1 ♂ “Pantian’ge, Weixi, Yunnan, 23.VII.1981, 2500m, light trap, leg. Liao Subai” (IZAS).

**Description.** Length: 8.3 mm, length of elytra: 7.0 mm, width: 5.2 mm. Body oblong, reddish brown, antennal club yellowish brown, dorsal surface moderately shiny, nearly glabrous except a few long setae on head.

Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins straight and strongly convergent anteriorly, anterior angles moderately rounded, anteriorly weakly sinuate medially, margins moderately reflexed; surface slightly convex and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture indistinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with a few minute punctures and a few long setae. Frons shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes large, ratio diameter/interocular width: 0.82. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 2.5 times as long as remaining antennomeres combined; antennomere 4 subequal to two thirds of length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum subrectangular, widest at middle, lateral margins strongly and evenly convex, distinctly convergent anteriorly and posteriorly, before posterior angles deeply concavely sinuate, anterior angles sharp and moderately produced, posterior angles right-angled, very weakly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border fine and long but sparse;

hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with coarse, dense punctures, narrowly impunctate on basal midline, with minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures concentrated along striae, penultimate lateral interval with single long and fine, erect setae, otherwise with only very minute setae, otherwise glabrous; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface moderately shiny, nearly dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.4. Pygidium strongly convex and shiny, coarsely and densely punctate, with a narrow smooth midline, with a few long erect setae along apical margin.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and sparsely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/3.6; dorsal margin sharply carinate, with three groups of spines, basal group at middle, median one shortly behind middle, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, finely and sparsely punctate, sparsely setose, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust nearly equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth indistinct; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 2I–K. Female unknown.

**Diagnosis.** The new species differs from all species of the *N. septemlamellata* group with a shiny dorsal surface and in shape of pronotum: its lateral margins are strongly narrowed towards base and concavely sinuate before posterior angles.

**Etymology.** The new species is named with the composed adjective, *pluri* – (prefix from Latin *plus*, *pluris* – more) and *lamellata* (from Latin *lamellatus* – lamellate)

**Variation.** Length: 8.3–8.6 mm, length of elytra: 6.9–7.0 mm, width: 5.2–5.8 mm.

***Neoserica* (s.l.) *bansongchana* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/3B1BF1AA-74FF-4BDA-B3F0-00C58BB3982D>

[http://species-id.net/wiki/Neoserica\\_bansongchana](http://species-id.net/wiki/Neoserica_bansongchana)

Figs 3A–D, 7

**Type material examined.** Holotype ♂ “Laos, 1.-16.v.1998 Louangphrabang pr. 20°33–4'N 102°14'E Ban Song Cha (5km W) 1200m, Vít Kubáň leg./ Coll. P. Pacholátko Brno Merhautova 68 Czech Republic/ 176 Sericni: Asia spec.” (CPPB).

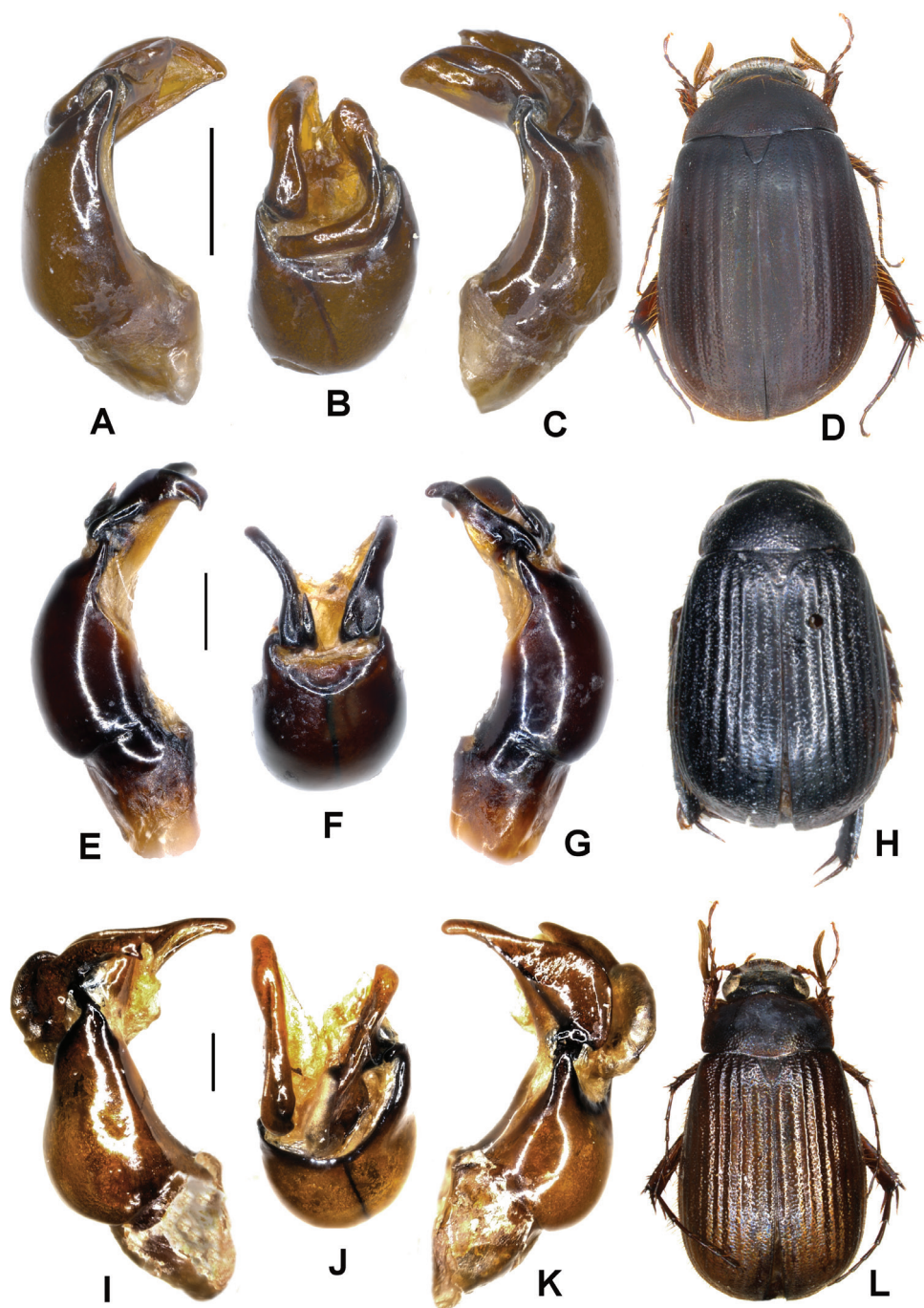
**Description.** Length: 9.7 mm, length of elytra: 6.9 mm, width: 5.7 mm. Body oblong, dark brown, antennal club yellowish brown, dorsal surface dull, except a few long setae on head and sides of elytra nearly glabrous.

Labroclypeus subtrapezoidal, considerably wider than long, widest at base, lateral margins moderately convex and strongly convergent anteriorly, anterior angles strongly rounded, anterior margin weakly sinuate medially, margins moderately reflexed; surface convexly elevated medially and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus short (length = 1/4 of ocular diameter) and wide, with moderately large punctures and a few long setae. Frons in posterior quarter dull, otherwise moderately shiny, with coarse and fine, dense punctures, densely covered with long erect setae being partly bent posteriorly. Eyes moderately large, ratio diameter/interocular width: 0.63. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 1.5 times as long as remaining antennomeres combined; antennomere 4 subequal to half of length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum subrectangular, widest at base, lateral margins evenly convex and moderately convergent anteriorly, anterior angles moderately sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin moderately convexly produced medially, with a medially widely incomplete marginal line; surface densely and coarsely punctate, only with minute setae, and a few long erect setae on anterior sides; setae of lateral border fine and moderately dense, those of anterior margin numerous and widely displaced from margin; hypomerion distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with fine, dense punctures, basally at middle impunctate, with minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures mainly concentrated along striae, with minute setae, odd intervals in sides and apical declivity with a few erect setae (lacking on disc); epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border broadly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row



**Figure 3.** A–D *Neoserica bansongchana* Ahrens, Liu & Fabrizi sp. n. (holotype), E–H *N. septemfoliata* Moser (lectotype) I–L *N. gaoligongshanica* Ahrens, Liu & Fabrizi sp. n. (holotype) A, E, I Aedeagus, left side lateral view C, G, K Aedeagus, right side lateral view B, F, J parameres, dorsal view D, H, L Habitus. Scale: 0.5 mm.



of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.56. Pygidium strongly convex and dull, coarsely and densely punctate, with a narrow smooth midline, with dense, long erect setae and minute setae.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and moderately densely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and little widened and smooth, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and short, widest at apex, ratio of width/length: 1/2.7; dorsal margin sharply carinate, with three groups of spines, basal group at the middle, median one at two thirds, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length and ending shortly before metatibial apex; lateral face longitudinally convex, coarsely and moderately densely punctate, with a few robust setae, in apical half punctures less dense, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust, nearly equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere as long as following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, distinctly tridentate; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 3A–C.

**Diagnosis.** *Neoserica bansongchana* sp. n. differs from *N. takakuwai* sp. n. by the slightly shorter antennal club, and the shorter, more stout parameres.

**Etymology.** The new species is named according to its type locality Ban Song Cha (Laos).

### *Neoserica* (s.l.) *septemfoliata* Moser, 1915

[http://species-id.net/wiki/Neoserica\\_septemfoliata](http://species-id.net/wiki/Neoserica_septemfoliata)

Figs 3E–H, 7

*Neoserica septemfoliata* Moser, 1915b: 381.

**Type material examined.** Lectotype (here designated): ♂ “Yunnan/ *Neoserica septemfoliata* Mos. Type Mos.” (ZMHB).

**Additional material examined.** 1 ♂ “Coll. R.I.Sc.N.B. Chine/ Sud Yunnan Tche-Ping-Tcheou/ Coll. P. Guerry Le Moults vendit” (ISNB).

**Redescription.** Length: 8.4 mm, length of elytra: 6.6 mm, width: 5.2 mm. Body oblong, black, antennal club yellowish brown, dorsal surface shiny, nearly glabrous except a few long setae on head.



Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex and convergent anteriorly, anterior angles moderately rounded, anteriorly weakly sinuate medially, margins moderately reflexed; surface slightly convex and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture indistinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length =  $1/3$  of ocular diameter) and wide, with a few minute punctures and a few long setae. Frons shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes moderately large, ratio diameter/interocular width: 0.64. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 2.5 times as long as remaining antennomeres combined; antennomere 4 subequal to two thirds of length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum subrectangular, widest shortly before base, lateral margins evenly convex and moderately convergent anteriorly, slightly narrowed basally, anterior angles sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border fine and sparse; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with coarse, dense punctures and minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures concentrated along striae, with only very minute setae, otherwise glabrous; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at  $100\times$ ).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa:  $1/1.49$ . Pygidium moderately convex and shiny, coarsely and densely punctate, with a narrow smooth midline, with a few long erect setae along apical margin.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and sparsely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length:  $1/3.2$ ; dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one shortly behind middle, and apical group at  $4/5$  of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin  $4/5$  of metatibial length; lateral face longitudinally convex, finely and sparsely punctate, with-

out convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate anteriorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere distinctly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth blunt; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 3E–G. Female unknown.

**Remarks.** We designate here the lectotype for the species, since in the original description it is not mentioned on how many specimens it was based.

***Neoserica* (s.l.) *gaoligongshanica* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/D81287E8-AEDF-4678-AF2E-84D259899683>

[http://species-id.net/wiki/Neoserica\\_gaoligongshanica](http://species-id.net/wiki/Neoserica_gaoligongshanica)

Figs 3I–L, 7

**Type material examined.** Holotype ♂ “China, Yunnan prov.; Gaoligongshan mts.; 90km W of Baoshan; S. Bečvář leg.; 26-29.v.1995/ Coll. P. Pacholátko Brno Merhautova 68 Czech Republic/ 714 Sericni: Asia spec.” (CPPB). Paratypes: 8 ♂♂, 3 ♀♀ “China, W Yunnan prov., mts. 60Km E Tengchong, 2300m 14.-19.v.2006, S. Murzin & I. Shokhin leg./ Coll. P. Pacholátko Brno Merhautova 68 Czech Republic” (CPPB, ZFMK).

**Description.** Length: 10.5 mm, length of elytra: 7.3 mm, width: 5.9 mm. Body oblong, dark reddish brown, antennal club yellowish brown, dorsal surface except dull pronotum moderately shiny, except a few long setae on head and sides of elytra nearly glabrous.

Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex and convergent anteriorly, anterior angles moderately rounded, anteriorly very weakly sinuate medially, margins moderately reflexed; surface slightly convex and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture indistinctly incised, slightly elevated and distinctly angled medially; smooth area anterior to eye approximately twice as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with a few minute punctures and a few long setae. Frons shiny, in posterior third dull, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes moderately large, ratio diameter/interocular width: 0.65. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 2.5 times as long as remaining antennomeres combined; antennomere 4 subequal to two thirds of length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum moderately transverse, subrectangular, widest a quarter before base, weakly shiny, on disc with dull tomentum, lateral margins evenly convex and moderately convergent anteriorly, slightly narrowed basally, anterior angles moderately sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border fine and sparse; hypomerion distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with coarse, dense punctures and minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures except on second interval concentrated along striae, with only very minute setae, otherwise glabrous, penultimate lateral interval with single, long erect setae, ultimate lateral interval with short, fine, adjacent setae instead of minute ones; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin slightly concave; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a more robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.34. Pygidium strongly convex and shiny, coarsely and densely punctate, with a narrow smooth midline, with a few long erect setae on apical half.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and sparsely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/3.5; dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one shortly behind middle, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, finely and sparsely punctate, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust setae with the posterior one being more distant from the others; medial face smooth, apex concavely sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, but basal tooth rather indistinct; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 3I–K.

**Diagnosis.** *N. gaoligongshanica* sp. n. is in external shape most similar to *N. septemfoliata*, but it differs by the dull pronotum, the larger body size, and the shape of male copulatory organ: the phallobasis is wider, strongly asymmetric apically, with the parameres being strongly dorsoventrally produced having large basal lobes fused with the rest of the paramere.

**Etymology.** The new species is named according its type locality, Gaoligongshan.

**Variation.** Length: 10.2–11.3 mm, length of elytra: 7.3–8.0 mm, width: 5.9–6.0 mm. Female: Antennal club composed of five antennomeres, slightly longer than remaining antennomeres combined, first joint of club a quarter to one third of length of club, 5th antennomere slightly transversely produced; eyes slightly smaller than in male (ratio diameter/interocular width: 0.58).

***Neoserica* (s.l.) *daweishanica* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/AF9F30F7-1886-4AF5-8D07-497A9A3542FF>

[http://species-id.net/wiki/Neoserica\\_daweishanica](http://species-id.net/wiki/Neoserica_daweishanica)

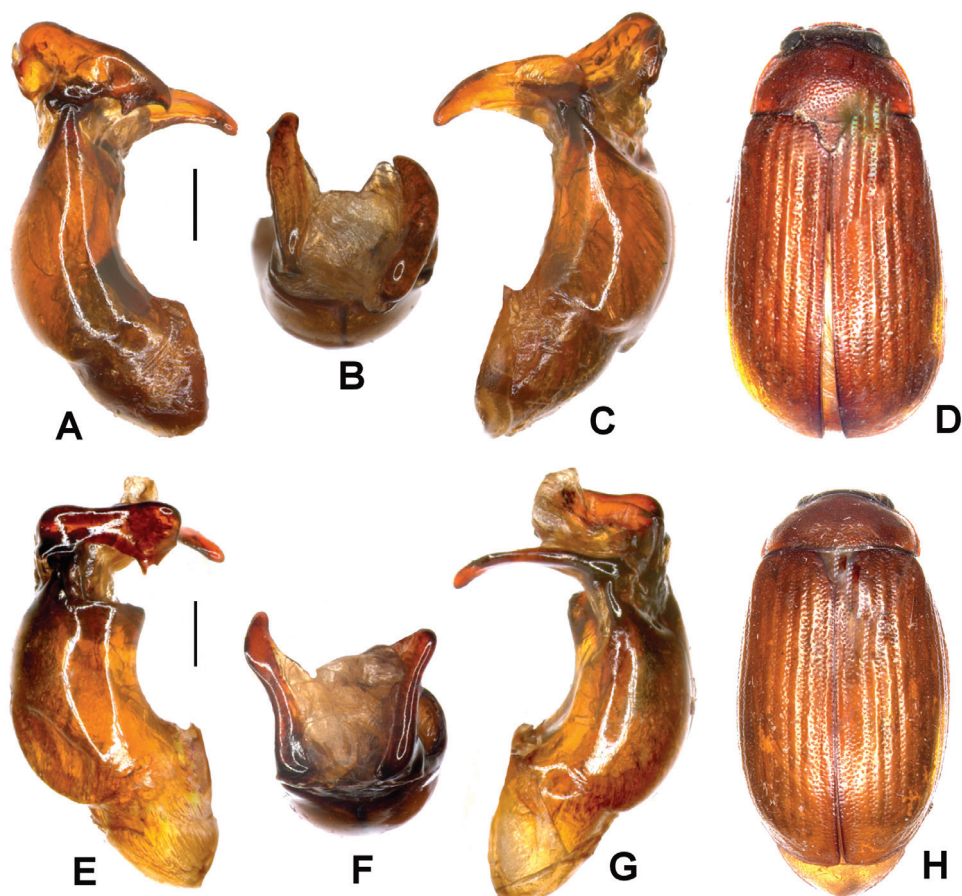
Figs 4A–D, 6

**Type material examined.** Holotype ♂ “Mt. Daweishan, Pingbian, Yunnan, 19.VI.1956, 1500m, leg. Huang Keren etc.” (IZAS). Paratype. 1 ♂ “Mt. Daweishan, Pingbian, Yunnan, 23.VI.1956, 1300m, leg. Huang Keren etc.” (ZFMK).

**Description.** Length: 9.5 mm, length of elytra: 6.9 mm, width: 5.2 mm. Body oblong, reddish brown, antennal club yellowish brown, dorsal surface moderately shiny, nearly glabrous except a few long setae on head.

Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins straight and distinctly convergent anteriorly, anterior angles moderately rounded, anteriorly weakly sinuate medially, margins moderately reflexed; surface slightly convex and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, slightly elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with a few minute punctures and a few long setae. Frons shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes moderately large, ratio diameter/interocular width: 0.71. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, twice as long as remaining antennomeres combined; antennomere 4 subequal to half length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum moderately transverse, subrectangular, widest at base, lateral margins evenly weakly convex and moderately convergent anteriorly, anterior angles sharp and distinctly produced, posterior angles nearly blunt but strongly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border



**Figure 4.** **A–D** *Neoserica dawuishanica* Ahrens, Liu & Fabrizi sp. n. (holotype) **E–H** *N. jiulongensis* Ahrens, Liu & Fabrizi sp. n. (holotype) **A, E** Aedeagus, left side lateral view **C, G** Aedeagus, right side lateral view **B, F** parameres, dorsal view **D, H** Habitus. Scale: 0.5 mm.

fine and sparse; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with coarse, dense punctures and minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals moderately convex, finely and densely punctate, punctures concentrated along striae, with only very minute setae, penultimate lateral interval with a few single fine and long erect setae, otherwise glabrous; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae



half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.4. Pygidium moderately convex and shiny, coarsely and densely punctate, with a narrow smooth midline, with a few long erect setae along apical margin.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and sparsely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/3.3; dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one shortly behind middle, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, finely and sparsely punctate, with a few single setae, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere slightly longer than dorsal tibial spur, subsequent tarsomeres lacking in holotype. Protibia short, tridentate; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 4A–C. Female unknown.

**Diagnosis.** The new species is in external appearance rather similar to *N. septemfoliata*; it differs in the shape of left paramere (dorsal view), which is strongly widened basally (lateral view) having a sharp ventral tooth at apex. Furthermore its antennal club is in male only twice as long as the remaining antennomeres combined (instead of 2.5 times as in *N. septemfoliata*).

**Etymology.** The new species is named after its type locality, Mt. Daweishan.

**Variation.** Length: 8.6–9.5 mm, length of elytra: 6.5–6.9 mm, width: 5.2 mm. First metatarsomere slightly shorter than following two tarsomeres combined.

***Neoserica* (s.l.) *jiulongensis* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/CBAB425A-AD3B-44D8-9842-5866C0A5FB5B>

[http://species-id.net/wiki/Neoserica\\_jiulongensis](http://species-id.net/wiki/Neoserica_jiulongensis)

Figs 4E–H, 6

**Type material examined.** Holotype ♂ “Jiulong, Sichuan, 26.VI.1979, leg. Collecting Group” (IZAS).

**Description.** Length: 9.4 mm, length of elytra: 6.9 mm, width: 5.0 mm. Body oblong, reddish brown, antennal club yellowish brown, dorsal surface moderately shiny, nearly glabrous except a few long setae on head.



Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins weakly convex and convergent anteriorly, anterior angles moderately rounded, anteriorly weakly sinuate medially, margins moderately reflexed; surface slightly convex and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture indistinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length =  $1/3$  of ocular diameter) and wide, with a few minute punctures and one or two long terminal setae. Frons shiny, with fine, dense punctures, beside eyes and behind frontoclypeal suture with long erect setae, on disc only a few slightly shorter setae. Eyes moderately large, ratio diameter/interocular width: 0.61. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, twice as long as remaining antennomeres combined; antennomere 4 subequal to half length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum subrectangular, widest shortly before base, lateral margins evenly convex and moderately convergent anteriorly, slightly narrowed basally, anterior angles sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin moderately convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border fine and sparse; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with coarse, dense punctures and minute setae.

Elytra oblong, widest shortly behind middle, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures concentrated along striae, with only very minute setae, penultimate lateral intervals with single, long setae, otherwise glabrous; epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100 $\times$ ).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.35. Pygidium strongly convex apically and shiny, finely and very densely punctate, with a narrow smooth midline, with a few long erect setae along apical margin.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and sparsely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/3.4; dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one shortly behind middle, and apical group at  $4/5$  of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin  $4/5$  of

metatibial length; lateral face longitudinally convex, finely and sparsely punctate, with sparse fine setae, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate anteriorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere distinctly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth blunt; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 4E–G. Female unknown.

**Diagnosis.** The new species shares with *N. plurilamellata* sp. n. a ventroapically produced phallobasis. It can be easily distinguished by the evenly narrowed posterior lateral margins of pronotum (being not deeply concavely sinuate as in *N. plurilamellata* sp. n.) and the left paramere, which is apically abruptly widened.

**Etymology.** The new species is named after its type locality, Jiulong.

***Neoserica* (s.l.) *changrae* Ahrens, 2004**

Fig. 6

*Neoserica changrae* Ahrens, 2004: 167.

**Distribution.** Bhutan: so far only known from type locality, Changra, 18 km S Tongsa 1900 m [27°24'N, 90°27'E].

***Neoserica* (s.l.) *crenatolineata* Ahrens & Fabrizi, 2009**

Fig. 6

*N. crenatolineata* Ahrens & Fabrizi, 2009: 262.

**Distribution.** Arunachal Pradesh (India): so far only known from type locality, Dirang vicinity [27°21–23'N, 92°13–16'E].

***Neoserica* (s.l.) *sapaensis* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/91F3EE70-8468-4AFF-9ACB-B6B03D1D492F>

[http://species-id.net/wiki/Neoserica\\_sapaensis](http://species-id.net/wiki/Neoserica_sapaensis)

Figs 5A–D, 7

**Type material examined.** Holotype ♂ “N-Vietnam Sa Pa env., Lao Cai Prov. 22°19'52"N, 103°50'35"E 1630–1680m 23.–27.V.1999 leg. Fabrizi, Jäger, Ahrens” (ZFMK). Paratypes: 13 ♂♂, 6 ♀♀ “N-Vietnam Sa Pa env., Lao Cai Prov.

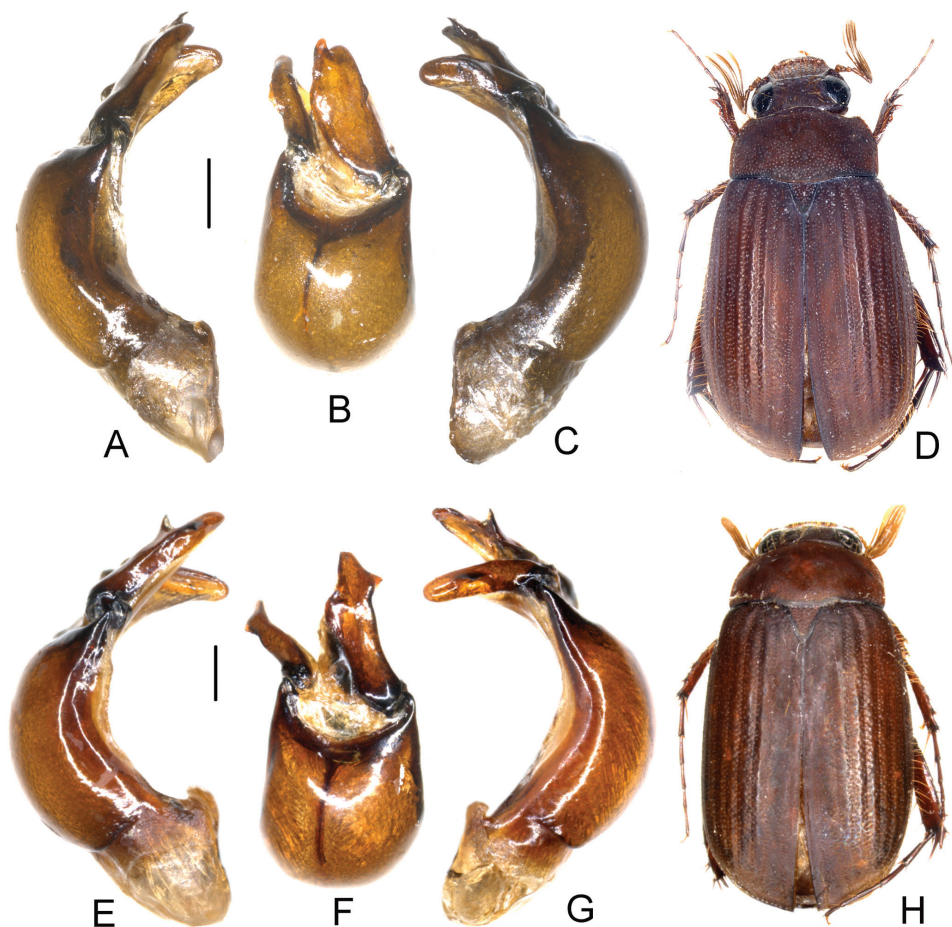
22°19'52"N, 103°50'35"E, 1630–1680m 23.–27.V.1999 leg. Fabrizi, Jäger, Ahrens" (ZFMK), 3 ♂♂ "N.-Vietnam Fan Si Pan near Sapa, 1500–1950m 17.–30.VI.1999 A. Kallies leg." (ZFMK), 1 ♂, 2 ♀♀ "N. Vietnam: Lao Cai Prov. Sa Pa 2-4/VII/1997 collr. C.L. Li" (ZFMK), 2 ♂♂ "Vietnam N (Sa Pa) Lao Cai Prov., 250km from Hanoi bearing 31°, Sa Pa vill. env. Hoang Lien Son Nat. Res. 16.–20.VI.1998 1250m leg. A. Napolov" (CNAR), 1 ♂ "Vietnam N (Sa Pa) Lao Cai Prov., 250km from Hanoi bearing 31°, Sa Pa vill. env. Hoang Lien Son Nat. Res. 27.V.–15.VI.1995 1250m leg. A. Napolov" (CNAR), 1 ♂ N Vietnam (Tonkin) pr. Vinh Phu 1990 Tam Dao 17.–21.V. P. Pacholátko leg./ VS92" (CPPB), 1 ♂ "N Vietnam, 21,35N 106,30E 52km SW of Lang Son, 27.iv.–6.v.1996, 370m Pacholátko & Dembický leg./ VS106" (CPPB), 1 ♂ "Chine-Yunnan Res. Huanglian Shan 22°54'N; 102°18'E alt. 1900M/ Museum Paris 19.VI.2001 Deuve, Mantilleri, Rougerie & Tian leg." (MNHN), 1 ♂ "Yunnan, Yakou, 2012-V-11" (IZAS), 2 ♂♂ "Hetouzhai, Jinping, Yunnan, 12.V.1956, 1600-1700m, leg. Huang Keren etc." (IZAS), 1 ♂ "Hetouzhai, Jinping, Yunnan, 14.V.1956, 1700m, light trap, leg. Huang Keren etc." (IZAS), 1 ♂ "Hetouzhai, Jinping, Yunnan, 10.V.1956, 2000m, leg. Huang Keren" (IZAS), 1 ♂ "Hetouzhai, Jinping, Yunnan, 9.V.1956, 1700m, leg. Huang Keren etc." (IZAS).

**Description.** Length: 9.9 mm, length of elytra: 6.8 mm, width: 5.3 mm. Body oblong, dark reddish brown, antennal club yellowish brown, dorsal surface dull, nearly glabrous except a few long setae on head.

Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight and strongly convergent anteriorly, anterior angles strongly rounded, anterior margin very weakly sinuate medially, margins moderately reflexed; surface flat and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with minute punctures and a few long setae. Frons dull, anterior quarter shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes large, ratio diameter/interocular width: 0.74. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 2.5 times as long as remaining antennomeres combined; antennomere 4 subequal to two thirds of length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.

Pronotum subrectangular, widest at base, lateral margins nearly straight and subparallel in basal half, evenly convex and moderately convergent in anterior half, anterior angles moderately sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border fine and moderately dense; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with fine, dense punctures and minute setae.

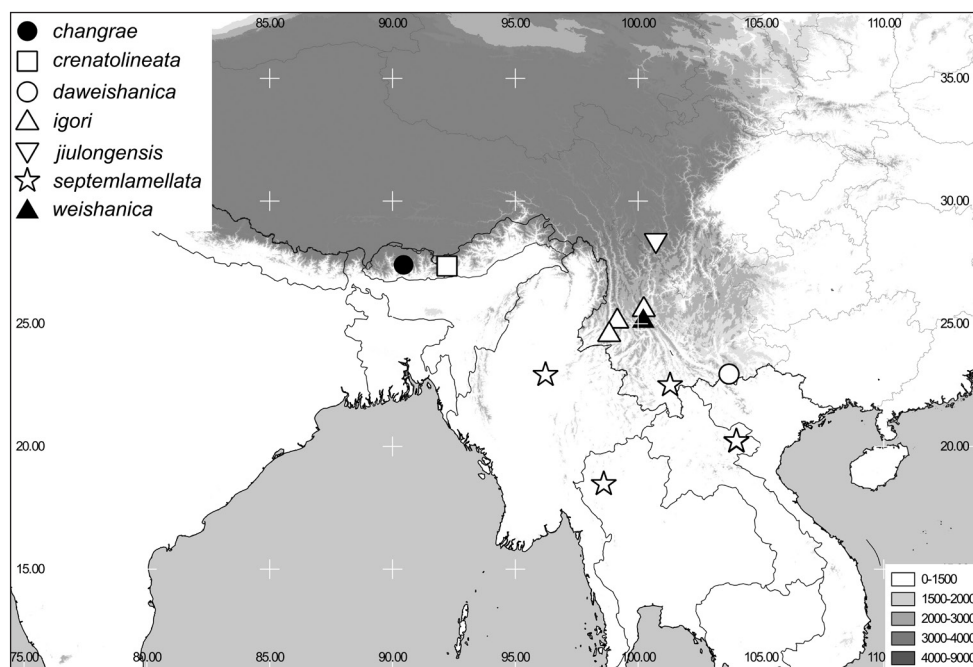
Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures concentrat-



**Figure 5.** **A–D** *Neoserica sapaensis* Ahrens, Liu & Fabrizi sp. n. (holotype) **E–H** *N. igori* Ahrens, Liu & Fabrizi sp. n. (holotype) **A, E** Aedeagus, left side lateral view **C, G** Aedeagus, right side lateral view **B, F** parameres, dorsal view **D, H** Habitus. Scale: 0.5 mm.

ed along striae, with minute setae, odd intervals with a few erect setae (partially lacking on disc); epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100×).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.31. Pygidium strongly convex and dull, coarsely and densely punctate, with a narrow smooth midline, with dense, long erect setae and minute setae.



**Figure 6.** Distribution of the species of the *Neoserica* (s.l.) *septemlamellata* group: *N. changrae*, *N. crenatolineata*, *N. daweishanica*, *N. igori*, *N. jiulongensis*, *N. septemlamellata*, *N. weishanica*.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and moderately densely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/2.9; dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one shortly behind middle, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, finely and moderately densely punctate, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere distinctly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth blunt; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.



Aedeagus: Fig. 5A–C.

**Diagnosis.** The new species is quite similar to *N. septemlamellata* in external morphology. It may be distinguished by the lacking dense dorsal pilosity on pronotum and elytra, and by the shape of male copulation organ: left paramere much wider, without basal lobe, right paramere not widened apically but with a lateral tooth at the middle.

**Etymology.** *N. sapaensis* sp. n. is named according to its type locality Sa Pa (Vietnam).

**Variation.** Length: 8.9–9.9 mm, length of elytra: 6.4–6.8 mm, width: 4.9–5.3 mm. Female: Antennal club composed of five antennomeres, slightly longer than remaining antennomeres combined, first joint of club a quarter to one third of length of club, 5th antennomere slightly transversely produced; eyes slightly smaller than in male (ratio diameter/interocular width: 0.62).

***Neoserica* (s.l.) *igori* Ahrens, Fabrizi & Liu, sp. n.**

<http://zoobank.org/6282FD81-D221-4952-A48F-2959D23B466A>

[http://species-id.net/wiki/Neoserica\\_igori](http://species-id.net/wiki/Neoserica_igori)

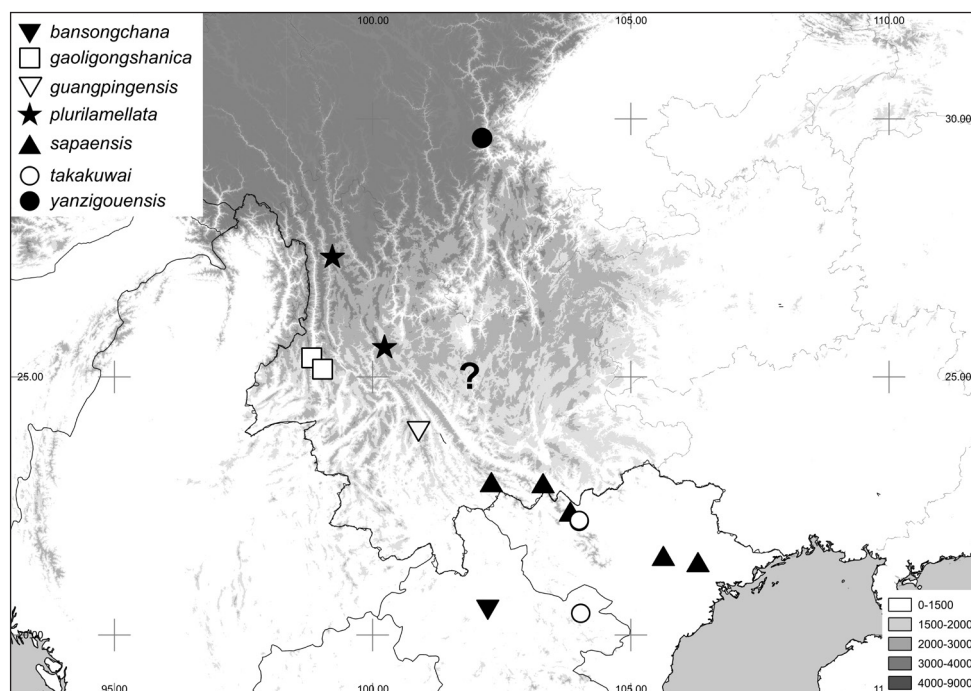
Figs 5E–H, 6

**Type material examined.** Holotype: ♂ “China, N.Yunnan, env. Xiaguan, 2400m, 29.vii.2002, leg. S. Murzin, I. Shokhin/ Coll. P. Pacholátko Brno Merhautova 68 Czech Republic/ 821 Sericini: Asia spec.” (CPPB). Paratypes: 1 ♂, 1 ♀ “China, N.Yunnan, env. Xiaguan, 2400m, 29.vii.2002, leg. S. Murzin, I. Shokhin/ Coll. P. Pacholátko Brno Merhautova 68 Czech Republic ” (CPPB, ZFMK), 4 ♂♂ “China, W. Yunnan, env. Baoshan, 2500m, 2.–3.viii.2002, leg. S. Murzin, I. Shokhin/ Coll. P. Pacholátko Brno Merhautova 68 Czech Republic ” (CPPB, ZFMK), 1 ♂ “Mt. Heishan, Longxin, Longling, Yunnan, 23-25.VII.2008, leg. Xu Jishan, Gao Zhenhua” (HBUM).

**Description.** Length: 9.0 mm, length of elytra: 6.5 mm, width: 4.9 mm. Body oblong, dark reddish brown, antennal club yellowish brown, dorsal surface dull, nearly glabrous except a few long setae on head.

Labroclypeus trapezoidal, distinctly wider than long, widest at base, lateral margins nearly straight and strongly convergent anteriorly, anterior angles strongly rounded, anterior margin nearly straight, margins moderately reflexed; surface flat and shiny, basis without dull tomentum, punctation dense, small punctures mixed with coarse ones each bearing a long erect seta; frontoclypeal suture distinctly incised, not elevated and distinctly angled medially; smooth area anterior to eye approximately 2.5 times as wide as long; ocular canthus moderately long (length = 1/3 of ocular diameter) and wide, with minute punctures and a few long setae. Frons dull, anterior quarter shiny, with coarse and fine, dense punctures, densely covered with long erect setae. Eyes large, ratio diameter/interocular width: 0.74. Antenna with ten antennomeres, club with seven antennomeres, moderately reflexed, 2.5times as long as remaining antennomeres combined; antennomere 4 subequal to two thirds of length of club, antennomere 3 half as long as pedicellus. Mentum elevated and slightly flattened anteriorly.





**Figure 7.** Distribution of the species of the *Neoserica* (s.l.) *septemlamellata* group: *N. bansongchana*, *N. gaoligongshanica*, *N. guangpingensis*, *N. plurilamellata*, *N. sapaensis*, *N. takakuwai*, *N. yanzigouensis*. "?" stands for the not localised records of *N. septemfoliata* from Yunnan.

Pronotum subrectangular, widest at base, lateral margins nearly straight and sub-parallel in basal half, evenly convex and moderately convergent in anterior half, anterior angles moderately sharp and distinctly produced, posterior angles blunt, slightly rounded at tip; anterior margin convexly produced medially, marginal line incomplete medially; surface densely and coarsely punctate, only with minute setae; setae of anterior and lateral border fine and moderately dense; hypomeron distinctly carinate basally, carina not produced. Scutellum narrow and long, dull, with fine, dense punctures and minute setae.

Elytra oblong, widest in posterior third, striae weakly impressed, finely and densely punctate, intervals weakly convex, finely and densely punctate, punctures concentrated along striae, with minute setae, odd intervals with a few erect setae (partially lacking on disc); epipleural edge wide, ending at widely rounded apical angle of elytra, epipleura densely setose, apical border narrowly membranous, with a fine fringe of microtrichomes (visible at 100 $\times$ ).

Ventral surface dull, coarsely and densely punctate, metasternum moderately setose; metacoxa glabrous, with a few long setae laterally, posterior margin straight; abdominal sternites finely and densely punctate, minutely setose, with a transverse row of coarse punctures each bearing a robust, long seta. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.33. Pygidium

strongly convex and dull, coarsely and densely punctate, with a narrow smooth midline, with dense, long erect setae and minute setae.

Legs moderately slender and not very long; femora with two longitudinal rows of setae, finely and moderately densely punctate, nearly glabrous; metafemur dull, anterior margin acute, immediately behind anterior edge with a continuously serrated line, punctures and setae of anterior longitudinal row complete, posterior margin in apical half ventrally smooth and not widened, posterior margin smooth dorsally, not serrated, with dense, short setae. Metatibia moderately slender and long, widest at apex, ratio of width/length: 1/3.1; dorsal margin sharply carinate, with three groups of spines, basal group shortly before middle, median one shortly behind middle, and apical group at 4/5 of metatibial length, basally with a few robust but single setae; beside dorsal margin with a continuously serrated line being subparallel with dorsal margin 4/5 of metatibial length; lateral face longitudinally convex, finely and moderately densely punctate, without convex subdorsal longitudinal carina on lateral face; ventral margin finely serrated, with four robust equidistant setae; medial face smooth, apex indistinctly sinuate interiorly near tarsal articulation. Tarsomeres with dense, short setae ventrally, not carinate laterally, smooth dorsally; metatarsomeres with a strongly serrated ventral ridge and a sharp subventral carina immediately beside it, first metatarsomere distinctly shorter than following two tarsomeres combined and slightly longer than dorsal tibial spur. Protibia short, tridentate, basal tooth blunt; anterior claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 5E–G.

**Diagnosis.** The new species is similar to *N. sapaensis* sp. n. in external and genital morphology. It may be distinguished by the presence of a lateral external tooth at apical external margin of the left paramere.

**Etymology.** The new species is named after one of its collectors, Igor Shokhin.

**Variation.** Length: 8.6–9.5 mm, length of elytra: 6.5–7.2 mm, width: 4.9–5.2 mm. Female: Antennal club with five antennomeres, short, as long as remaining antennomeres combined, first joint of club half as long as club; eyes smaller than in male (ratio diameter/interocular width: 0.58).

## Acknowledgements

D.A. was in main part of the taxonomic revisions for this work supported by grants from the German Science foundation (GRK 5 503/2, AH175/1-1) and by SYNTHESYS (GB-TAF-63 and 917, SE-TAF 3424). Part of this research was supported by the National Basic Research Program of China (973 Program) (No. 2011CB302102), the National Natural Science Foundation of China (Nos. 31010103913, 31172143). We are grateful to Ren Guodong (HBUM), Liu Guoqing (NKU), Konjev Desender (ISNB), Manfred Uhlig, Johannes Frisch (both ZMHB), Martin Baehr (ZSM), Olivier Montreuil (MNHN), Petr Pacholátko (Brno), and Jiří

Hájek (NMPC) for their kindly loaning to us unidentified Sericini specimens, to the Alexander Koenig Gesellschaft (Bonn) for funding in part the technical work of this study at the ZFMK.

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