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Batwanema gen. n. and *Chokwenema* gen. n. (Oxyurida, Hystrignathidae), new nematode genera as parasites of Passalidae (Coleoptera) from the Democratic Republic of Congo

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Abstract

Two new genera and species parasitizing passalid beetles from the Democratic Republic of Congo are described. *Batwanema congo* **gen. n. et sp. n.** is characterized by having females with the cervical cuticle armed with scale-like projections, arranged initially in rows of eight elements that gradually divide and form pointed spines toward the end of the spiny region, two cephalic annuli, clavate procorpus and genital tract monodelphic-prodelphic. Two Malagasian species of *Artigasia* Christie, 1934 were placed in this genus as *B. latum* (Van Waerebeke, 1973) **comb. n.** and *B. annulatum* (Van Waerebeke, 1973) **comb. n.** *Chokwenema lepidophorum* **gen. n. et sp. n.** is characterized by having females with the cervical cuticle armed with scale-like projections, arranged initially in rows of eight elements (similar to *Batwanema*) that divide gradually, forming spines; a single cephalic annule cone-like, truncated, moderately inflated; procorpus sub-cylindrical and genital tract didelphic-amphidelphic.

Keywords
Nematoda, Hystrignathidae, *Batwanema*, *Chokwenema*, Passalidae, Democratic Republic of Congo

Introduction

The nematode family Hystrignathidae Travassos, 1920 is well known as a parasite group restricted to the gut of passalid beetles. At present, 29 genera have been described with more than 100 species.

One of these genera: *Artigasia* Christie, 1934 was diagnosed on the basis of presenting spines on the cervical cuticle, a clavate procorpus and a genital system monodelphic-prodelphic (Christie 1934, Adamson and Van Waerebeke 1992). Considering this diagnosis, many species have been described and placed in *Artigasia.* However, current studies on the genus showed that several species differ notably in features previously ignored, but with a great taxonomic value, such as the form of the cephalic end and the arrangement and shape of the cervical spines. Such combination of features appears to support the statement of *Artigasia* as a complex of genera morphologically distinct.

The African fauna of Hystrignathidae is poorly known with a few species belonging to the genera *Artigasia* (with the larger number of species), *Hystrignathus* Leidy, 1850; *Passalidophila* Van Waerebeke, 1973 and *Xyo* Cobb, 1898 (Théodoridès 1955, 1958; Baker 1967, Van Waerebeke 1973, Van Waerebeke and Remillet 1982). Recently, the study of the group in the area was retaken by Morffe and García (2013) with the description of two new genera from the Democratic Republic of Congo: *Kongonema* Morffe & García, 2013 and *Lubanema* Morffe & García, 2013.

As a continuation of the studies on Congolese hystrignathids, the present paper deals with two new genera. One of these is created in order to separate two peculiar species of *Artigasia.*

Materials and methods

Several specimens of passalid beetles from the Democratic Republic of Congo were examined during a research visit to the Royal Museum of Central Africa, Tervuren, Belgium. Six specimens of *Pentalobus barbatus* (Fabricius, 1801), three of *Didimoides* cf. *parastictus* (Imhoff, 1843) (all the latter from Mongwalu, Ituri province, Democratic Republic of Congo) and four specimens of *Pentalobus* sp. from Bambesa, Uele region, Democratic Republic of Congo were revised for parasitological studies. All of these passalids were collected during the Belgian expeditions to the Congo in the 1930´s and stored in 70% ethanol.

The hosts were dissected by making incisions in both pleural membranes and the last abdominal sternites. Intestines were extracted and kept in Petri dishes with 70%

ethanol. The guts were excised and the parasites removed. Nematodes were transferred to anhydrous glycerine via the slow evaporation method and mounted in the same medium. The edges of the coverslips were sealed using nail polish. Measurements were made with a calibrated eyepiece micrometer attached to a compound microscope. De Man's ratios a, b, c and V% were calculated. Each variable is shown as the range followed by the mean plus standard deviation in parentheses; the number of measurements is also given. Micrographs were taken with an AxioCam digital camera attached to a Carl Zeiss AxioScop 2 Plus compound microscope. Line drawings were made with the softwares CorelDRAW X3 and Adobe Photoshop CS2 using the micrographs as masters. Scale bars of all plates are given in millimeters.

Some specimens were processed for SEM as follows: they were dehydrated in a graded ethanol series, critical point-dried, mounted in aluminum stubs and coated in gold. SEM micrographs were taken at an acceleration voltage of 22–25 kV.

The type material and vouchers are deposited in the Colección Helmintológica de las Colecciones Zoológicas (CZACC), Instituto de Ecología y Sistemática, Havana, Cuba; the Collection of the Royal Museum of Central Africa (RMCA), Tervuren, Belgium; the Royal Belgian Institute of Natural Sciences (RIT), Brussels, Belgium and the Coleçao Helmintologica do Instituto Oswaldo Cruz (CHIOC), Rio de Janeiro, Brazil.

Systematics

Family Hystrignathidae Travassos, 1920

Genus *Batwanema* gen. n.

http://zoobank.org/9B039791-CD4A-4932-A5F8-9A5F7A333FE3
http://species-id.net/wiki/Batwanema

Generic diagnosis. Female. Cervical cuticle armed with wide, scale-like projections, arranged initially in rows of eight elements. Scales divide gradually, forming pointed spines toward the end of the spiny region. Lateral alae present. Head bearing eight rounded, paired papillae. Two short, not prominent cephalic annuli next to head, the second slightly longer and wider than the first. Oesophagus with procorpus clavate, its base set-off from the isthmus. Excretory pore post-bulbar. Genital tract monodelphic-prodelphic. Eggs ovoid. Tail subulate.

Type species. *Batwanema congo* Morffe & García, gen. n. et sp. n.

Other species. *B. latum* (Van Waerebeke, 1973) comb. n.; *Artigasia lata* Van Waerebeke, 1973: pag. 13, fig. 90–101.; *B. annulatum* (Van Waerebeke, 1973) comb. n.; *Artigasia annulata* Van Waerebeke, 1973: pag. 13, fig. 84–89.

Distribution. Democratic Republic of Congo, Madagascar.

Etymology. The generic epithet (neuter in gender), is a combination of Batwa, after the pygmy ethnic group that inhabits the D. R. of Congo, and the suffix–nema.

***Batwanema congo* sp. n.**
http://zoobank.org/303612B9-C74C-4296-9BC9-8C291145AFD1
http://species-id.net/wiki/Batwanema_congo
Figure 1 A–G, 2 A–E

Type material. ♀ holotype, Democratic Republic of Congo, Ituri province, Mongwalu; in *Pentalobus barbatus*; 5.VI.1939; Lepersonne coll.; CZACC 11.4700. Paratypes: 4 ♀♀, same data as holotype, CZACC 11.4701-11.4704; 3 ♀♀, same data as holotype, RMCA; 1 ♀♀, same data as holotype, RIT820; 1 ♀♀, same data as holotype, CHIOC.

Additional material. Vouchers: 3♀♀, Democratic Republic of Congo, Uele region, Bambesa, 3°28'N, 25°43'E; in *Pentalobus* sp.; 15.V.1937; J. Vrijdagh coll.; CZACC 11.4705-11.4707. 2♀♀, same data as the latter, RMCA.

Measurements. Holotype (female) a = 14.81, b = 6.24, c = 7.90, V% = 50.63, total length = 2.370, maximum body width = 0.160, stoma length = 0.045, procorpus length = 0.290, isthmus length = 0.033, diameter of basal bulb = 0.070, total length of oesophagus = 0.380, nerve ring to anterior end = 0.200, excretory pore to anterior end = 0.550, anus to posterior end = 0.300, eggs = 0.100–0.110×0.045–0.050 (0.106 ± 0.005×0.048 ± 0.003 n = 3).

Paratypes (females) (n = 9) a = 13.20–17.50 (14.72 ± 1.50 n = 9), b = 4.92–5.56 (5.33 ± 0.24 n = 9), c = 6.28–7.48 (6.87 ± 0.40 n = 9), V% = 51.83–54.29 (52.76 ± 0.92 n = 7), total length = 1.820–2.170 (2.013 ± 0.138 n = 9), maximum body width = 0.120–0.160 (0.138 ± 0.015 n = 9), stoma length = 0.040–0.050 (0.045 ± 0.003 n = 9), procorpus length = 0.270–0.320 (0.283 ± 0.016 n = 9), isthmus length = 0.025–0.035 (0.031 ± 0.004 n = 9), diameter of basal bulb = 0.060–0.075 (0.067 ± 0.004 n = 9), total length of oesophagus = 0.350–0.420 (0.378 ± 0.020 n = 9), nerve ring to anterior end = 0.170–0.210 (0.191 ± 0.013 n = 9), excretory pore to anterior end = 0.490–0.550 (0.515 ± 0.026 n = 4), anus to posterior end = 0.260–0.310 (0.293 ± 0.015 n = 9), eggs = 0.098–0.123×0.030–0.053 (0.108 ± 0.006×0.041 ± 0.006 n = 16).

Specimens from Bambesa. Females (n = 5) a = 15.91–21.00 (18.40 ± 2.22 n = 5), b = 5.11–6.10 (5.60 ± 0.40 n = 5), c = 5.39–6.13 (5.68 ± 0.30 n = 5), V% = 49.74–54.30 (51.84 ± 1.65 n = 5), total length = 1.510–1.890 (1.716 ± 0.162 n = 5), maximum body width = 0.080–0.110 (0.094 ± 0.011 n = 5), stoma length = 0.040–0.050 (0.043 ± 0.004 n = 5), procorpus length = 0.185–0.270 (0.227 ± 0.030 n = 5), isthmus length = 0.025–0.038 (0.032 ± 0.005 n = 5), diameter of basal bulb = 0.033–0.058 (0.049 ± 0.010 n = 5), total length of oesophagus = 0.258–0.360 (0.308 ± 0.036 n = 5), nerve ring to anterior end = 0.135–0.180 (0.155 ± 0.019 n = 4), excretory pore to anterior end = 0.380–0.430 (0.397 ± 0.029 n = 3), anus to posterior end = 0.280–0.340 (0.302 ± 0.023 n = 5), eggs = 0.095–0.118×0.033–0.045 (0.110 ± 0.008×0.039 ± 0.005 n = 10).

Description. Body comparatively slender, widening from the base of the second cephalic annule, maximum body diameter at level of the vulva, tapering towards anus.

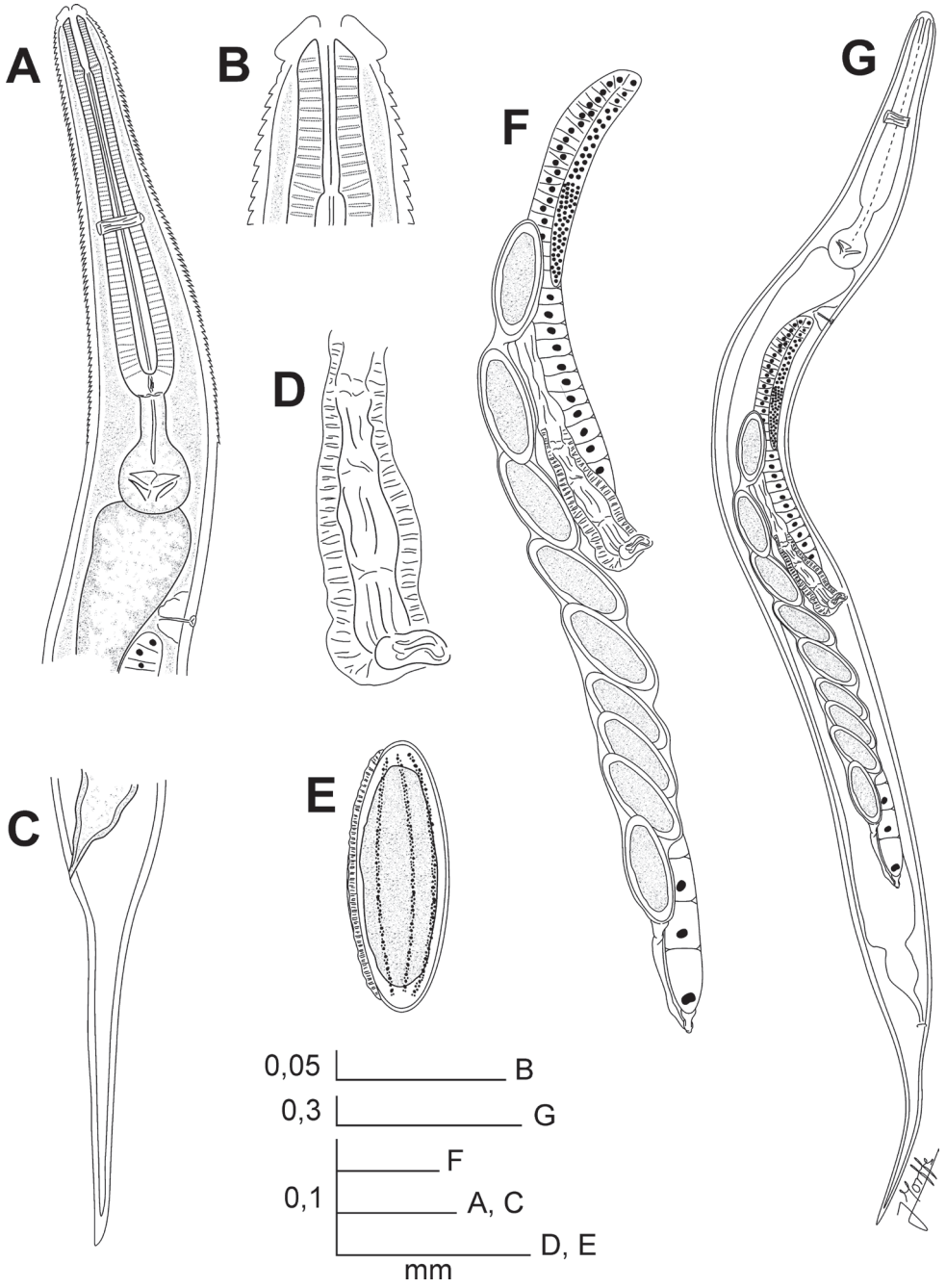

Figure 1. *Batwanema congo* gen. n. et sp. n. Female. **A** Oesophageal region, lateral view **B** Cephalic end, internal view **C** Tail, lateral view **D** Vulva, ventro-lateral view **E** Egg **F** Genital tract, ventro-lateral view **G** Habitus, ventro-lateral view.

Cuticle markedly annulated in the spiny region, annuli (*ca.* 2 μm) less marked in the rest of body. Cervical region armed with rows of cuticular projections from the end of the second cephalic annule to the base of isthmus. First row consisting of eight wide, rectangular, scale-like cuticular projections. At level of row 3-4, a shallow cleavage at midpoint of the scales becoming deeper and wider towards the posterior region of body, until reaching row 8–9, where each scale is divided in two or three spines, their tips rounded. Next to it, spines become pointed gradually and increase their number: *ca.* 22 elements in the median rows and *ca.* 34 in the last rows. Lateral alae commencing at level of the isthmus, within the spiny region and extending to about three body-widths posterior to the vulva. Sub-cuticular longitudinal striae present. Head set-off from body by a deep groove, bearing eight rounded, less prominent, paired papillae. Amphids lateral, pore-like. Next to head, two short, not prominent cephalic annule; the second slightly wider and longer than the first. Cephalic annuli poorly differentiated one from the other, only by a shallow groove. Mouth circular. Stoma about four head-lengths long, surrounded by an oesophageal collar. Lumen of anterior region of stoma triangular, with a ridge in each side. Oesophagus consisting of a muscular clavate procorpus, well set-off from the isthmus. Basal bulb rounded, valve plate well developed. Intestine simple, sub-rectilinear. Rectum short, anus not prominent. Nerve ring encircling procorpus at about its midpoint. Excretory pore situated at about half of body width posterior to basal bulb. Vulva a median transverse slit near midbody, lips slightly prominent. Vagina muscular, forwardly directed. Genital tract monodelphic-prodelphic. Ovary reflexed behind the excretory pore, distal flexure *ca.* 1.5 body-widths long. Eggs ovoid, shell with eight rough, longitudinal, hardly prominent ridges. Tail conical, subulate, ending in a sharp point. Male unknown.

Discussion. *Batwanema* gen. n. presents a similar arrangement of the cervical cuticular projections to *Chokwenema* gen. n., consisting of a first row of eight rectangular scales that gradually bifurcate, becoming pointed spines. It can be differentiated by its reproductive system monodelphic-prodelphic contrary to didelphic-amphidelphic. The genus has two cephalic annuli barely expanded *vs.* the unique truncate, more expanded first cephalic annule of *Chokwenema* gen. n. In addition, the procorpus of *Batwanema* gen. n. is clavate *vs.* sub-cylindrical.

The other genera with scales in the cervical cuticle are *Lepidonema* Cobb, 1898 and *Salesia* Travassos & Kloss, 1958, both having genital tracts didelphic-amphidelphic and with more elements in the first row of spines: 16 *vs.* 8 and a single, large cephalic annuli *vs.* the two shorter of *Batwanema* gen. n. Also, *Lepidonema* has a sub-cylindrical procorpus *vs.* the clavate of *Batwanema* gen. n.

Van Waerebeke (1973) described 14 species of Malagasian *Artigasia*, all of these quite variable in the shape of the cephalic end and the form and arrangement of spines. Two of such species: *A. lata* and *A. annulata* are characterized, in addition to the clavate procorpus and the monogonant genital tract, by the presence of two cephalic annuli (the second larger) and the cervical region with scale-like cuticular projections. These scales are arranged initially in a row of eight elements, which increase their number and become gradually in pointed spines. The latter features agree with the

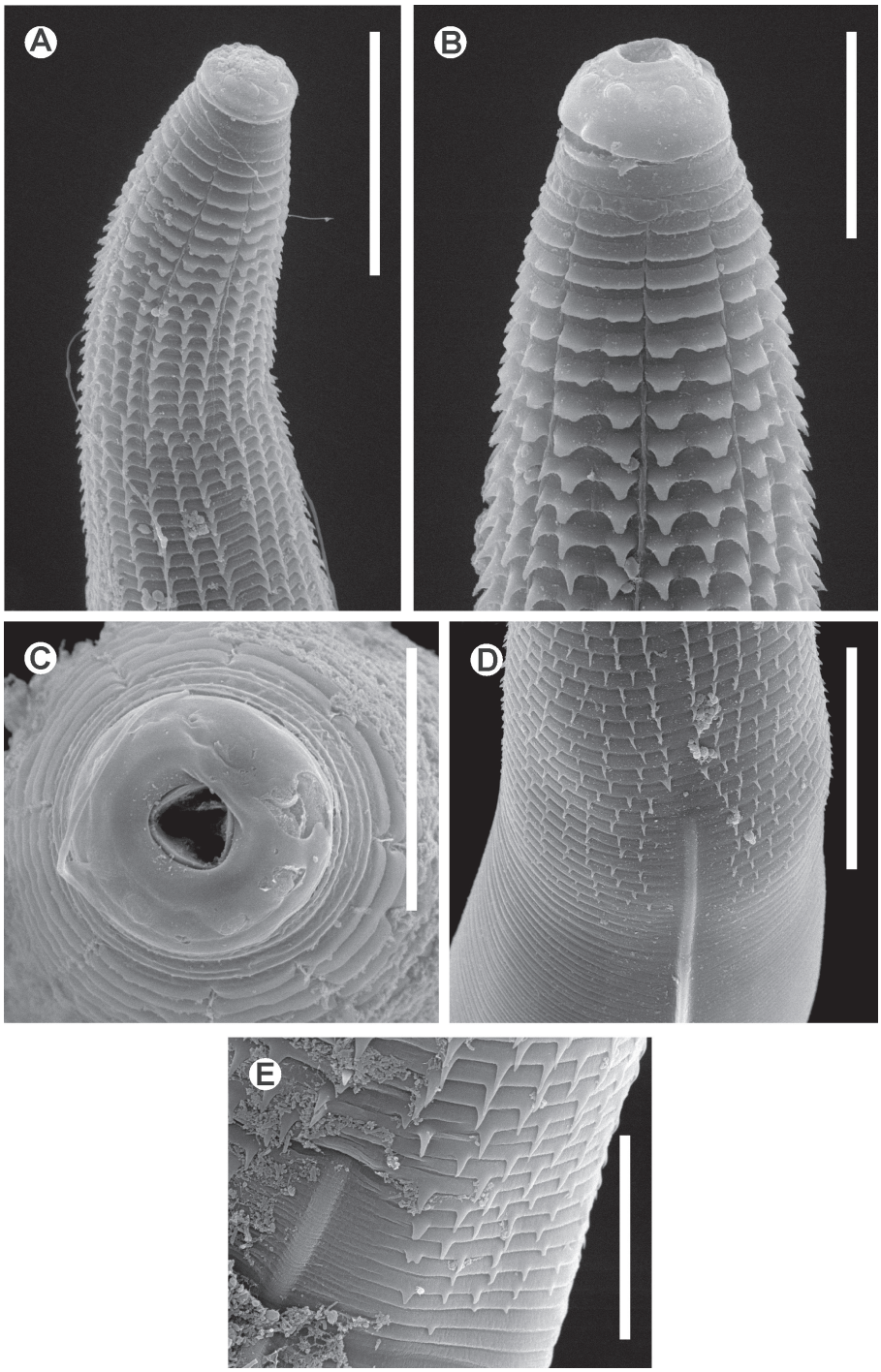

Figure 2. *Batwanema congo* gen. n. et sp. n. Female. SEM images **A** Cervical region **B** Cephalic end, lateral view **C** Cephalic end, *en face* view **D** End of the spiny region and beginning of a lateral ala **E** Detail of the beginning of a lateral ala. Scale lines: **A, D** 0.05 mm, **B** 0.025 mm, **C, E** 0.02 mm.

diagnosis of *Batwanema* gen. n., supporting the establishment of *Batwanema latum* comb. n. and *B. annulatum* comb. n. as new combinations of *A. lata* and *A. annulata.*

B. congo gen. n. et sp. n. can be segregated from *B. latum* comb. n. by the extension of the cervical spines and lateral alae. In the new species, the spines end at level of the basal bulb *vs.* the level of the nerve ring in *B. latum* comb. n. On the other hand, the lateral alae of *B. congo* gen. n. et sp. n. arise within the spiny region and extend to a distance beyond the vulva, whereas *B. latum* comb. n. presents lateral alae from the beginning of the isthmus to the level of anus. *B. congo* gen. n. et sp. n. has a larger body (1.820–2.370 *vs.* 1.360–1.472) but the oesophagus is comparatively shorter (b = 4.92–6.24 *vs.* 4.10–4.60).

The eggs of both taxa are similar in size (*B. congo* gen. n. et sp. n. = 0.098–0.123×0.030–0.053; *B. latum* = 0.112–0.116×0.039–0.042), but are ridged-shelled in *B. congo* gen. n. et sp. n. *vs.* the smooth-shelled eggs of *B. latum* comb. n. The tail of *B. congo* gen. n. et sp. n. is comparatively longer (c = 6.28–7.90 *vs.* 11.00–13.00).

B. congo gen. n. et sp. n. differs from *B. annulatum* comb. n. by the cervical spines extending further down the body, whereas *B. annulatum* comb. n. has spines ending before the level of the basal bulb. Lateral alae of *B. annulatum* comb. n. extend from the level of the isthmus to the level of the anus in opposition to *B. congo* gen. n. et sp. n. where the lateral alae clearly finish before the anus. *B. congo* gen. n. et sp. n. is also longer (1.820–2.370 *vs.* 1.439–1.509), with the oesophagus comparatively shorter (b = 4.92–6.24 *vs.* 4.50–4.60). Moreover, the eggs of *B. annulatum* comb. n. are smooth-shelled *vs.* the ridged-shelled ones of *B. congo* gen. n. et sp. n.

Type host. *Pentalobus barbatus* (Fabricius, 1801) (Coleoptera: Passalidae).

Other host. *Pentalobus* sp. (Coleoptera: Passalidae).

Site. Gut caeca.

Type locality. Mongwalu, Ituri province, Democratic Republic of Congo.

Other locality. Bambesa, Uele region, Democratic Republic of Congo.

Etymology. Specific epithet in apposition refers to the country of the new taxon.

Genus *Chokwenema* gen. n.

http://zoobank.org/CF402D0C-D9CB-47F4-9B52-08BAC87A6D11
http://species-id.net/wiki/Chokwenema

Generic diagnosis. Female. Cervical cuticle armed with wide, scale-like projections, arranged initially in rows of eight elements. Scales divide gradually, forming spines. Head bearing eight rounded, paired papillae. First cephalic annule cone-like, truncated, comparatively long, moderately inflated. Oesophagus with procorpus sub-cylindrical, its base set-off from the short isthmus. Excretory pore post-bulbar. Genital tract didelphic-amphidelphic. Eggs ovoid. Tail subulate.

Type species. *Chokwenema lepidophorum* Morffe & García gen. n. et sp. n.

Distribution. Democratic Republic of Congo.

Etymology. The generic name (neuter in gender) is derived of Chokwe, after an ethnic group from Central Africa (including the D. R. of Congo) and the suffix–nema.

***Chokwenema lepidophorum* sp. n.**
http://zoobank.org/124AD063-4948-4F9C-8BD2-F796C14DAA59
http://species-id.net/wiki/Chokwenema_lepidophorum
Figure 3 A–H, 4 A–C

Type material. ♀ holotype, Democratic Republic of Congo, Ituri province, Mongwalu; in *Didimoides* cf. *parastictus*.; 5.VI.1939; Lepersonne coll.; CZACC 11.4708. Paratypes: 3 ♀♀, same data as holotype, CZACC 11.4709-11.4711; 4 ♀♀, same data as holotype, RMCA; 1 ♀♀, same data as holotype, CHIOC.

Additional material. Vouchers: 3♀♀, Democratic Republic of Congo, Ituri province, Mongwalu; in *Pentalobus barbatus*; 5.VI.1939; Lepersonne coll.; CZACC 11.4712-11.4714; 2♀♀, same data as the latter, RMCA; ♀, same data as the latter, RIT821.

Measurements. Holotype (female) a = 11.65, b = 5.25, c = 13.40, V% = 55.97, total length = 2.680, maximum body width = 0.230, first cephalic annule (length×width) = 0.018×0.063, stoma length = 0.038, procorpus length = 0.400, isthmus length = 0.025, diameter of basal bulb = 0.090, total length of oesophagus = 0.510, nerve ring to anterior end = 0.260, excretory pore to anterior end = 0.720, anus to posterior end = 0.200, eggs = 0.093–0.098×0.038–0.040 (0.095 ± 0.003×0.039 ± 0.001 n = 3).

Paratypes (females) (n = 8) a = 9.09–15.63 (10.87 ± 2.40 n = 6), b = 4.26–4.90 (4.62 ± 0.28 n = 5), c = 11.68–12.53 (12.04 ± 0.36 n = 4), V% = 54.40–57.75 (55.76 ± 1.24 n = 6), total length = 2.000–2.500 (2.192 ± 0.181 n = 6), maximum body width = 0.160–0.225 (0.209 ± 0.021 n = 8), first cephalic annule (length×width) = 0.015–0.020×0.058–0.063 (0.018 ± 0.002×0.060 ± 0.002 n = 6), stoma length = 0.030–0.040 (0.035 ± 0.004 n = 7), procorpus length = 0.330–0.420 (0.376 ± 0.032 n = 7), isthmus length = 0.023–0.038 (0.027 ± 0.006 n = 5), diameter of basal bulb = 0.088–0.100 (0.093 ± 0.005 n = 8), total length of oesophagus = 0.450–0.520 (0.487 ± 0.026 n = 6), nerve ring to anterior end = 0.210–0.260 (0.235 ± 0.021 n = 4), excretory pore to anterior end = 0.660, anus to posterior end = 0.170–0.210 (0.184 ± 0.019 n = 4), eggs = 0.090–0.100×0.038–0.050 (0.097 ± 0.004×0.043 ± 0.004 n = 11).

Specimens from *Pentalobus barbatus*. Females (n = 6) a = 10.36–15.00 (13.25 ± 1.85 n = 6), b = 4.94–5.80 (5.41 ± 0.31 n = 6), c = 13.35–15.73 (14.21 ± 0.95 n = 6), V% = 51.31–56.99 (53.49 ± 2.40 n = 5), total length = 2.175–2.720 (2.453 ± 0.228 n = 6), maximum body width = 0.170–0.210 (0.187 ± 0.016 n = 6), first cephalic annule (length×width) = 0.015–0.018×0.048–0.058 (0.016 ± 0.001×0.053 ± 0.004 n = 6), stoma length = 0.033–0.038 (0.036 ± 0.002 n = 6), procorpus length = 0.310–0.390 (0.353 ± 0.027 n = 6), isthmus length = 0.018–0.033 (0.025 ± 0.006 n = 5), diameter of basal bulb = 0.083–0.103 (0.091 ± 0.007 n = 6), total length of oesophagus = 0.410–0.490 (0.453 ± 0.029 n = 6), nerve ring to anterior end = 0.210–0.250 (0.228 ± 0.015 n = 5), anus to posterior end = 0.150–0.200 (0.173 ± 0.022 n = 6), eggs = 0.088–0.100×0.035–0.050 (0.095 ± 0.004×0.042 ± 0.004 n = 10).

Description. Female body robust, widening from the base of the first cephalic annule, maximum body diameter at level of the vulva, then tapering towards anus. Cuticle markedly annulated in the spiny region, annuli less marked in the rest of the body (*ca.*

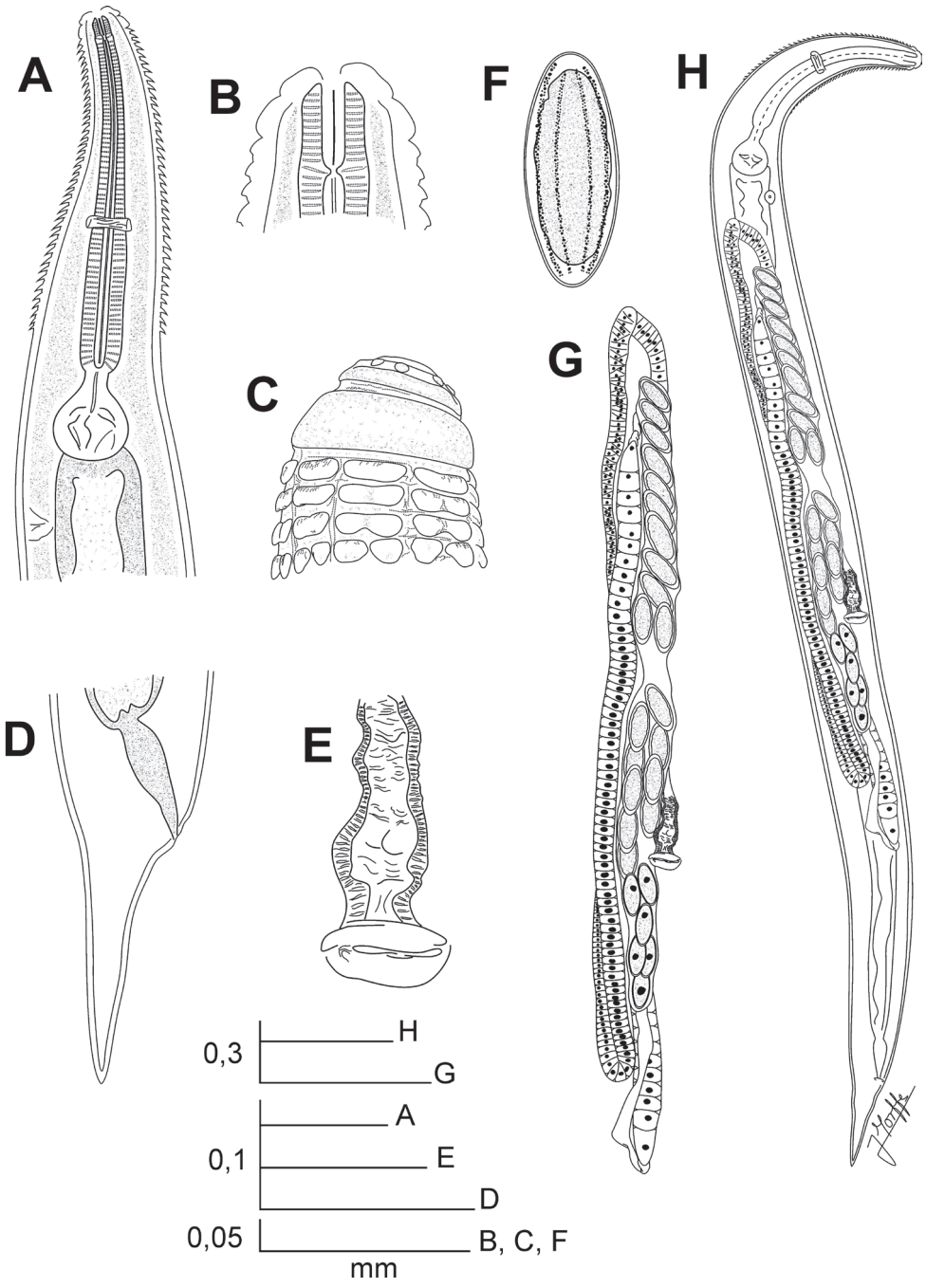

Figure 3. *Chokwenema lepidophorum* gen. n. et sp. n. Female. **A** Oesophageal region, lateral view **B** Cephalic end, internal view **C** Cephalic end, external view **D** Tail, lateral view **E** Vulva, ventral view **F** Egg **G** Genital tract, ventro-lateral view **H** Habitus, ventro-lateral view.

3–5 µm). Cervical cuticle armed initially by opposite rows of rectangular scales, arranged in number of eight. Scales bifurcate gradually at the third row by a cleavage. Division is total at level of the fifth row, with 16 shorter scales, their tips rounded. Scales becoming pointed towards the end of the spiny region. Last rows of spines (a total of 35–36) end at about one seventh of the body-width before the base of the procorpus. Sub-cuticular longitudinal striae present. Lateral alae absent. Head bearing eight rounded, paired papillae. Amphids lateral, pore-like. First cephalic annule similar in length to head, cone-like, truncated, slightly inflated. Stoma short, about two first cephalic annule-lengths long, surrounded by an oesophageal collar. Oesophagus consisting of a muscular, sub-cylindrical procorpus, its base well set-off from the short isthmus. Basal bulb pyriform, valve-plate well developed. Intestine simple, sub-rectilinear. Rectum short, anus not prominent. Nerve ring encircling the procorpus at *ca.* 55% of its length. Excretory pore located at *ca.* three fourths of the body-width posterior to the basal bulb. Vulva a median transverse slit, displaced to the posterior half of body, its lips slightly prominent. Vagina muscular, directed forwardly. Genital tract didelphic-amphidelphic, both ovaries reflexed. Oocytes in single rows. Eggs comparatively small, ovoid, with eight rough longitudinal ridges in the shell. Tail short, conical, subulate, ending in a sharp tip. Male unknown.

Discussion. *Chokwenema* gen. n. resembles the African genus *Batwanema* gen. n. by having a similar arrangement of the cervical spines: first row of eight rectangular scales gradually bifurcating, turning into pointed spines. The genus differs by its genital tract didelphic-amphidelphic *vs.* monodelphic-prodelphic in *Batwanema* gen. n. The procorpus is sub-cylindrical in *Chokwenema* gen. n. in opposition to the clavate procorpus of *Batwanema* gen. n. Moreover, *Chokwenema* gen. n. posses a single, evident truncate first cephalic annule, slightly inflated instead of the two hardly marked annuli of *Batwanema* gen. n., barely expanded.

Lepidonema and *Salesia* also bear scale-like projections in the cervical cuticle and shows a didelphic-amphidelphic genital system (Travassos and Kloss 1958). In addition, *Lepidonema* have a sub-cylindrical procorpus. *Chokwenema* gen. n. can be differentiated from both by the arrangement of the cervical spines with eight scales in the first row and the characteristic bifurcation of these, their number increasing towards the end of the spiny region. *Lepidonema* and *Salesia* present more elements in their first rows of spines, that are not bifurcated. Moreover, *Salesia* present a clavate procorpus *vs.* the sub-cylindrical of *Chokwenema* gen. n.

The other digonant genus with spines in the cuticle and sub-cylindrical procorpus is *Soaresnema* Travassos & Kloss, 1958, which can be segregated from *Chokwenema* gen. n. by lacking scales in the cervical cuticle, by the spines forming transverse rows *vs.* opposite rows and by the larger number of elements in the first row (16) *vs.* eight in *Chokwenema* gen. n.

Type host. *Didimoides* cf. *parastictus* (Imhoff, 1843) (Coleoptera: Passalidae).

Other host. *Pentalobus barbatus* (Fabricius, 1801) (Coleoptera: Passalidae).

Site. gut caeca.

Type locality. Mongwalu, Ituri province, Democratic Republic of Congo.

Etymology. Specific epithet derived from the Greek *lepidos*: scale and *phoreus*: to bear, after the scale-like projections of the cervical cuticle.

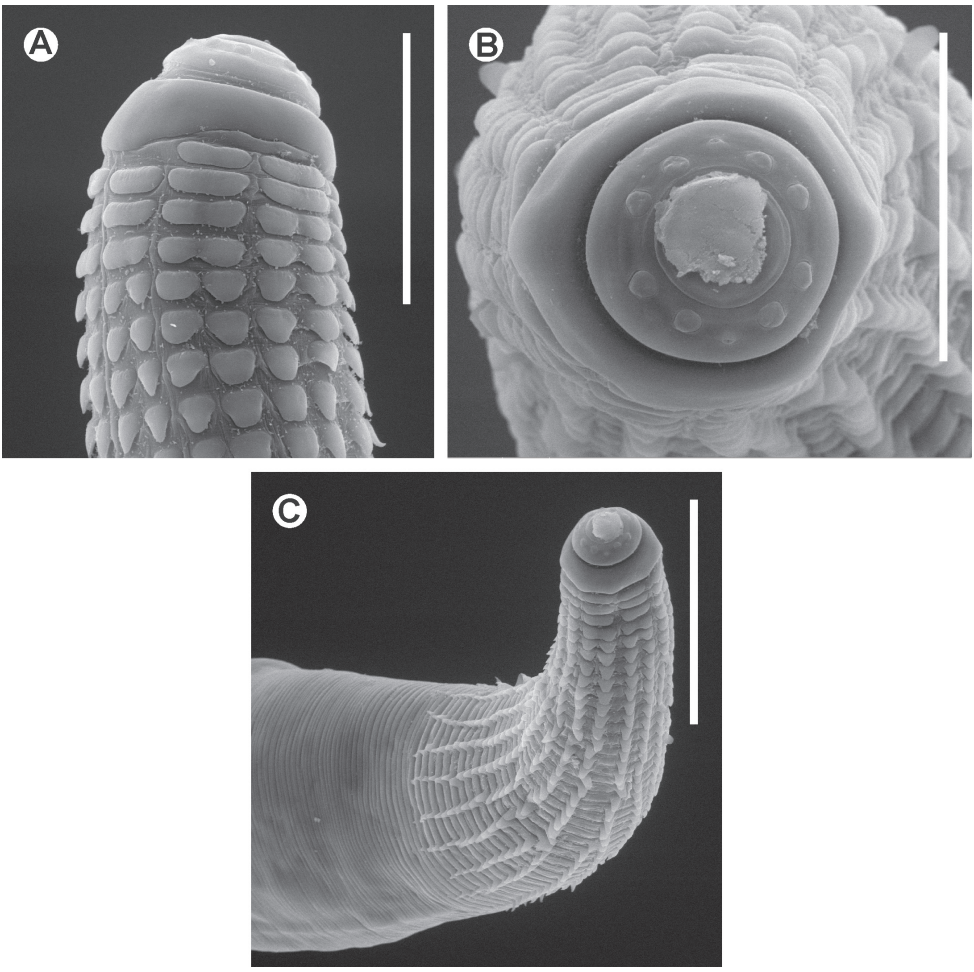

Figure 4. *Chokwenema lepidophorum* gen. n. et sp. n. Female. SEM images **A** Cephalic end **B** Cephalic end, *en face* view **C** Cervical region. Scale lines: **A** 0.05 mm, **B** 0.04 mm, **C** 0.1 mm.

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RESEARCH ARTICLE

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New water mites of the family Hygrobatidae (Acari, Hydrachnidia) from Turkey

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§ *http://zoobank.org/1069D2FB-415C-4EEA-9F21-D3443F250C81*
| *http://zoobank.org/1ACD91B7-6BB3-4BC0-B955-780F8257D8CA*

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Abstract

In this study, the findings of three water mite species of the family Hygrobatidae collected from different streams in Turkey were evaluated. *Hygrobates* (s. str.) *anatolicus* Esen & Pešić, **sp. n.** is described as new for science. *Hygrobates* (*Rivobates*) *diversiporus* Sokolow, 1927 and *Atractides* (s. str.) *nikooae* Pešić, 2004, which were illustrated and thoroughly discussed, are new records for the Turkish fauna.

Keywords

Acari, Hygrobatidae, water mites, new records, Turkey

Introduction

After the family Arrenuridae Thor, 1900, the Hygrobatidae Koch, 1842 is the most species-rich in Turkey. So far, 42 species have been found in Turkey (Erman et al. 2010, Esen et al. 2013) belonging to the genera *Atractides* Koch, 1837 (31 species), *Hygrobates* Koch, 1837 (9 species) and *Mixobates* Thor, 1905 (2 species).

During a survey of the freshwater fauna of Kahramanmaraş, Malatya and Siirt Provinces, Turkey, three interesting species for the Turkish fauna were collected. This article aims to describe this material and contribute to our knowledge of water mites distribution in Turkey.

Material and methods

During fieldwork, water mites were collected by hand netting, sorted on the spot from the living material, conserved in Koenike's fluid and dissected as described elsewhere (e.g., Gerecke et al. 2007). The holotype and some paratypes of the new species are deposited in the research collection of the Department of Biology, Fırat University, Elazığ, Turkey, other paratypes are deposited in the Museum of Natural History of Montenegro, Podgorica, Montenegro.

The composition of the material is given as: (males/females/deutonymphs). All measurements are given in micrometers. For a detailed description and discussion of the characteristics of the genus *Atractides* and a detailed methodological introduction, see Gerecke (2003) and Davids et al. (2005). The following abbreviations are used: asl. = above sea level, Ac-1 = first acetabulum, Cx-I = first coxae, dL = dorsal length, H = height, L = length, %L = relative length, I-L-6 = Leg 1, sixth segment (tarsus), mL = medial length, P-1 = palp, first segment, S-1 = large proximal ventral seta at I-L-5, S-2 = large distal ventral seta at I-L-5, Vgl = ventroglandulare, V = ventrale, W = width.

Results

Family Hygrobatidae Koch, 1842
Genus *Hygrobates* Koch, 1837

***Hygrobates* (s. str.) *anatolicus* Esen & Pešić, sp. n.**
http://zoobank.org/AE8FEF58-1CEE-4F5F-BFC7-EFEFBFC71BE6
http://species-id.net/wiki/Hygrobates_anatolicus
Figs 1, 2A–C, F, I

Material examined. Holotype: male, dissected and slide mounted in Hoyer's fluid, Turkey: Kahramanmaraş Province, Çağlayancerit, Göksu stream, 37°44'26"N, 37°22'21"E, 975 m asl., 28.10.2010. Paratypes: 33/49/0, same data as holotype, five males and five females dissected and slide mounted in Hoyer's fluid.

Diagnosis. Integument lineated. P-2 ventral margin straight, distally forming a right angle; P-4 ventral setae at the same level.

Description. General features: Integument lineated, occassionaly lines formed as irregular ridges (Fig. 2C). Posteromedial margin of Cx-I slightly triangular, Cx-IV medial margin nose-like protruding. Acetabula arranged in an obtuse triangle; excretory pore

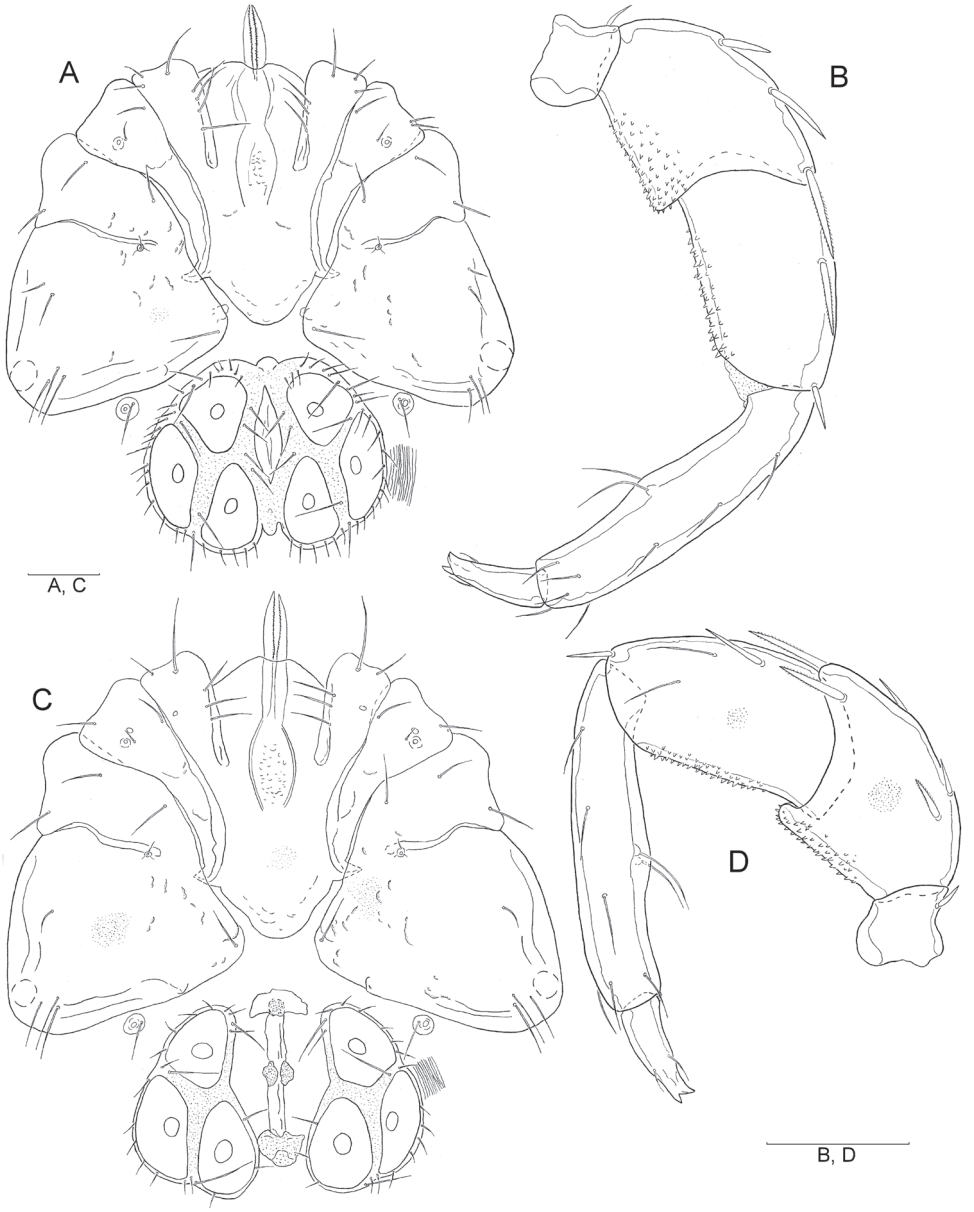

Figure 1. A–D *Hygrobates* (s. str.) *anatolicus* sp. n. (**A–B** male **C–D** female): **A** Coxal and genital field **B** Palp, medial view **C** Coxal and genital field **D** Palp, lateral view (Scale bars = 100 μm).

unsclerotized, distance genital field – excretory pore L in male 110-241, in female 280-351. Palp: P-2 ventral margin straight, distally forming a right angle, denticles covering two-thirds of the ventral margin of both P-2 and P-3; P-4 ventral setae on the same level.

Male (holotype, in parentheses measurements of paratype, n = 5): Idiosoma L/W 960/810 (720–1115/645–940); coxal field (Fig. 1A) L/W 516/680 (495–612/600–

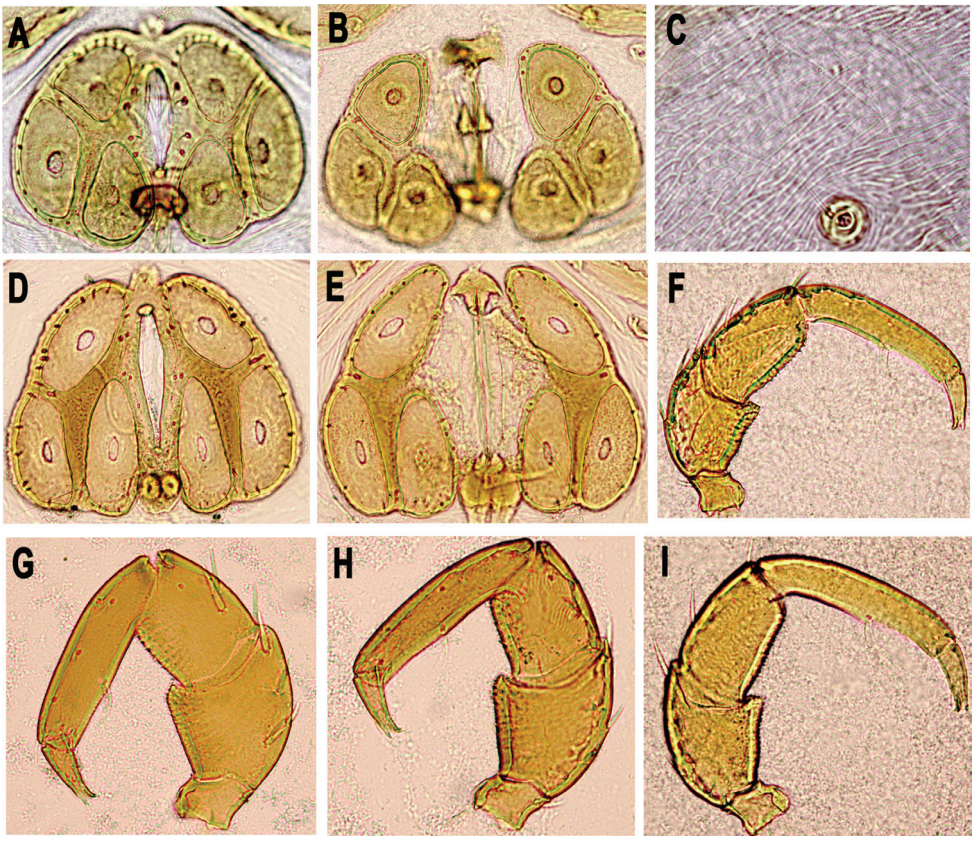

Figure 2. A–C, F, I photographs of *Hygrobates anatolicus* sp. n. (**A, F** male **B–C, I** female), Göksu stream, Turkey **D–E, G–H** photographs of *Hygrobates nigromaculatus* Lebert, 1879 (**D, G** male **E, H** female), Ohrid Lake, Macedonia: **A–B, D–E** genital field **C** detail of dorsal integument **F–I** palp.

745), median length of Cx-I + gnathosoma 395 (380–450); genital plate (Figs 1A, 2A) L/W 261/340 (210–285/315–380), gonopore L 137 (108–130), L Ac-1–3: 107 (102–112), 145 (140–150), 121 (115–125); anterior margin with a small, knob-shaped medial projection, posterior margin indented, with a short, rounded medial projection. Distance between genital field and excretory pore L 200 (110–241). Palp (Fig. 1B, 2F) total L 621 (586–665), dL: P-1, 40 (36–48); P-2, 157 (146–170); P-3, 136 (128–140); P-4, 218 (208–235); P-5, 70 (68–72). Chelicera L 487 (440–496), claw L 170 (157–172). Legs: dL of I-L-4–6: 257 (250–270), 266 (258–275), 243 (235–258); dL of IV-L-4–6: 391 (365–410), 397 (382–422), 346 (325–368).

Female (n = 5): Idiosoma L/W 720–1507/540–1250; coxal field (Fig. 1C) L/W 495–610/550–847; median length of Cx-I + gnathosoma 400–460. Palp (Figs 1D, 2I) total L 668–749, dL: P-1, 47–51; P-2, 160–198; P-3, 144–160; P-4, 241–262; P-5, 78–80. Chelicera L 490–548, claw L 170–190. Genital field (Fig. 1C, 2B) W 330–418, genital plate L 230–268, genital opening L 210–280, L Ac-1–3: 110–120,

145–150, 126–130. Legs: dL of I-L-4–6 285–302, 295–310, 267–286; dL of IV-L-4–6: 430–456, 440–460, 361–385.

Discussion. Due to the shape of palp with a straight ventral margin of P-2, distally forming a right angle, the new species closely resembles *Hygrobates* (s. str.) *nigromaculatus* Lebert, 1879 (Fig. 2D–E, G–H) and *H. setosus* Besseling, 1942. The later species, for a long time was considered a morphotype of *H. nigromaculatus* (Viets 1960), but differs in size (median length of Cx-I + gnathosoma > 350 μm. Males: P-4 length > 140, genital plate length > 170 μm. Females: P-4 length > 165, genital plate length > 175 μm), life cycle with larvae parasitic on chironomid Diptera and habitat preference for running waters (Martin et al. 2010). The larger dimensions and habitat preference for running waters makes the new species close to *H. setosus*. However, presence of lineated integument will easily distinguished *Hygrobates anatolicus* sp. n. from two above-mentioned species bearing finely striated integument.

Remarks. Due to the shape of the genital field, population from Göksu stream resembles populations of *Hygrobates nigromaculatus* and *H. setosus* from the Northern Germany (P. Martin pers. communication). However, population of *H. nigromaculatus* from the Ohrid Lake clearly differs in the shape of genital field (see Figs 2D-E), with the acetabula distinctly elongated, similar to those in *H. longiporus* Thor, 1898. The similar*, longiporus*-shape of the acetabula was recently detected in the population of *H. nigromaculatus* from Luxembourg (R. Gerecke pers. communication), suggesting that this character, in the *H. nigromaculatus* like-species complex, vary and can not be used in taxonomical separation. If possible the species should be included in a possibly molecular and morphological revision of the *H. nigromaculatus* like-species complex.

Etymology. Named after the country of the type locality.

Habitat. Rhithrobiont.

Distribution. Known only from the type locality in Kahramanmaraş Province, Turkey.

Subgenus *Rivobates* Thor, 1897

Hygrobates (*Rivobates*) *diversiporus* Sokolow, 1927

http://species-id.net/wiki/Hygrobates_diversiporus
Figs 3, 4

Material examined. Turkey, Malatya Province, Doğanşehir, Avcapınar stream, 38°00'38"N, 37°57'56"E, 1335 m asl., 04.07.2004, (7/24/0).

Compared material. Senckenberg Museum Frankfurt, Germany, *Hygrobates* (*Decabates*) *quanaticola,* holotype, ♂, P.J/15, Locality. Quanat near Rezazeh, 29.9.1974 coll. Schwoerbel; präp. J/14, *Hygrobates (Decabates) quanaticola,* ♀, Quanat near Rezazeh, 29.9.1974, Schwoerbel.

Morphology. General characters. Posteromedial margin of Cx-I convexly rounded, medial margin of Cx-IV rounded; genital field with 8–13 pairs of acetabula.

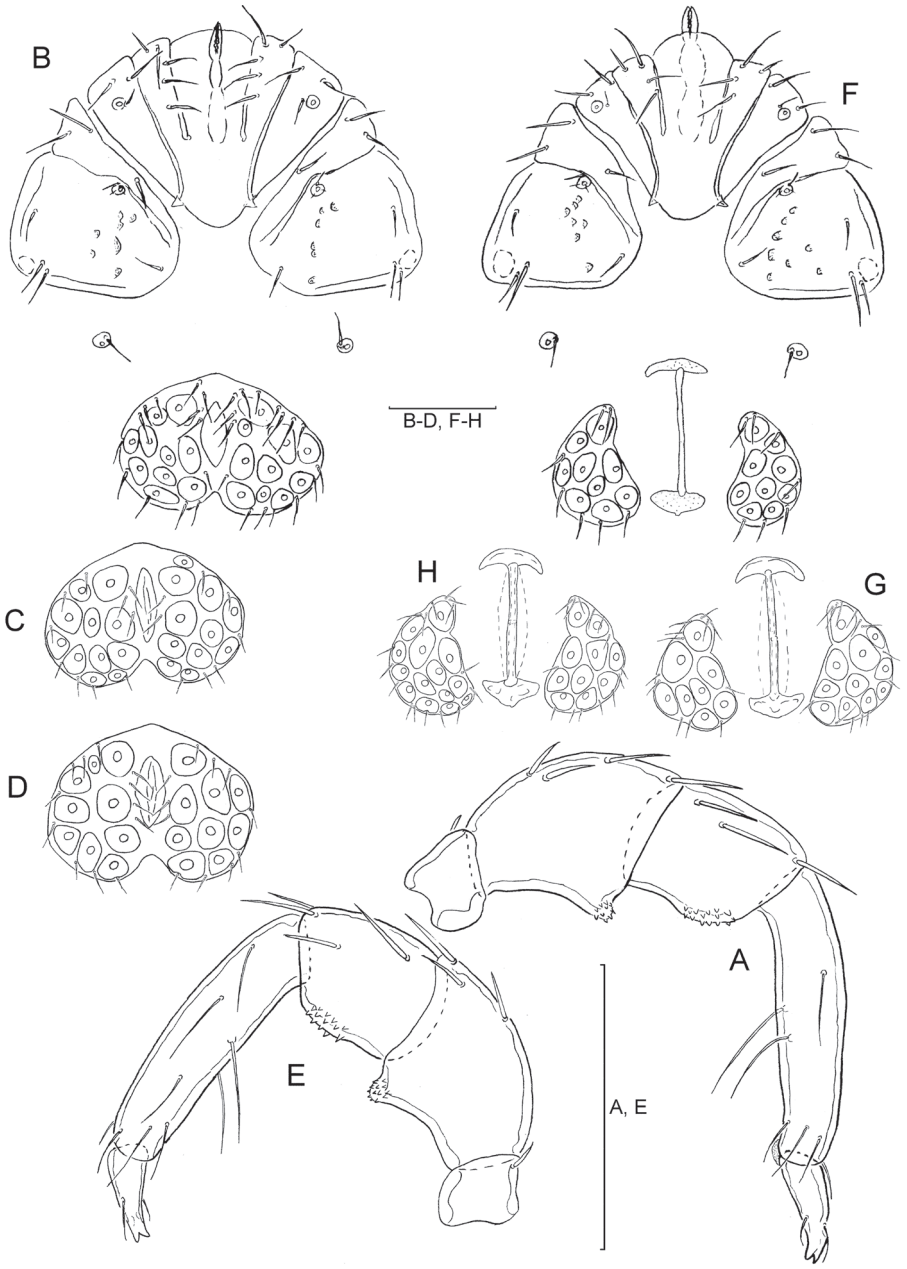

Figure 3. A–H *Hygrobates* (*Rivobates*) *diversiporus* Sokolow, 1927 (**A–D** male **E–H** female): **A** Palp, medial view **B, F** Coxal and genital field **C–D, G–H** Genital field **E** Palp, lateral view (Scale bars = 100 μm).

Ventral margin P-2 proximally concave, distally protruding in a nose- or knob-shaped projection bearing denticles, distal part of P-3 ventral margin covered by denticles, P-4 ventral setae distance 14–19 μm.

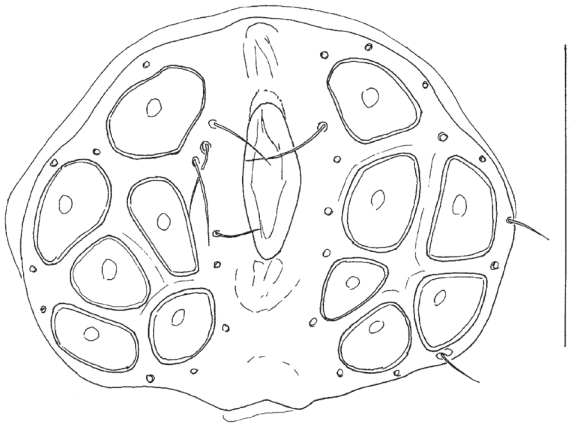

Figure 4. *Hygrobates quanaticola* Schwoerbel & Sepasgozarian, 1976, male holotype: genital field (Scale bar = 100 μm).

Male (n =3): Idiosoma L 805–890 W 690–783; median length of Cx-I + gnathosoma 232–240. Genital field (Figs 3B–D) L 188–191, W 242–273, posterior margin strongly indented. Gonopore L 88–90, distance between genital field and excretory pore 72–100. Palp (Fig. 3A): total L 366–388, dL: P-1, 30–32; P-2, 96–104; P-3, 69–70; P-4, 130–140; P-5, 41–42; chelicera L 210–225.

Female (n =5): Idiosoma L 815–1058 W 670–910; median length of Cx-I + gnathosoma 243–248; genital plate (Figs 3F–H) L 167–180, W 100–104. Distance between genital field and excretory pore L 83–110, genital opening L 200–250, maximum diameter of egg 170. Palp (Fig. 3E): total L 374, dL: P-1, 32–35; P-2, 100–103; P-3, 70–72, P-4, 140–142; P-5 43–45; chelicera L 225–247.

Remarks. Sokolow (1927) described *Hygrobates diversiporus* based on one male and one female specimen from a first order stream in Caucasus. Later on this species has been reported by Bader (1955) from the Ohrid Lake in Macedonia. The latter record of this probably rithrobiontic species from a lacustrine habitat, require confirmation for a better understanding of its geographical distribution. The specimens from Turkey agree well with the type specimen in the shape of male genital field orginally desribed by Sokolow (1927) in German as reverse heart-shaped ("verkehrtherzförmig"), with an acute anterior angle and a indented posterior margin having a broad, rounded median notch.

The second member of subgenus *Rivobates* Thor known from Turkey, *Hygrobates quanaticola* Schwoerbel & Sepasgozarian, 1976, has been orginally described from Iran (Schwoerbel and Sepasgozarian 1976), and later on reported from Kayseri, Elazığ and Afyon provinces in Turkey (Erman et al. 2010). This species differs (based on re-examination of the holotype) from *H. diversiporus* in the shape of male genital field with irregularly convex posterior margin (compare Figures 3B–D and 4).

Habitat. Rhithrobiont.

Distribution. Russia (Caucasus). New for Turkey.

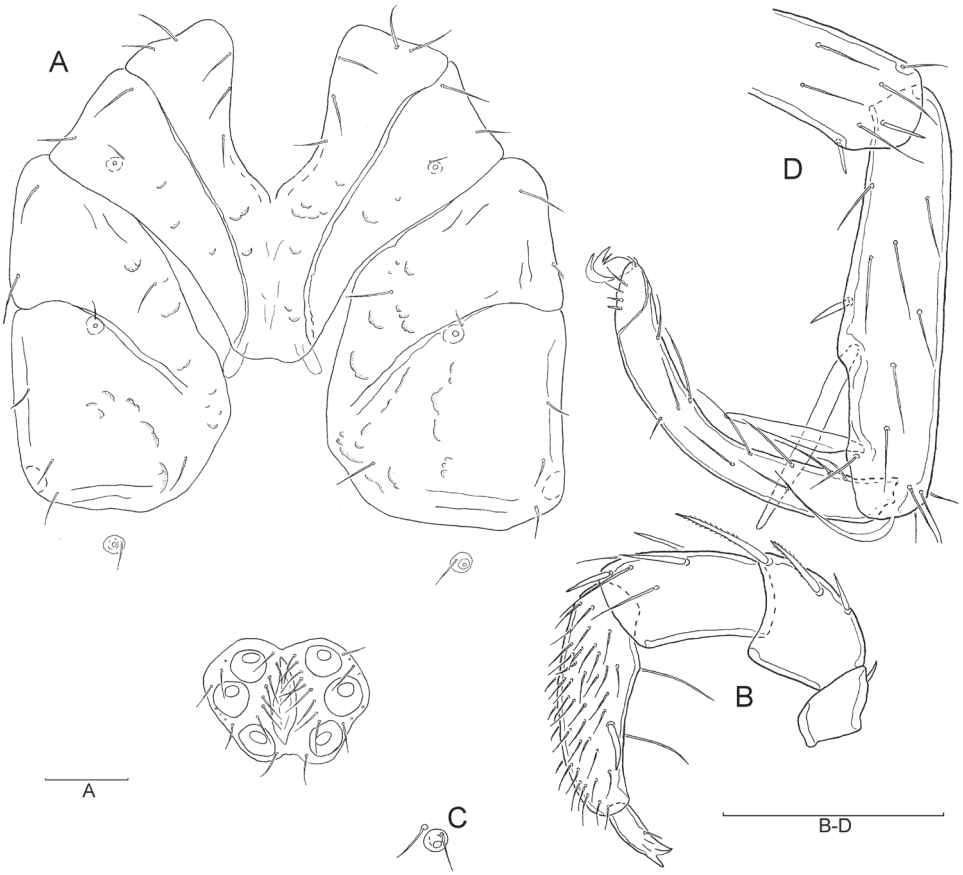

Figure 5. A–D *Atractides* (s. str.) *nikooae* Pešić, 2004, male: **A** Coxal and genital field **B** Palp, medial veiw **C** Vgl-1–2 **D** I–L-5–6 (Scale bars = 100 μm).

Genus *Atractides* Koch, 1837

Atractides (s. str.) *nikooae* Pešić, 2004

http://species-id.net/wiki/Atractides_nikooae
Figs 5, 6

Material examined. Siirt Province, Kezer stream, 37°57'42"N, 41°51'25"E, 545 m asl., 16.09.2012, (4/8/0); Başur stream, 37°57'42"N, 41°47'19"E, 525 m asl., 15.09.2012, (0/2/0).

Morphology. General features. Integument dorsally finely striated; muscle attachment plates unsclerotized. Coxal field: mediocaudal margin of Cx-I+II with a slightly concave or convex area between the laterally directed apodemes of Cx-II. Palp: weak sexual dimorphism, P-2 and P-3 ventral margin straight; P-4 with maximum height near proximoventral hair, sword seta near distoventral hair, ventral margin divided by hair insertions 1:1:1. Genital field with Ac in a weakly curved line; excretory pore smooth; Vgl-

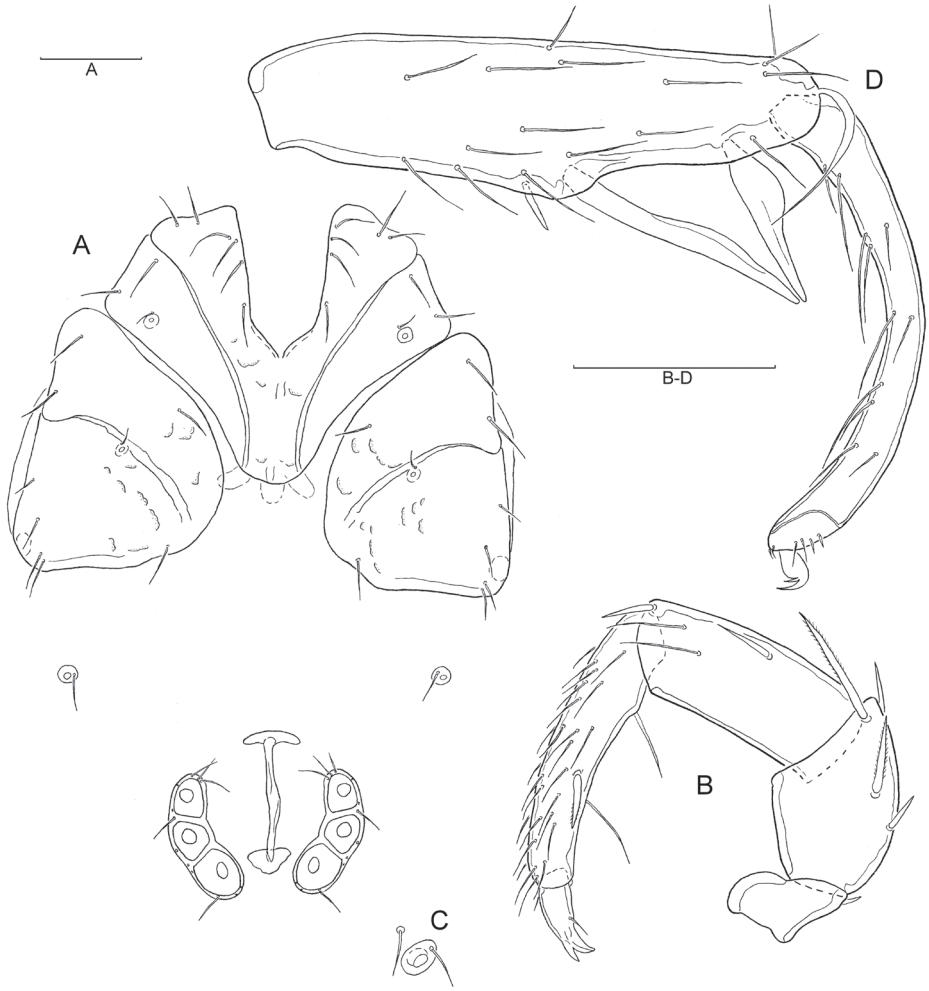

Figure 6. A–D *Atractides* (s. str.) *nikooae* Pešić, 2004, female: **A** Coxal and genital field **B** Palp, medial veiw **C** Vgl-1–2 **D** I–L-5–6 (Scale bars = 100 μm).

1 separate from Vgl-2. I-L-5: S-1 and -2 strongly heteromorphic and widely distanced, S-2 strongly thickened in the basal third; I-L-6 strongly curved, basally thickened.

Male (n = 2). Idiosoma L 470–527 W 420–432. Coxal field (Fig. 5A) L 320–311, Cx-III W 340–360, Cx-I+II medial suture line L 105–108. Palp (Fig. 5B) total L 285–296, dL and %L (in parentheses): P-1, 26–28 (9.0–9.5); P-2, 64–67 (22.2–22.6); P-3, 68–70 (23.6–23.7); P-4, 97–100 (33.8); P-5, 30–31 (10.5); chelicera L 170–187. Genital field apple shaped, L 90–92, W 100, anterior and posterior margin with shallow indentations (Fig. 5A). Legs: I-L-5 dL 192–193, vL 110–113, H 45–47; S-1 L 95, S-2 L 66–68; S-1–2 interspace 40–42; I-L-6 L 160–165, H 22–23; dL ratio I-L-5/6 1.2.

Female (n = 5). Idiosoma L 745–760 W 640–652. Coxal field (Fig. 6A) L 382–421, Cx-III W 465–480, Cx-I+II mL 135–142. Palp (Fig. 6B) total 417–445, dL and

%L (in parentheses): P-1, 38–40 (9.0); P-2, 90–100 (22.1); P-3, 107–116 (30.0); P-4, 142–148 (33.4); P-5, 40–41 (9.5); P-4 more slender than in male; chelicera L 208. Genital field W 180–204, genital plate L 110–121. Legs: I-L-5 dL 263–280, vL 140–148, H 70–76; S-1 L 128–138, S-2 L 72–88, W 20–21 (ratio 3.6–4.2), ratio L S-1/2 1.78–1.57, S-1–2 interspace 70–72; I-L-6 L 217–230, H 28–30; dL ratio I-L-5/6 1.2.

Remarks. Due to the similar morphology of the genital field (relatively small Ac arranged in a weakly curved line, male genital field apple-shaped with anterior an posterior margin slightly indented), I-L-5 and -6 (S-1 and S-2 with relatively wide setal interspace, I-L-6 strongly curved and slender) and palp (without sexual dimorphism, P-2 ventral margin straight in the both sexes), the specimens from Turkey shows conformity with *Atractides nikooae* Pešić, 2004, a species known from both sexes from the Markazi Province (western Iran, Pešić et al. 2004).

Atractides (s. str.) *diastema* (Szalay, 1935), a weakly defined species from Hungary and Poland, known only from a female sex, differs from *A. nikooae* (in parentheses data taken from Gerecke 2003) in a weakly S-shaped ventral margin of P-2, ventral margin P-4 divided by hair insertions in sections 2:2:1, more stouter palp segments (L/H P-3 2.77, P-4 4.2), and a less heteromorphic setae S-1/2 (L S-1/2 1.3).

Habitat. Rhithrobiont.

Distribution. Iran (Pešić et al. 2004). New for Turkey.

Acknowledgements

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RESEARCH ARTICLE

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Reassessment of *Paleotachina* Townsend and *Electrotachina* Townsend and their removal from the Tachinidae (Diptera)

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Abstract

The monotypic genera *Paleotachina* Townsend, 1921 and *Electrotachina* Townsend, 1938 were originally described as fossils in amber but were later discovered to be inclusions in copal. Both taxa were originally assigned to the Tachinidae (Diptera) and this placement has continued to the present day. The holotypes of the two type species, *P. smithii* Townsend and *E. smithii* Townsend, were examined and the following taxonomic and nomenclatural changes are proposed: *Paleotachina* is transferred to the Muscidae and placed in synonymy with *Aethiopomyia* Malloch, 1921, **syn. n.**; *P. smithii* Townsend, type species of *Paleotachina*, is synonymized with *Aethiopomyia gigas* (Stein, 1906), **syn. n.**; *Electrotachina* is transferred to the Sarcophagidae and placed in synonymy with *Dolichotachina* Villeneuve, 1913, **syn. n.**; *E. smithii* Townsend, type species of *Electrotachina*, is recognized as a valid species of *Dolichotachina* **comb. n.** Images of the holotypes of *P. smithii* and *E. smithii* are provided and features that have helped place these copal inclusions in their new combinations are discussed.

Keywords

Tachinidae, Muscidae, Sarcophagidae, amber, copal, inclusions

Introduction

For such a large family of Diptera, the Tachinidae have a very meager fossil record. There are about 8500 valid species in the family (O'Hara 2013b), but only ten species in eight genera were listed as fossil Tachinidae by Evenhuis (1994). The oldest of these were presumed to be of Eocene age, thus establishing the Eocene as the minimum age of the Tachinidae.

A preliminary investigation into the authenticity of the presumed oldest tachinid fossils by O'Hara (2013a) called into question the family identifications of the three taxa involved: *Vinculomusca vinculata* (Scudder), *Paleotachina smithii* Townsend, and *Electrotachina smithii* Townsend. The first was described from "part of emptied skins" of dipteran larvae preserved in rock and originating from Chagrin Valley, Colorado (Scudder 1877). The species was originally described in *Musca* Linnaeus, but Townsend (1938) erected the new genus *Vinculomusca* for it and declared it of "apparently exoristid or tachinid stock" (i.e., Tachinidae). As noted by O'Hara (2013a), there is insufficient evidence to place the fossilized larval remains to family and assignment to the Tachinidae—the larvae of which are arthropod endoparasitoids—is especially unmerited.

Treated in this paper are the monotypic genera *Paleotachina* and *Electrotachina*. Both were described by Townsend (1921, 1938) based on figures in Smith (1868). As explained below, they were until relatively recently thought to be Baltic amber fossils but are now known to be much younger specimens preserved in East African copal. Our examination of the holotypes of the two species involved, *P. smithii* and *E. smithii*, has confirmed O'Hara's (2013a) suspicion that neither belongs to the Tachinidae. Their identities are discussed and the appropriate taxonomic and nomenclatural changes are proposed. Images of the type specimens are provided.

Materials and methods

The holotypes of *Paleotachina smithii* and *Electrotachina smithii* are deposited in the Natural History Museum, London, United Kingdom (NHM). One of us (AP) studied the holotype of *P. smithii* and another (DW) studied the holotype of *E. smithii*, thus allowing these inclusions to be placed with some confidence to the species or genus level within the Muscidae and Sarcophagidae, respectively. Each specimen is preserved within a small piece of copal, which is in turn embedded in Canada balsam within a square open-topped glass case glued to a slide. The glass case containing *E. smithii* was covered with a cover slip following the recent restoration of the Canada balsam surface, which was scratched. Images for Figs 2–3 and 8–9 were taken with a Canon EOS 550D camera fitted with a Canon MP-E 65 mm lens; images for Figs 4–6 and 10–11 were taken with a Canon EOS 5D Mark II camera fitted with a Canon MP-E 65 mm lens; images for Figs 12–13 were

taken with a Canon EOS 650D camera fitted with a 0.63x adaptor mounted on a Leica MZ125 stereomicroscope. Images for Figs 4–6 and 10–13 were stacked using Helicon Focus (version 5.3) software. Figures 1 and 7 were scanned from a plate in Smith (1868) and their low resolution is a reflection of the poor quality of the plate in the original publication.

Age of fly inclusions depicted in Smith (1868)

The paper by Zaddach (1868) was a detailed account of the origins of the amber deposits of "Samland", an area known today as the Samland Peninsula in Kaliningrad Oblast, Russia. This area is the richest source for Baltic amber, which is mined locally or erodes out of deposits under the Baltic Sea and washes ashore. Zaddach (1868) referred to the age of the deposits as "Eocene or Lower Oligocene". Modern dating methods have established an Eocene origin for Baltic amber with an age of about 44 Ma (Engel 2001).

The editors of the *Quarterly Journal of Science* followed Zaddach's (1868) paper with a plate meant to "convey some idea of the organic remains usually found in this fossil resin" (p. 183) and a list of works on amber and inclusions. The editors assumed responsibility for both the plate and list of works, but also noted (p. 183): "The specimens figured in that plate belong to the National Collection in the British Museum; and for the facts relating to the Insects embodied in the annexed explanation of it, we are indebted to the kind and able assistance of Mr. Frederick Smith, of the Entomological Department of that Museum". For the purposes of bibliographic reference, both the plate and the explanation of it are cited here as Smith (1868).

Neither Smith (1868) nor the editors of the *Quarterly Journal of Science* gave the provenance of the "amber" pieces depicted in the plate but subsequent authors assumed the pieces originated from Baltic deposits and were authentic amber of the age suggested by Zaddach (1868). This is evident in the descriptions of *Paleotachina* and *Electrotachina* by Townsend (1921, 1938, 1942) and in later works citing these taxa, for example Spahr (1985), Evenhuis (1994), Lehmann (2003), and O'Hara (2013a). However, in a semi-popular paper on *Forgeries of Fossils in "Amber"* overlooked by Lehmann (2003) and O'Hara (2013a), Grimaldi et al. (1994) discussed Smith's (1868) inclusions and changed both their age and origin. The ten pieces containing arthropods had been purchased by the British Museum (Natural History) (now NHM) in 1867 and were thought at the time to have originated from Baltic deposits in the vicinity of "Stettin" (present-day Szczecin in Poland) (Grimaldi et al. 1994). In truth, the pieces are copal from East Africa (Grimaldi op. cit.). Further details about the age of the copal or the location where it was found in East Africa are lacking.

Systematics

***Aethiopomyia* Malloch, 1921 (Muscidae)**
http://species-id.net/wiki/Aethiopomyia

Aethiopomyia Malloch, 1921: 426. Type species: *Spilogaster gigas* Stein, 1906 (as "*Mydaea gigas*, Stein"), by original designation.
Paleotachina Townsend, 1921: 134. Type species: *Paleotachina smithii* Townsend, 1921 (= *Spilogaster gigas* Stein, 1906, syn. n.), by monotypy. Syn. n.
Palaeotachina. Incorrect subsequent spelling of *Paleotachina* Townsend, 1921 (Evenhuis 1994: 467, Lehmann 2003: 116, O'Hara 2013a: 11, 12).

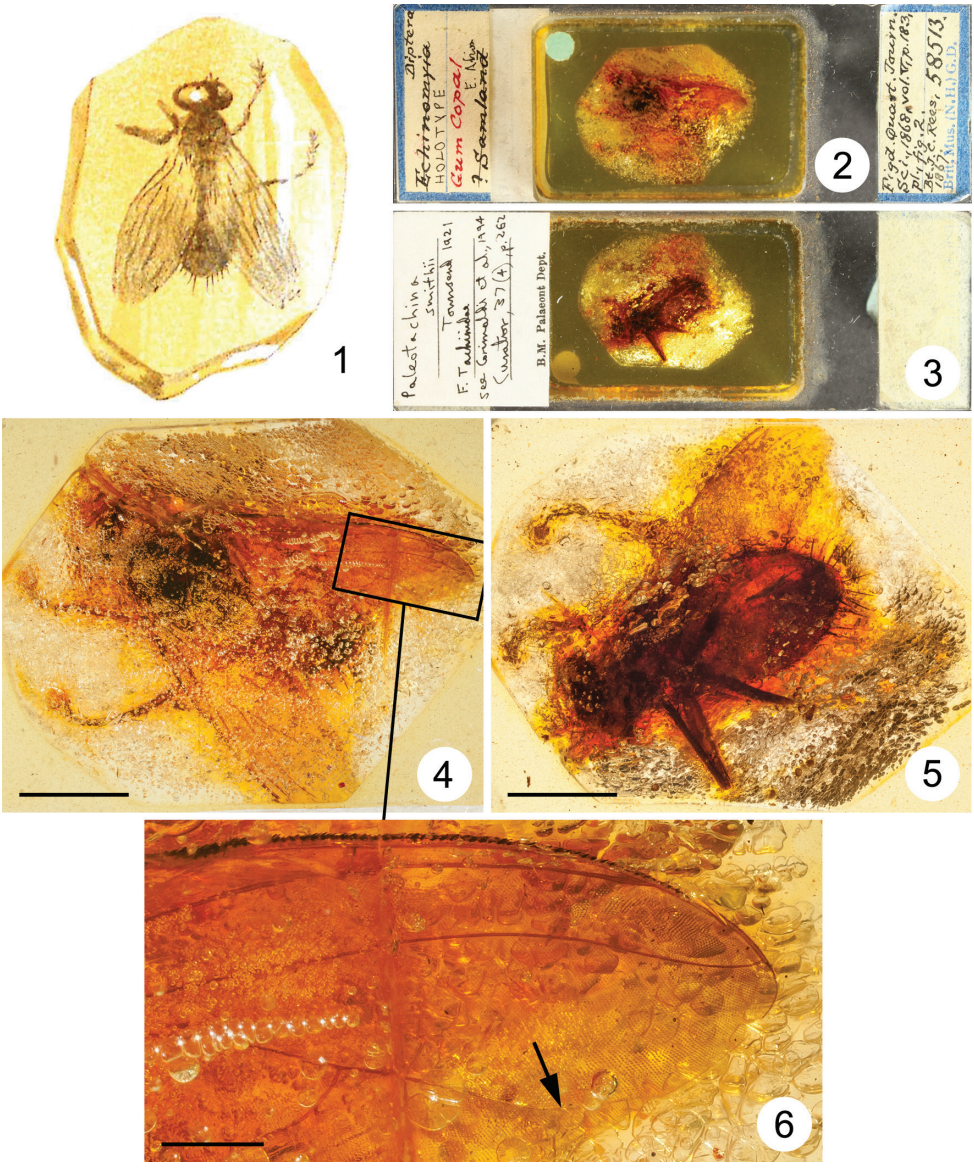
Remarks. The genus-group names *Aethiopomyia* and *Paleotachina* were both made available in 1921. The paper by Malloch (1921) was published on May 1 (Evenhuis 2003) and the paper by Townsend on October 3 (Evenhuis 1994), thus giving date priority to *Aethiopomyia*.

***Aethiopomyia gigas* (Stein, 1906)**
http://species-id.net/wiki/Aethiopomyia_gigas
Figs 1–6

Spilogaster gigas Stein, 1906: 37. Syntypes, 1 male and 2 females (Museum für Naturkunde der Humboldt-Universität zu Berlin, Berlin; seen by Pont 2013: 77). Type locality: Cameroon, Barombi.
Paleotachina smithii Townsend, 1921: 134. Holotype male, in copal (NHM, No. 58513). Type locality: East Africa (Grimaldi et al. 1994). Syn. n.

Remarks. Smith (1868: 183), in his explanation of a plate of "amber" inclusions, wrote the following caption for the specimen that later became the holotype of *P. smithii*: "Fig. 2.—A Dipterous Insect belonging to the European genus *Echinomyia*. Enlarged one-half". Based on this caption and the figure itself, Townsend (1921: 134) wrote the following for his new genus and species: "*Paleotachina* gen. nov. *smithii* sp. nov. (fossil).—Proposed for *Echinomyia* sp. Smith (1868), Qu. Jn. Sc. V, 183, f. 2. From the Lower Oligocene of Baltic amber. The description indicates one of the Larvaevorini or allied tribes".

The "Larvaevorini" of Townsend (1921) later became known as the Tachinini when *Larvaevora* Meigen, 1800 was suppressed by ICZN (1963). Although the species *P. smithii* was not described by Townsend (or by Smith, despite Townsend's statement to the contrary), the species-group name was made available by bibliographic reference to fig. 2 in Smith (1868) (Article 12.2.1 of ICZN 1999). Townsend (1942: 17) later provided a brief description of the genus, presumably from fig. 2 in Smith (1868), and referred to the genus as "evidently tachinid".



Figures 1–6. *Paleotachina smithii* Townsend, 1921 (junior synonym of *Aethiopomyia gigas* (Stein, 1906), syn. n.), Muscidae **1** reproduction of illustration in Smith (1868, fig. 2) showing inclusion originally identified as "*Echinomyia*" sp. (i.e., *Echinomya* Latreille, 1805, junior synonym of *Tachina* Meigen, 1803, Tachinidae) **2–6** holotype male **2–3** entire slide **2** dorsal view **3** ventral view **4–6** inclusion **4** dorsal view (scale bar = 5.0 mm) **5** ventral view (scale bar = 5.0 mm) **6** enlarged portion of wing circumscribed in Fig. 4 (arrow indicates bend of vein M) (scale bar = 1.0 mm).

A considerable amount of artistic liberty was taken in the depiction of NHM specimen #58513 (holotype of *P. smithii*) in fig. 2 in Smith (1868), which was also shown as a mirror image of the original specimen; cf. Figs 1, 4.

The holotype of *P. smithii* is a large fly in the family Muscidae, with a body length of about 14 mm and a wing length of about 14 mm. It is well preserved, but large parts of it are obscured by masses of small air bubbles (see Figs 2–5). The conformation of the abdominal tip suggests that it is a male, but nothing can be seen of the head and associated features. Because of its size, coloration and habitus, the presence of very long stout setae on abdominal tergites 4 and 5, and a vein M that is weakly curved forward towards vein R_{4+5} in its apical part (Fig. 6), leaving a wide open cell r_{4+5}, the species can be readily assigned to either *Aethiopomyia* Malloch or *Alluaudinella* Giglio-Tos, two genera confined to the Afrotropical Region. It is possible to see several small setulae on the node at the base of vein R_{4+5}, and such setulae are present in *Aethiopomyia* but not in *Alluaudinella*. Other characters used to differentiate these genera (proepisternal depression setulose or bare, katatergite with fine setulae or bare) cannot be seen in the holotype.

The scutum, scutellum and at least abdominal tergites 4 and 5 are black; the remainder of the body (the head excepted) is yellow. The femora and tibiae are yellow, and the tarsi black. This coloration is most similar to that of *Aethiopomyia gigas* (Stein), described from Cameroon and widespread though never common across western, eastern and southern Africa. *Paleotachina smithii* Townsend, 1921 is accordingly synonymized with *Aethiopomyia gigas* (Stein, 1906), syn. n.

Dolichotachina Villeneuve, 1913 (Sarcophagidae)

Dolichotachina Villeneuve, 1913: 112. Type species: *Tachina marginella* Wiedemann, 1830, by monotypy.

Electrotachina Townsend, 1938: 166. Type species: *Electrotachina smithii* Townsend, 1938, by original designation. Syn. n.

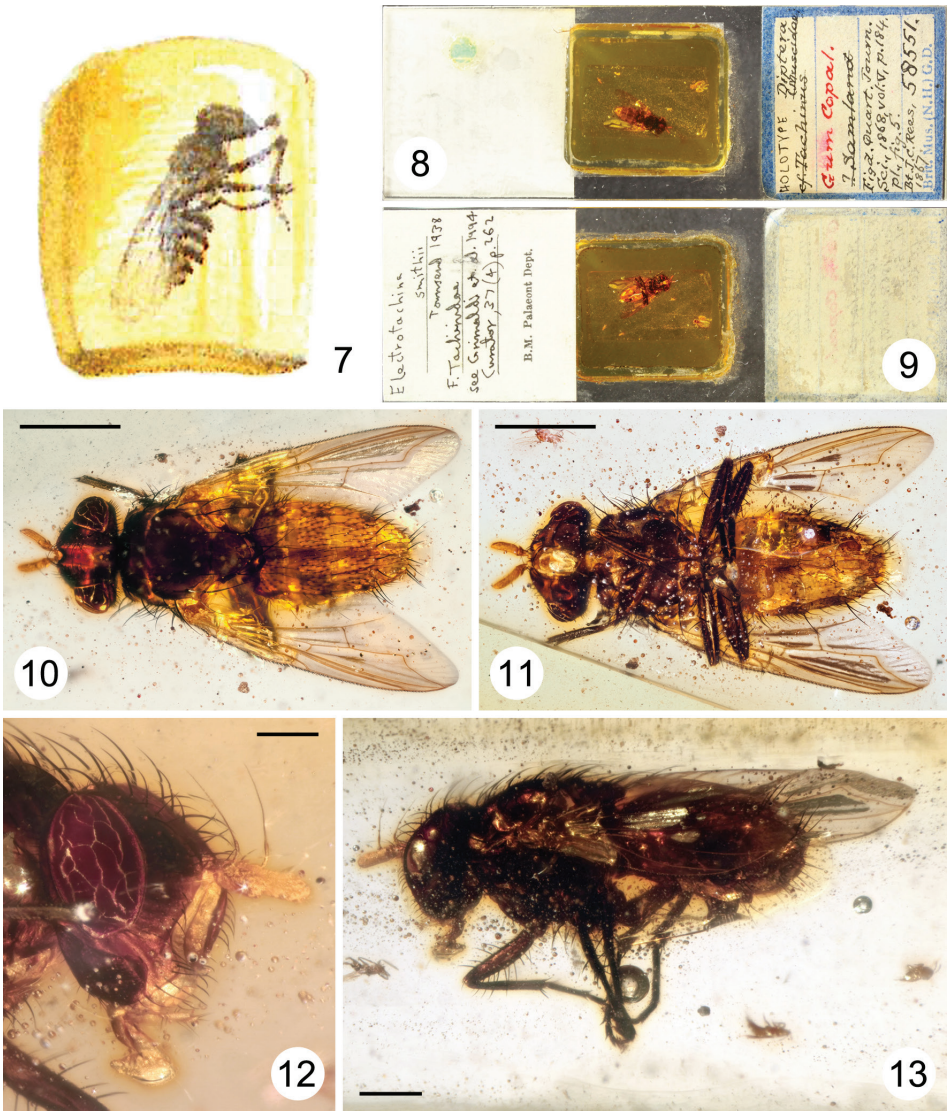
Dolichotachina smithii (Townsend, 1938), comb. n.

http://species-id.net/wiki/Dolichotachina_smithii

Figs 7–13

Electrotachina smithii Townsend, 1938: 166. Holotype female, in copal (NHM, No. 58551). Type locality: East Africa (Grimaldi et al. 1994).

Remarks. Townsend (1938: 166) began his description of *Electrotachina* with: "Genotype, *E. smithii* sp. nov. For new genus Muscidae aff. *Tachina* sp. F. Smith, Quart. Jn. Sc., V, 184, pl. 18, fig. 5 (1868). Fly Lower Oligocene of Baltic amber". A brief description followed, ending with the statement "probably exoristid or tachinid stock". There is no indication that Townsend examined the specimen and his description is consistent with the drawing of a fly in fig. 5 in Smith (1868). As with *Paleotachina*, Townsend (1942: 12) later provided a brief description of the genus, presumably from fig. 5 in Smith (1868), and referred to the genus as "almost certainly exoristid stock".



Figures 7–13. *Electrotachina smithii* Townsend, 1938 (now *Dolichotachina smithii* (Townsend, 1938), comb. n.), Sarcophagidae **7** reproduction of illustration in Smith (1868, fig. 5) showing inclusion originally identified as a new genus near "*Tachinus*" (i.e., *Tachina* Meigen, 1803, Tachinidae) **8–13** holotype female **8–9** entire slide **8** dorsal view **9** ventral view **10–13** inclusion **10** dorsal view (scale bar = 2.0 mm) **11** ventral view (scale bar = 2.0 mm) **12** head, right lateral view (scale bar = 0.5 mm) **13** body, left lateral view (scale bar = 1.0 mm).

As with *P. smithii*, certain liberties were taken in the depiction of NHM specimen #58551 (holotype of *E. smithii*) in fig. 5 in Smith (1868), and it may also have been shown as a mirror image of the original specimen; cf. Figs 7, 13.

Electrotachina smithii belongs to the family Sarcophagidae, subfamily Miltogramminae. The holotype female has a body length of about 7 mm and is preserved in a

small block of copal (approx. 15 × 10 × 7 mm) together with two other adult dipterans: a small female Agromyzidae and a Cecidomyiidae. The specimen is in very good condition except for the lack of its right fore tarsus. Antennae, wings and chaetotaxy are all in excellent condition. The specimen can be confidently assigned to the genus *Dolichotachina* based on the following combination of external character states: arista short pubescent, thickened on approximately basal 1/5; eye bare; parafacial with an uneven row of setae anteriorly; proepisternum bare; katepisternum with two, widely separated, setae; mid tibia with one anterodorsal seta; wing cell r_{4+5} open at wing margin.

In addition to the above features, *Dolichotachina smithii* is characterized by an elongated postpedicel (about 3 times length of pedicel), relatively short vibrissa, and short proboscis (about twice as long as wide).

Dolichotachina is a mainly Afrotropical genus with 12 species previously known from this region (Pape 1996). Material recently collected in Burundi and Namibia has demonstrated that the Afrotropical diversity of *Dolichotachina* is probably greatly underestimated (Whitmore & Pape, unpublished). The condition of the holotype and the difficulty of identifying *Dolichotachina* females have not allowed us to verify whether this specimen is conspecific with any of the other described species. Lacking any strong indication to the contrary, we consider *D. smithii* to be a valid, probably extant, species from East Africa.

Age of the Tachinidae

Fossils are the most reliable indicators of the minimum age of the lineage to which they belong, but they provide false information if they are incorrectly identified or dated. As explained above, the minimum age of the Tachinidae is no longer the Eocene based on fossil evidence. Instead, the oldest fossils date the family to the Oligocene (Evenhuis 1994), assuming those fossils are accurately identified and dated. Von Tschirnhaus and Hoffeins (2009) reported on a dipteran in Baltic amber that might belong to the Tachinidae but it is in such poor condition that even tachinid specialist H.-P. Tschorsnig (Stuttgart) could not be sure of its placement to family.

The merging of phylogenetic data with data from fossils of known age and identity to create chronograms is becoming more common in evolutionary studies. The results are generally speculative but provide an estimated evolutionary timeline that can be further refined and tested by future research. Two recent studies on the Diptera have suggested different ages for the origin of the Tachinidae. One, a large study by Wiegmann et al. (2011), estimated the origin of the Tachinidae at about 30 million years ago (mya) (i.e., mid Oligocene). The other, by Zhao et al. (2013) and based on fewer data, suggested the Tachinidae originated about 48 mya (i.e., mid Eocene). This latter estimate was tempered by a broad confidence interval. Neither of these estimates is inconsistent with the re-assessed fossil record of Tachinidae, which does not contribute towards an understanding of the age of the family beyond that of the minimum age.

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New species of *Pseudopoda* Jäger, 2000 from Southern China (Araneae, Sparassidae)

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Abstract

Four new species of the huntsman spider genus *Pseudopoda* Jäger, 2000 are described from Southern China: *Pseudopoda acuminata* **sp. n.** from Suiyang County, Guizhou Province, *P. emei* **sp. n.** from Emei Mountain, Sichuan Province, *P. lacrimosa* **sp. n.** from Fugong County and Tengchong County, Yunnan Province, and *P. robusta* **sp. n.** from Jinyun Mountain, Chongqing Municipality.

Keywords

Taxonomy, Heteropodinae, huntsman spiders, new species

Introduction

The members of the huntsman spider family Sparassidae Bertkau, 1872 are small to large sized spiders. Currently it includes 84 genera and 1132 known species (Platnick 2013). Of these, 102 species from eleven genera (*Bhutaniella* Jäger, 2000, *Eusparassus* Simon,

1903, *Gnathopalystes* Rainbow, 1899, *Heteropoda* Latreille, 1804, *Micrommata* Latreille, 1804, *Olios* Walckenaer, 1837, *Pseudopoda* Jäger, 2000, *Rhitymna* Simon, 1897, *Sagellula* Strand, 1942, *Sinopoda* Jäger, 1999 and *Thelcticopis* Karsch, 1884) have been recorded from China (Song et al. 1999; Platnick 2013).

The genus *Pseudopoda*, established by Jäger (2000), belongs to the subfamily Heteropodinae Thorell, 1873. After that, Jäger (2001) made a major revision on Himalayan representatives and described 51 new species, for which he proposed five species groups. Jäger and Vedel (2007) revised the genus *Pseudopoda* of Yunnan Province, China and described 15 new species, they discussed species groups proposed by Jäger (2001) with respect to the new results of their study. Several papers with descriptions of species from Asia have been published. Seven new species from India (Jäger 2001, 2002, 2008a), five new species from Laos (Jäger 2007; Jäger et al. 2006; Jäger and Praxaysombath 2009), two new species from Japan (Jäger and Ono 2002; Ono 2009;) and one new species from Vietnam (Jäger and Vedel 2005), have been described. Several papers also included transfers, twelve taxa were transferred from *Heteropoda* to *Pseudopoda* (Jäger 2000, 2001, 2002; Jäger and Yin 2001) and two taxa from *Sinopoda* to *Pseudopoda* (Jäger 2001; Jäger and Vedel 2007). To date, 98 species of the genus *Pseudopoda* have been recorded from Asia, of which 37 have been recorded from China (Jäger 2008b; Jäger and Ono 2001; Jäger et al. 2002; Liu et al. 2008; Sun and Zhang 2012; Tang and Yin 2000; Xu and Yin 2000; Yang and Chen 2008; Yang and Hu 2001; Yang et al. 2009; Zhang and Kim 1996).

During the examination of spider specimens collected from Southern China, four new species, *P. acuminata* sp. n., *P. emei* sp. n., *P. lacrimosa* sp. n. and *P. robusta* sp. n. were recognized and are here described. The systematic position of the new species within the genus is discussed. A distribution map of the new *Pseudopoda* species in China is also provided.

Material and methods

All specimens were kept in 75% ethanol and examined, drawn and measured under a Nikon SMZ1500 stereomicroscope, equipped with a camera lucida. Photos were taken with a Leica M205A stereomicroscope equipped with a DFC450 CCD camera. Measurement system mostly follows Jäger (2000). Carapace length was measured from the anterior margin to the rear margin of the carapace medially in dorsal view. Two eye rows were described in dorsal view. Eye sizes were measured as the maximum diameter of the lens in dorsal or frontal view. The measurements of legs are shown as: total length (femur, patella, tibia, metatarsus, tarsus). Spine notation follows Davies (1994). Spines are listed for each segment in the following order: prolateral, dorsal, retrolateral, ventral; a three digit formula indicates ventral spines missing. The epigyne was cleared in a warm solution of potassium hydroxide (KOH), transferred to 75% ethanol for drawing. All measurements are in millimeters. All specimens studied are deposited in

the Museum of Hebei University (MHBU, curator: Prof. Guodong Ren), Baoding, China and School of Life Science, Southwest University, Chongqing, China (SWUC, curator: Prof. Zhisheng Zhang).

Abbreviations

AB anterior longitudinal bands; aEF anterior margin of epigynal field; ALE anterior lateral eyes; AME anterior median eyes; amLL anterior margin of lateral lobes; C conductor; CD copulatory duct; CQ Chongqing Municipality, China; E embolus; EP embolic projection; FD fertilization duct; GLGS Gaoligongshan; KKS Kuankuoshui Nature Reserve; LL lateral lobes of epigyne; lmLL lateral margin of lateral lobes; MF median field of epigyne; mmLL median margin of lateral lobes; MOA median ocular area; PI posterior incisions; PLE posterior lateral eyes; pmLL posterior margins of lateral lobes; PME posterior median eyes; R ridges; RTA retrolateral tibial apophysis; S spermathecae; SC Sichuan Province, China; SD sperm duct; SP Sparassidae; ST subtegulum; T tegulum.

Taxonomy

Sparassidae Bertkau, 1872
Heteropodinae Thorell, 1873

***Pseudopoda* Jäger, 2000**
http://species-id.net/wiki/Pseudopoda

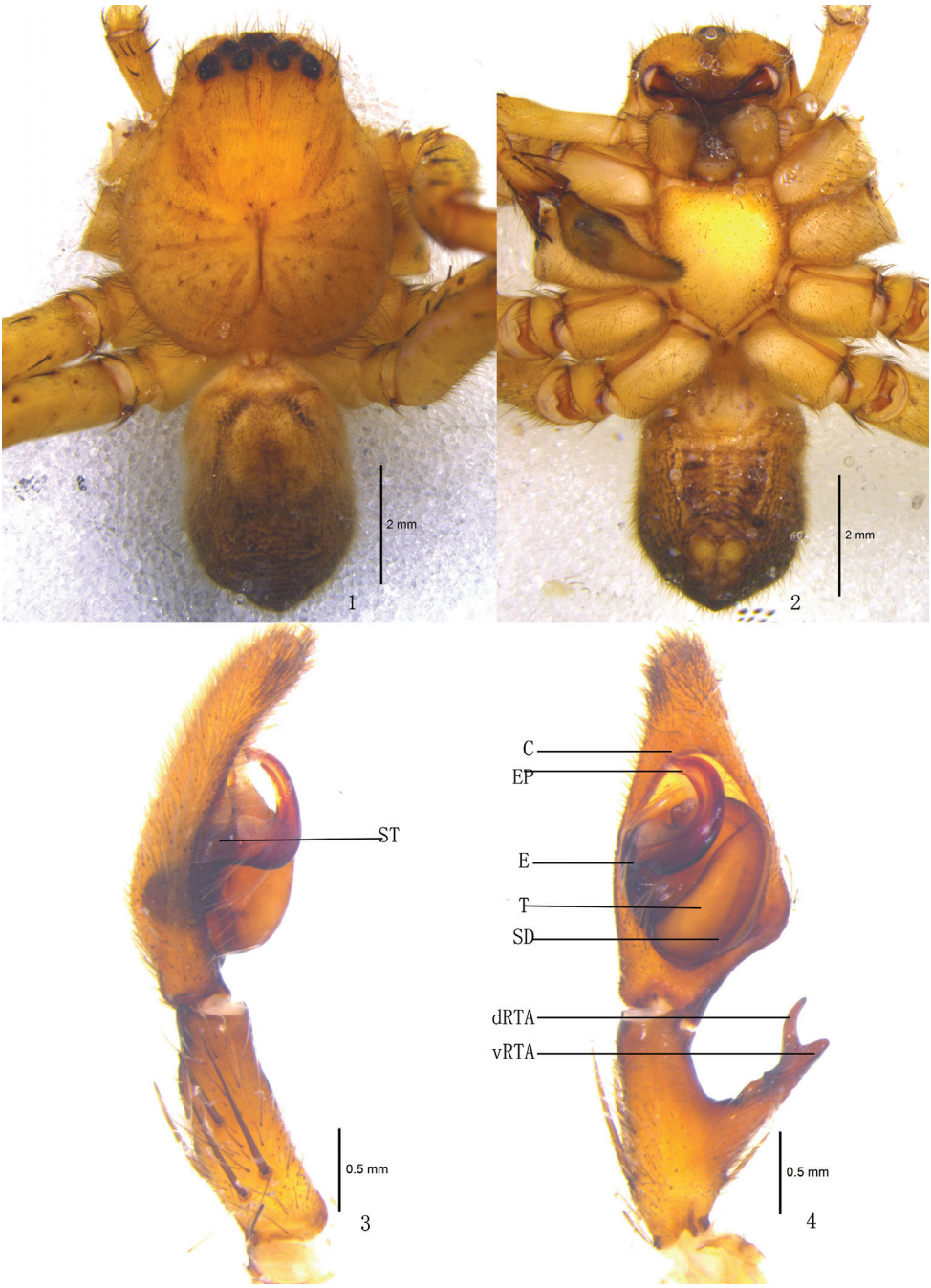
Type species. *Sarotes promptus* O. P.-Cambridge, 1885

Diagnosis. Conductor of male palp membranous; embolus broadened and flattened or at least in its proximal part broadened; retrolateral tibial apophysis arising in a medial or basal position; lateral lobes of epigyne rising beyond epigastric furrow, and covering median septum (Jäger 2000, 2001).

Distribution. China, Nepal, Bhutan, Myanmar, Thailand, Vietnam, Laos, Pakistan and India.

***Pseudopoda acuminata* sp. n.**
http://zoobank.org/B85A9DF9-D168-4542-A80E-B15667209820
http://species-id.net/wiki/Pseudopoda_acuminata
Figs 1–17

Type material. Holotype ♂ (SP–KKS–10–0816), from CHINA: Guizhou Province, Suiyang County, Kuankuoshui Nature Reserve (28°17'N, 107°11'E, 1200 m), 16.



Figures 1–4. *Pseudopoda acuminata* sp. n., Male (SP–SC–03–0050): **1–2** Body (**1** dorsal **2** ventral) **3–4** Left palp (**3** prolateral **4** ventral). Abbreviations: C conductor; dRTA dorsal branch of retrolateral tibial apophysis; E embolus; EP embolic projection; SD sperm duct; ST subtegulum; T tegulum; vRTA ventral branch of retrolateral tibial apophysis. Scale bars: 2 mm (**1–2**); 0.5 mm (**3–4**).

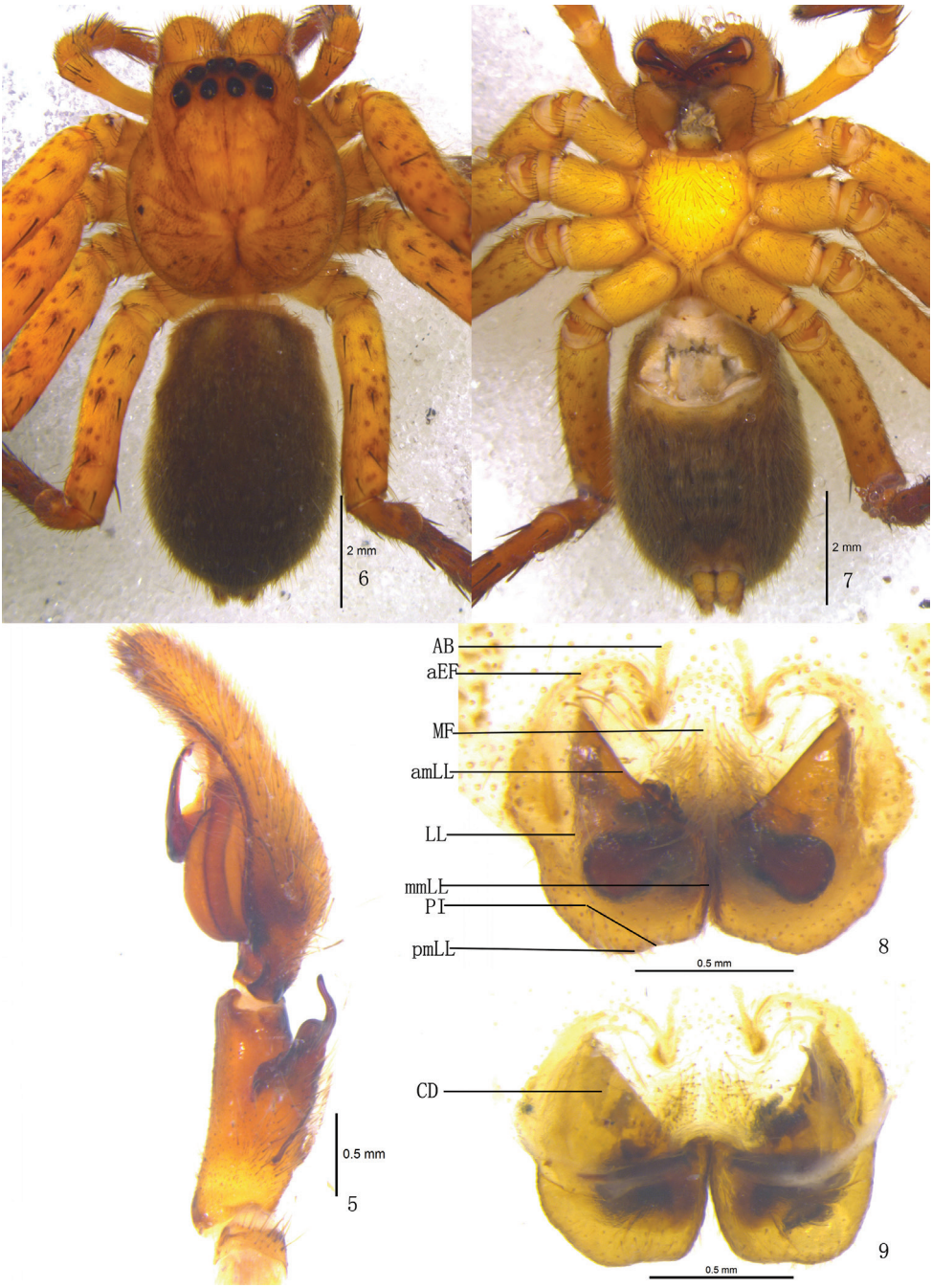
VIII.2010, Z.S. Zhang leg. (hand collecting), deposited in SWUC. **Paratype:** 1♀ (SP–KKS–10–0817), same data as holotype.

Etymology. The specific name is derived from the Latin word 'acuminatus, -a, -um', meaning 'acuminate', referring to the acute shape of the embolic projection; adjective.

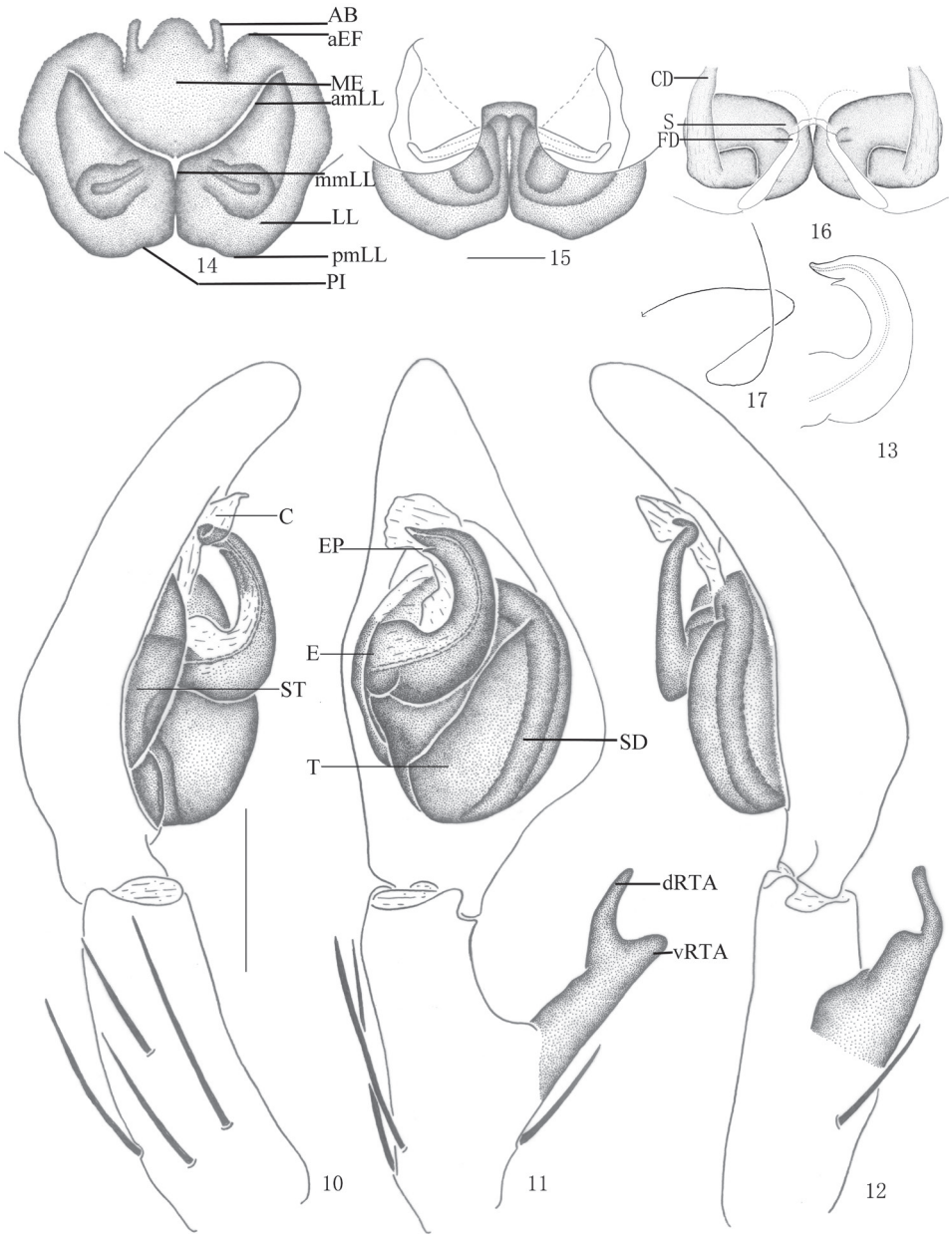
Diagnosis. Male and female of *P. acuminata* sp. n. resemble those of *P. contentio* Jäger & Vedel, 2007 by: embolus sickle-shaped and bent in a semicircle, embolic projection small, anterior margins of lateral lobes diagonal, internal duct system visible through cuticle in a ventral view as large, rather elongated patches. They are distinguished from the latter species by the following combination of characters: embolic projection spine-shaped (Figs 4, 11, 13); dorsal branch of retrolateral tibial apophysis slightly curved, ventral branch as a small hump (Figs 4–5, 11–12); anterior rims of lateral lobes curved, running more diagonal and pointing 30° anterio-laterally (Figs 8, 14); extending part of lateral lobes more narrow in dorsal view (Figs 9, 15); posterior end of first winding of internal duct system covered by lateral lobes (Figs 9, 15).

Description. Holotype (SP–KKS–10–0816): total length 11.23; prosoma 6.61 long, 4.82 wide; opisthosoma 4.58 long, 2.83 wide. Prosoma with some setae. Fovea long, longitudinal. Coloration: Dorsal shield of prosoma yellow brown. Radial furrows brownish. Fovea dark brown. Ocular area yellowish brown. Chelicerae yellowish brown. Labium, gnathocoxae and sternum yellow. Legs yellow, with dark dots randomly distributed, and especially on the setae and spine bases of coxa and femur. Opisthosoma color overall dark brown (Fig. 1), yellowish anterior-dorsally, ventral median dark brown (Fig. 2). Both eye rows slightly recurved. Eye diameters and interdistances: AME 0.26, ALE 0.36, PME 0.27, PLE 0.36; AME–AME 0.29, AME–ALE 0.05, PME–PME 0.42, PME–PLE 0.49. MOA 0.87 long, anterior width 0.60, posterior width 0.87. Clypeus height 0.26. Chelicerae with three promarginal and four retromarginal teeth, and with thirteen denticles between them. Sternum with dark setae. Leg measurements: I 24.25 (6.21, 2.10, 6.82, 6.52, 2.60), II 24.44 (6.23, 2.14, 6.88, 6.55, 2.64), III 23.79 (6.13, 1.96, 6.89, 6.35, 2.37), IV 24.12 (6.18, 2.03, 6.82, 6.52, 2.57). Leg formula: 2143. Leg spination: palps 131, 101, 2121; femur I–II 323, III 322, IV 331; patella I–III 101, IV 001; tibia I–II 2226, III–IV 2126; metatarsus I–II 2024, III 2026, IV 3036. Male palp. Embolus sickle-shaped, arising from 9- to 10-o'clock-position on tegulum, embolic tip pointing prolaterally (Figs 3–4, 10–11); sperm duct running submarginally along retrolateral margin of tegulum in ventral view (Figs 4–5, 11–12); EP spine-shaped (Figs 4, 11, 13); RTA long, with broad base, arising medially from tibia, dorsal branch long and thin, slightly curved, ventral branch short and thick, with blunt tip (Figs 4–5, 11–12).

Female. Paratype (SP–KKS–10–0817): total length 9.70; prosoma 4.51 long, 3.02 wide; opisthosoma 5.22 long, 2.82 wide. Coloration: Dorsal shield of prosoma reddish brown. Legs yellowish brown, with dark dots randomly distributed, and especially on the setae and spine bases of coxa and femur. Opisthosoma color overall dark brown (Figs 6–7). Eye diameters and interdistances: AME 0.21, ALE 0.32, PME 0.23, PLE 0.31; AME–AME 0.21, AME–ALE 0.13, PME–PME 0.36, PME–PLE



Figures 5–9. *Pseudopoda acuminata* sp. n., **5** Left palp of male (retrolateral). **6–9** Female (SP–SC–03–0052): **6–7** Body (**6** dorsal **7** ventral) **8–9** Epigyne (**8** ventral **9** dorsal). Abbreviations: AB anterior bands; aEF margin of epigynal field; amLL anterior margin of lateral lobes; CD copulatory duct; LL lateral lobes of epigyne; MF median field of epigyne; mmLL median margin of lateral lobes; pmLL posterior margins of lateral lobes; PI posterior incisions. Scale bars: 2 mm (**6–7**); 1 mm (**5, 8–9**).



Figures 10–17. *Pseudopoda acuminata* sp. n., **10–13** Male (SP–SC–03–0050): **10–12** Left palp (**10** prolateral **11** ventral **12** retrolateral) **13** embolus (ventral) **14–17** Female (SP–SC–03–0052): **14–16** Epigyne (**14** ventral **15** dorsal **16** apical); **17** Schematic course of internal duct system, dorsal. Abbreviations: AB anterior bands; aEF anterior margin of epigynal field; amLL anterior margin of lateral lobes; C conductor; CD copulatory duct; dRTA dorsal branch of retrolateral tibial apophysis; E embolus; EP embolic projection; FD fertilization duct; LL lateral lobes of epigyne; MF median field of epigyne; mmLL median margin of lateral lobes; pmLL posterior margins of lateral lobes; PI posterior incisions; S spermathecae; SD sperm duct; ST subtegulum; T tegulum; vRTA ventral branch of retrolateral tibial apophysis. Scale bars: 0.5 mm.

0.44. MOA 0.82 long, anterior width 0.60, posterior width 0.83. Clypeus height 0.25. Leg measurements: I 15.47 (4.62, 1.83, 3.81, 3.91, 1.30), II 15.72 (4.66, 1.83, 3.98, 3.93, 1.32), III 14.78 (4.55, 1.77, 3.62, 3.65, 1.19), IV 15.31 (4.59, 1.85, 3.75, 3.82, 1.30). Leg formula: 2143. Leg spination: palps 131, 101, 2121, 2112; femur I–II 323, III 322, IV 331; patella I–IV 001; tibia I 2026, II–IV 2126; metatarsus I–II 2024, III 2026, IV 3036. Epigyne. Epigynal field wider than long, anterior margin rather indistinct, anterior longitudinal bands thin and short (Figs 8, 14); LLs wider at the median part, touching each other along the median line, anterior margin of LLs pointing 30° anterior-laterally; posterior margins of LLs with distinct posterior incisions; internal duct system visible through cuticle as elongated patches (Figs 8, 14); posterior end of first winding of internal duct system covered by LLs (Figs 9, 15).

Distribution. Kuankuoshui Nature Reserve, Suiyang County, Guizhou Province, China.

Comments. Males of *Pseudopoda acuminata* sp. n. could be included in the *Pseudopoda martensi*-group (Jäger, 2001). Males of *Pseudopoda martensi*-group are characterized by: embolus sickle shaped, strongly flattened, and arising in a prolateral position on the tegulum, first bending in a retrolateral direction and then running in a distal direction; small embolic projection present. Females are difficult to distinguish (Jäger 2001).

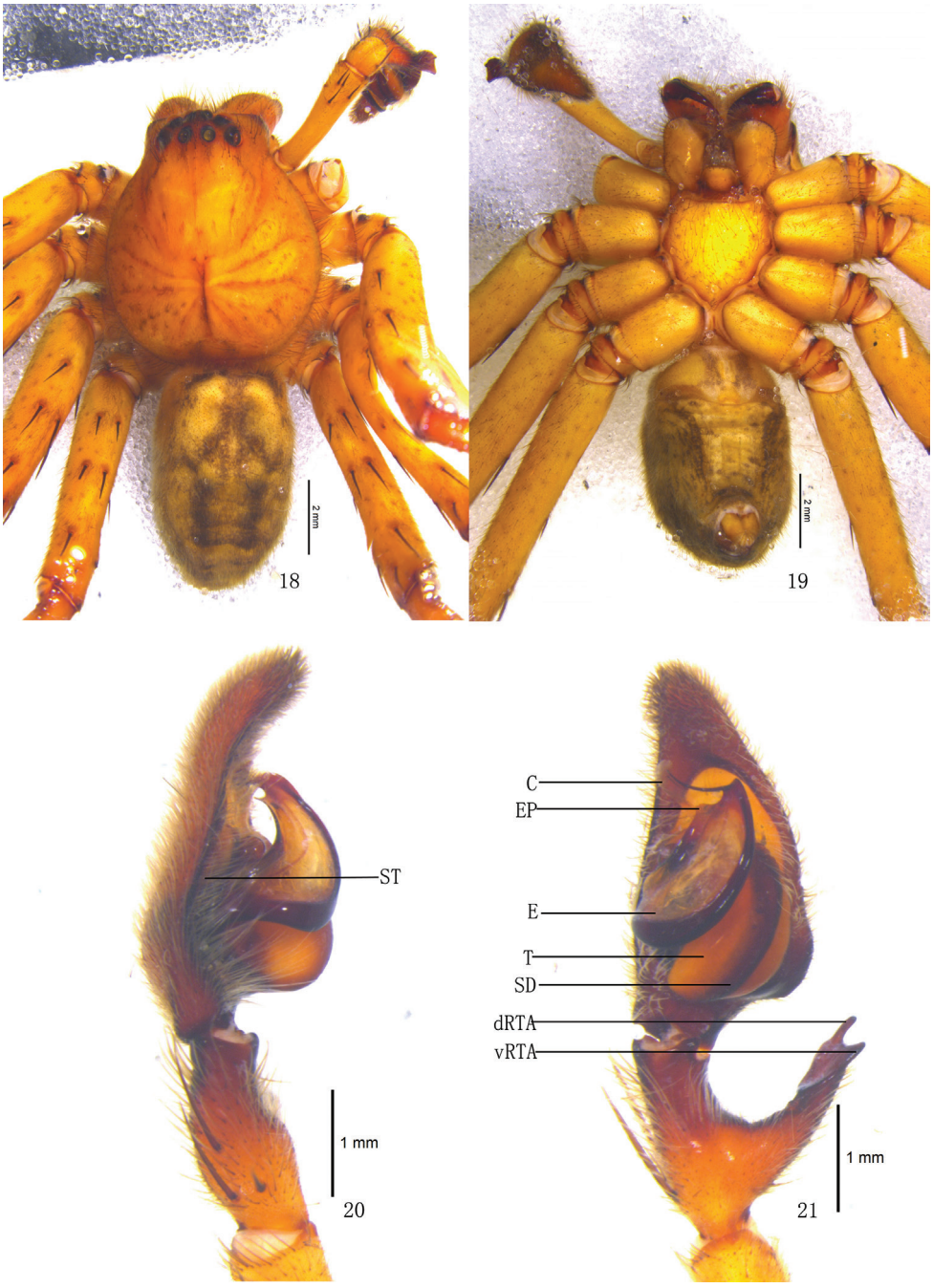
***Pseudopoda emei* sp. n.**

http://zoobank.org/7ED92A2A-117E-4B10-ADB1-052398DA2D24
http://species-id.net/wiki/Pseudopoda_emei
Figs 18–33

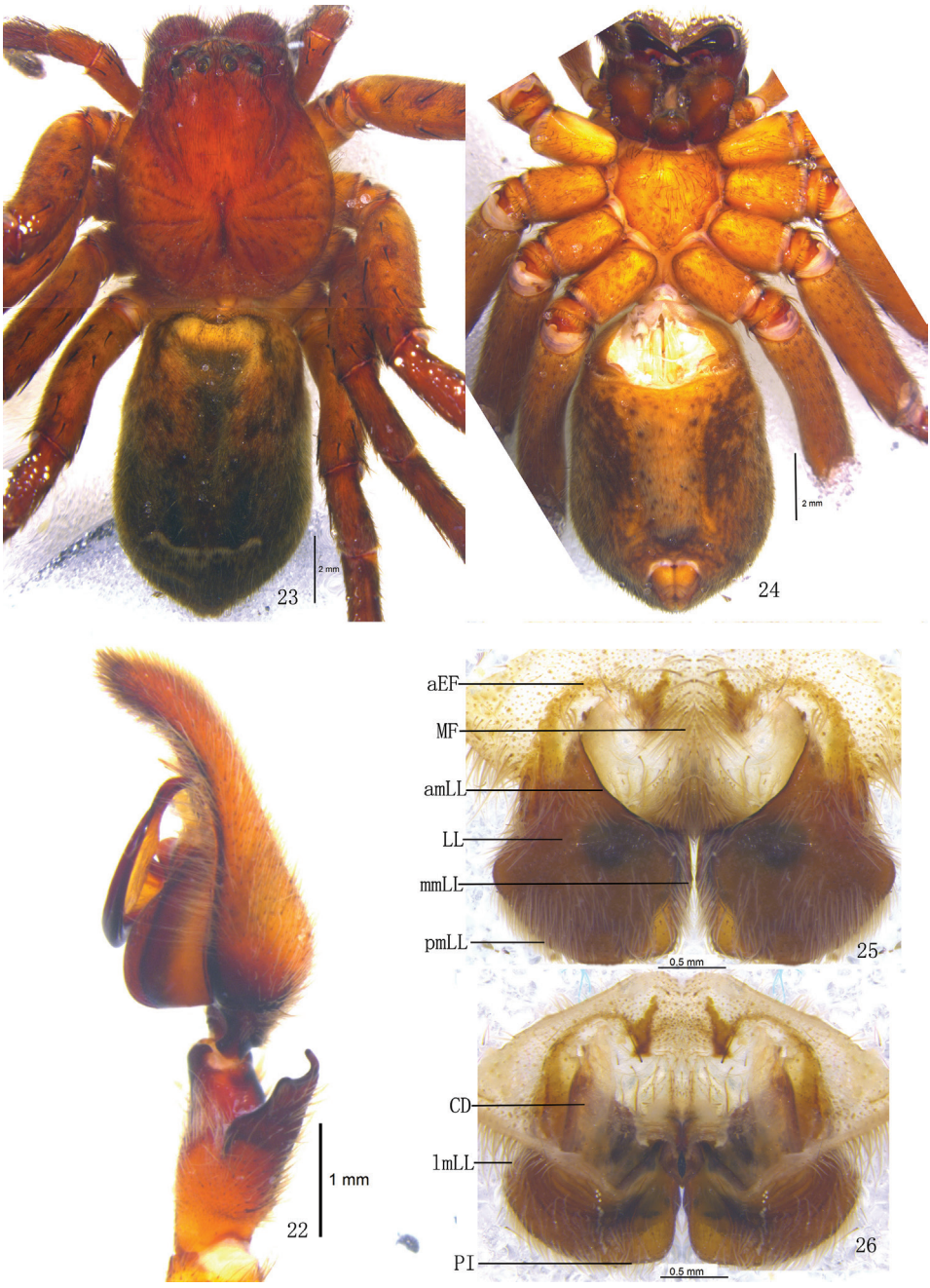
Type material. Holotype ♂ (SP–SC–03–0050), from CHINA: Sichuan Province, Emei Mountain, Fuhu Temple (29°59'N, 103°48'E, 1800 m), 26.VII.2003, J.X. Zhang leg. (hand collecting), deposited in MHBU. **Paratype:** 1♂ (SP–SC–03–0051), 2♀♀ (SP–SC–03–0052–0053), same data as holotype; 1♀ (SP–SC–09–24), from CHINA: Sichuan Province, Emei Mountain, native forest, 24.IX.2010, Y.W. Zhao leg. (hand collecting), deposited in MHBU.

Etymology. The specific name refers to the type locality, the mountain Emei; noun in apposition.

Diagnosis. Males of *P. emei* sp. n. resemble those of *P. virgata* (Fox, 1936), *P. kalinchoca* Jäger, 2001 and *P. khimtensis* Jäger, 2001 by the strongly flattened embolus and long embolic tip, but can be distinguished by the following combination of characters: basal and middle part of embolus very broad, but with slender tip, embolic tip filiform, curving slightly upward (Figs 20–21, 27–28), prolateral margin of embolus with a small embolic projection, embolic projection shorter than 1/3 length of embolic tip (Figs 21, 28). Females can be distinguished from those of other *Pseudopoda* species by: posterior epigynal field wider than anterior part; anterior margin of the lateral lobes



Figures 18–21. *Pseudopoda emei* sp. n., Male (SP–SC–03–0050): **18–19** Body (**18** dorsal **19** ventral) **20–21** Left palp (**20** prolateral **21** ventral). Abbreviations: C conductor; dRTA dorsal branch of retrolateral tibial apophysis; E embolus; EP embolic projection; SD sperm duct; ST subtegulum; T tegulum; vRTA ventral branch of retrolateral tibial apophysis. Scale bars: 2 mm (**18–19**); 1 mm (**20–21**).

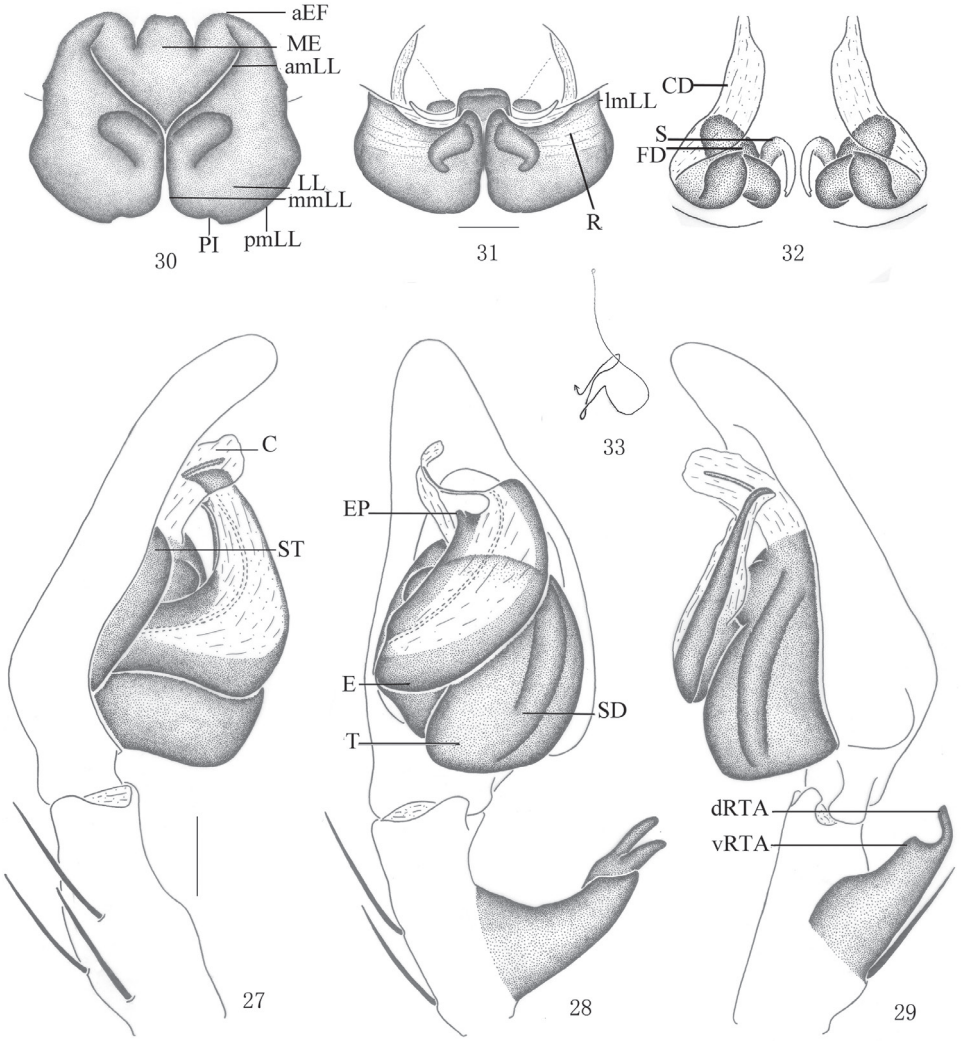


Figures 22–26. *Pseudopoda emei* sp. n., **22** Left palp of male (retrolateral). **23–26** Female (SP–SC–03–0052): **23–24** Body (**23** dorsal **24** ventral) **25–26** Epigyne (**25** ventral **26** dorsal). Abbreviations: aEF anterior margin of epigynal field; amLL anterior margin of lateral lobes; CD copulatory duct; LL lateral lobes of epigyne; lmLL lateral margin of lateral lobes; MF median field of epigyne; mmLL median margin of lateral lobes; pmLL posterior margins of lateral lobes; PI posterior incisions. Scale bars: 1 mm (**22**); 2 mm (**23–24**); 0.5 mm (**25–26**).

distinctly curved and pointing anterior-laterally (Figs 25, 30); lateral lobes large, with distinct ridges in dorsal view, the length of lateral margin of lateral lobes almost equal to that of median margin in dorsal view (Figs 26, 31); posterior half of first winding of internal duct system covered by lateral lobes (Figs 26, 31).

Description. Holotype (SP–SC–03–0050): total length 15.39; prosoma 7.21 long, 6.02 wide; opisthosoma 8.23 long, 4.82 wide. Prosoma with some setae. Fovea long, longitudinal. Coloration: Dorsal shield of prosoma yellow. Radial furrows and fovea dark brown. Chelicerae brown. Labium, gnathocoxae and sternum yellowish brown. Sternum with dark spots and setae. Legs yellow, with dark dots randomly distributed, and especially on the setae and spine bases of coxa and femur. Dorsal opisthosoma yellow, anterior part with black patches, cardiac pattern and muscle impressions dark brown, followed by three black transverse lines and two longitudinal black patches; lateral part with some smaller irregular patches (Fig. 18); venter yellow, with two black lateral lines and a black patch before spinnerets (Fig. 19). Both eye rows slightly recurved. Eye diameters and interdistances: AME 0.34, ALE 0.49, PME 0.36, PLE 0.47; AME–AME 0.21, AME–ALE 0.08, PME–PME 0.43, PME–PLE 0.52. MOA 1.17 long, anterior width 0.83, posterior width 1.16. Clypeus height 0.32. Chelicerae with three promarginal and four retromarginal teeth, and with thirteen denticles between them. Leg measurements: I 36.66 (9.51, 3.20, 10.22, 10.52, 3.21), II 36.85 (9.53, 3.23, 10.28, 10.56, 3.25), III 36.40 (9.43, 3.16, 10.19, 10.42, 3.20), IV 36.49 (9.48, 3.17, 10.22, 10.42, 3.20). Leg formula: 2143. Leg spination: palps 131, 101, 2121; femur I–III 323, IV 331; patella I–IV 101; tibia I–II 2226, III–IV 2126; metatarsus I–II 2024, III 2026, IV 3036. Male palp. Embolus long, arising from 8 o'clock-position on tegulum (Figs 20–21, 27–28), basal and middle part of embolus very broad, but with long and filiform tip, pointing ventro-prolaterally (Figs 20–21, 27–28); EP small (Figs 21, 28); sperm duct running submarginally along retrolateral margin of tegulum in ventral view (Figs 21–22, 28–29); RTA long, with broad base, arising medially to basally from tibia, dorsal branch narrow and curved, ventral branch short, wide, and as a small hump in retrolateral view (Figs 21–22, 28–29).

Females. Paratype (SP–SC–03–0052): total length 13.22; prosoma 6.41 long, 5.52 wide; opisthosoma 6.82 long, 4.89 wide. Coloration: Dorsal shield of prosoma reddish brown. Legs brown, with dark dots randomly distributed, and especially on the setae and spine bases of coxa and femur. Dorsal opisthosoma dark brown, cardiac pattern and muscle impressions black, followed by a transverse line composed of white hairs and two longitudinal black patches. Coloration pattern darker than male (Figs 23–24). Eye diameters and interdistances: AME 0.29, ALE 0.40, PME 0.33, PLE 0.39; AME–AME 0.29, AME–ALE 0.14, PME–PME 0.57, PME–PLE 0.47. MOA 1.17 long, anterior width 0.81, posterior width 1.14. Clypeus height 0.32. Leg measurements: I 22.27 (7.02, 2.83, 5.17, 5.17, 2.08), II 22.38 (7.06, 2.83, 5.18, 5.17, 2.14), III 21.71 (6.65, 2.81, 5.12, 5.15, 1.98), IV 21.89 (6.68, 2.83, 5.15, 5.19, 2.04). Leg formula: 2143. Leg spination: palps 131, 101, 2121, 2112; femur I–III 323, IV 321; patella I–IV 101; tibia I–IV 2126; metatarsus I–II 2024, III 2026, IV 3036. Epigyne. Epigynal field wider than long, anterior margin without longitudinal



Figures 27–33. *Pseudopoda emei* sp. n., **27–29** Male (SP–SC–03–0050): Left palp (**27** prolateral **28** ventral **29** retrolateral). **30–33** Female (SP–SC–03–0052): **30–32** Epigyne (**30** ventral **31** dorsal **32** apical) **33** Schematic course of internal duct system, dorsal. Abbreviations: aEF anterior margin of epigynal field; amLL anterior margin of lateral lobes; C conductor; CD copulatory duct; dRTA dorsal branch of retrolateral tibial apophysis; E embolus; EP embolic projection; FD fertilization duct; LL lateral lobes of epigyne; lmLL lateral margin of lateral lobes; MF median field of epigyne; mmLL median margin of lateral lobes; pmLL posterior margins of lateral lobes; PI posterior incisions; R ridges; S spermathecae; SD sperm duct; ST subtegulum; T tegulum; vRTA ventral branch of retrolateral tibial apophysis. Scale bars: 0.5 mm.

bands (Figs 25, 30); LLs width equal to length, touching each other along the median line, anterior margin of LLs distinctly curved and pointing anterior-laterally, posterior margins of LLs rounded, and with distinct posterior incisions (Figs 25, 30), LLs large,

with distinct ridges in dorsal view (Figs 26, 31); internal duct system visible through cuticle as almost rectangular dark patches (Figs 25, 30); posterior end of first winding of internal duct system covered by LLs (Figs 26, 31).

Variation. Male total body length from 15.32–15.39, and female from 13.22–14.21. Femur length of male: I from 9.48–9.51, II from 9.51–9.53, III from 9.42–9.43, IV from 9.46–9.48. Femur length of female: I from 7.02–7.05, II from 7.06–7.08, III from 6.65–6.66, IV from 6.68–6.70.

Distribution. Emei Mountain, Sichuan Province, China.

Comments. Males of *Pseudopoda emei* sp. n. could be included in the *Pseudopoda martensi*-group by: embolus sickle-shaped, strongly flattened, and arising in a prolateral position on the tegulum, first bending in a retrolateral direction and then running in a distal direction; small embolic projection present.

***Pseudopoda lacrimosa* sp. n.**

http://zoobank.org/E5DF75DE-B3DD-40B9-80A8-4F9E93B0A72B
http://species-id.net/wiki/Pseudopoda_lacrimosa
Figs 34–49

Type material. Holotype ♂ (SP–GLGS–11–41), from CHINA: Yunnan Province, Fugong County, Maji Town, native forest (27°28'N, 98°51'E, 1700 m), 10.III.2011, Z.X. Li leg. (hand collecting), deposited in SWUC. **Paratype:** 1♀ (SP–GLGS–11–42), same data as holotype; 1♂ (SP–GLGS–11–23), 1♀ (SP–GLGS–11–24), from CHINA: Yunnan Province, Baoshan City, Tengchong County, Jietou Town, native forest (25°18'N, 98°21'E, 1850 m), 25.II.2011, L.Y. Wang leg. (hand collecting), deposited in SWUC.

Etymology. The specific name is derived from the Latin word 'lacrimosus, -a, -um', meaning 'lachrymal', referring to the tear-drop shape of the epigynal median field; adjective.

Diagnosis. Males of *P. lacrimosa* sp. n. resemble those of *P. everesta* Jäger, 2001 by the embolus with almost equal length of tip and projection, but can be distinguished by the following combination of characters: tip of embolus thin and long (Figs 37, 44); embolic projection large, strip-like (Figs 36–37, 43–44); tip of embolus and embolic projection pointed (Figs 37–38, 44–45); retrolateral tibial apophysis with a small tooth on anterior margin of ventral branch (Figs 37–38, 44–45). Females resemble those of *P. diversipunctata* group by: anterior edges of lateral lobes oval and constrict; internal borders of lateral lobes not touching each other, but can be distinguished from other species of this group by: median field of epigyne narrow, almost tear-drop-shaped (Figs 41, 46); lateral lobes almost as an oblique rectangle, anterior margins of lateral lobes distinctly curved, bracket shaped and pointing medially (Figs 42, 47).

Description. Male. Holotype (SP–GLGS–11–41): total length 4.39; prosoma 2.11 long, 2.02 wide; opisthosoma 2.29 long, 1.43 wide. Fovea long, longitudinal. Coloration: Dorsal borders of prosoma brown, as the thick U-shaped pattern, rest

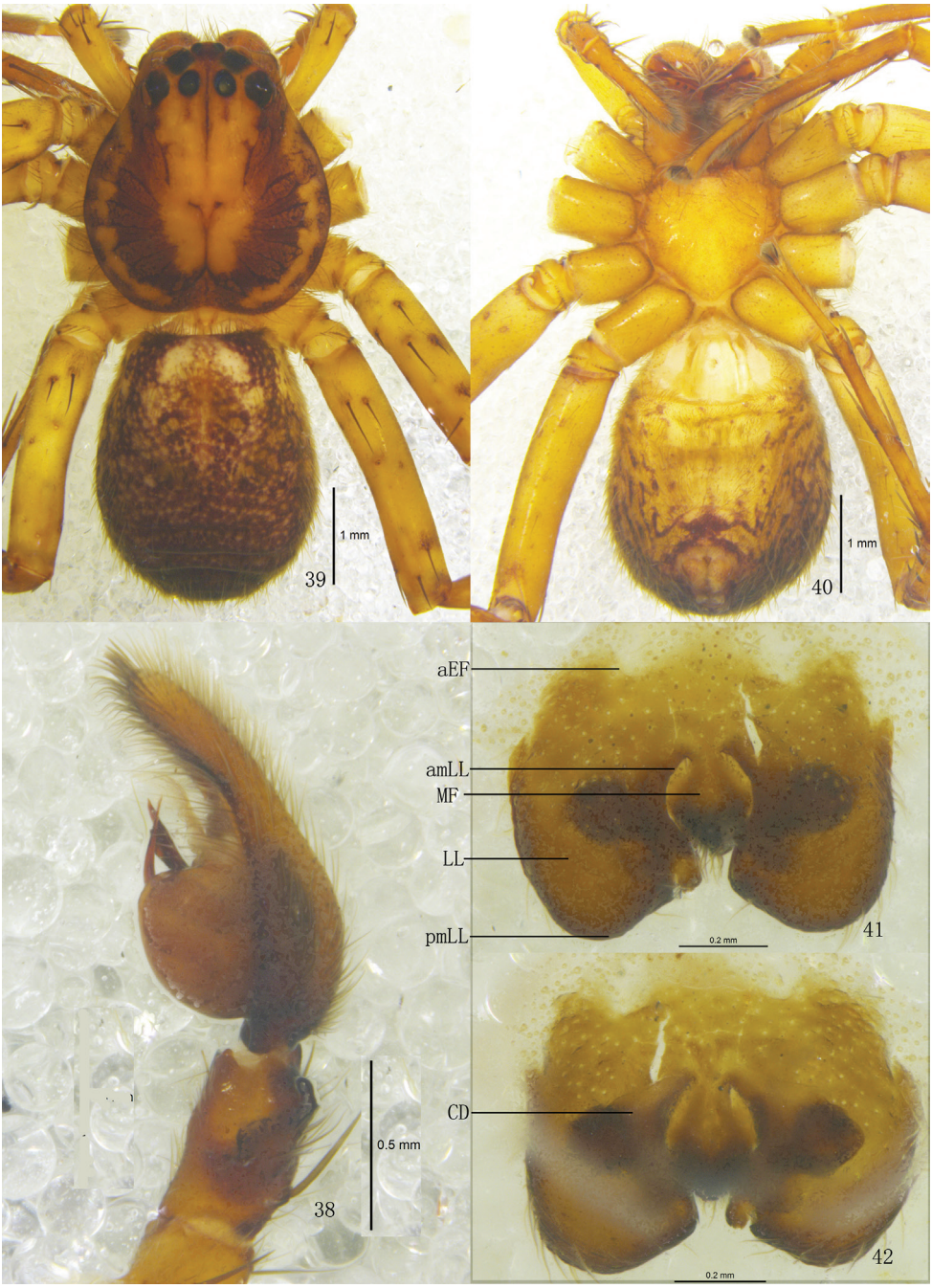
Figures 34–37. *Pseudopoda lacrimosa* sp. n., Male (SP–GLGS–11–41): **34–35** Body (**17** dorsal **18** ventral) **36–37** Left palp (**36** prolateral **37** ventral). Abbreviations: C conductor; dRTA dorsal branch of retrolateral tibial apophysis; E embolus; EP embolic projection; SD sperm duct; ST subtegulum; T tegulum; vRTA ventral branch of retrolateral tibial apophysis. Scale bars: 1 mm (**34–35**); 0.5 mm (**36–37**).

yellow. Radial furrows and fovea dark brown. Chelicerae, labium, gnathocoxae and sternum yellow. Sternum with dark setae. Legs yellow, with dark dots randomly distributed, and especially on the setae and spine bases of femur. Dorsal opisthosoma dark brown, with some small pale spots distributed around the opisthosoma, anterior part with two pale patches, cardiac pattern brown, muscle impressions yellow (Fig. 34); venter yellow (Fig. 35). Both eye rows slightly recurved. Eye diameters and interdistances: AME 0.13, ALE 0.26, PME 0.18, PLE 0.27; AME–AME 0.10, AME–ALE 0.03, PME–PME 0.16, PME–PLE 0.23. MOA 0.52 long, anterior width 0.30, posterior width 0.55. Clypeus height 0.21. Chelicerae with three promarginal and four retromarginal teeth, with eight denticles between them. Leg measurements: I 11.04 (2.41, 1.60, 2.81, 2.72, 1.50), II 12.24 (2.43, 1.64, 2.88, 2.73, 1.56), III 10.86 (2.33, 1.62, 2.69, 2.75, 1.47), IV 10.97 (2.38, 1.60, 2.78, 2.72, 1.49). Leg formula: 2143. Leg spination: palps 131, 101, 2121; femur I 223, II 323, III 322, IV 331; patella I–IV 001; tibia I–III 2026, IV 2126; metatarsus I–II 0004, III 2026, IV 3036. Male palp . Tegulum large (Figs 37, 44); embolus with thin tip and arising from 9 o'clock-position on tegulum (Figs 36–37, 43–44); embolic projection long, strip-like (Figs 36–37, 43–44); sperm duct S-shaped, running retrolaterally in the tegulum (Figs 37, 44–45); RTA with broad base, arising medially from tibia, dorsal branch thin, slightly curved, longer than ventral branch, ventral branch wide and with a small tooth on anterior margin (Figs 37–38, 44–45).

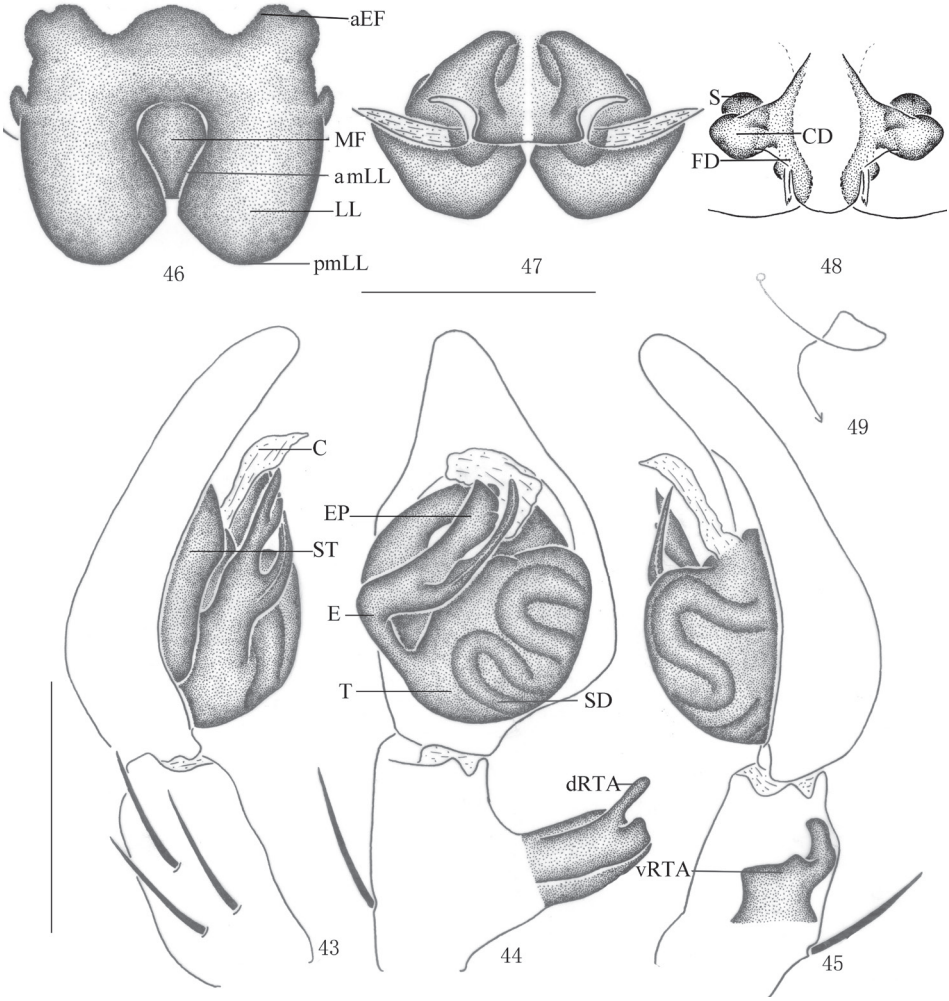
Females. Paratype (SP–GLGS–11–42): total length 6.51; prosoma 3.11 long, 2.22 wide; opisthosoma 3.42 long, 2.12 wide. Coloration: Venter yellow, with a black patch before spinnerets and some small black spots distributed laterally (Fig. 40). Shape, color and markings of body as in male (Figs 39–40). Eye diameters and interdistances: AME 0.13, ALE 0.26, PME 0.21, PLE 0.30; AME–AME 0.14, AME–ALE 0.07, PME–PME 0.27, PME–PLE 0.30. MOA 0.64 long, anterior width 0.39, posterior width 0.61. Clypeus height 0.21. Leg measurements: I 12.10 (3.82, 1.23, 2.81, 2.61, 1.63), II 12.21 (3.86, 1.23, 2.88, 2.63, 1.61), III 11.55 (3.69, 1.17, 2.62, 2.55, 1.52), IV 11.94 (3.78, 1.19, 2.78, 2.59, 1.60). Leg formula: 2143. Leg spination: palps 131, 101, 2121, 2112; femur I–II 323, III 322, IV 331; patella I–IV 001; tibia I–III 2026, IV 2126; metatarsus I–II 0004, III 2026, IV 3036. Epigyne. Median field of epigyne narrow, almost oval, anterior margin distinct, without longitudinal bands (Figs 41, 46); LLs longer than wide, closer to each other at the anterior median line, anterior and posterior margins of the LLs distinctly curved, anterior margins bracket shaped, (Figs 41, 46); posterior part of first winding of internal duct system wider than anterior part (Figs 42, 47).

Variation. Male total body length from 4.36–4.39, and female from 6.45–6.51. Femur length of male: I from 2.38–2.41, II from 2.41–2.43, III from 2.32–2.33, IV from 2.36–2.38. Femur length of female: I from 3.80–3.82, II from 3.85–3.86, III from 3.65–3.69, IV from 3.76–3.78.

Distribution. Maji Town, Fugong County, Yunnan Province, China; Jietou Town, Tengchong County, Baoshan City, Yunnan Province, China.



Figures 38–42. *Pseudopoda lacrimosa* sp. n., **38** Left palp of male (retrolateral). **39–42** Female (SP–GLGS–11–42): **39–40** Body (**39** dorsal **40** ventral) **41–42** Epigyne (**41** ventral **42** dorsal). Abbreviations: aEF margin of epigynal field; amLL anterior margin of lateral lobes; CD copulatory duct; LL lateral lobes of epigyne; MF median field of epigyne; pmLL posterior margins of lateral lobes. Scale bars: 1 mm (**39–40**); 0.5 mm (**38**); 0.2 mm (**41–42**).



Figures 43–49. *Pseudopoda lacrimosa* sp. n., **43–45** Male (SP–GLGS–11–41): Left palp (**43** prolateral **44** ventral **45** retrolateral) **46–49** Female (SP–GLGS–11–42): **46–48** Epigyne (**46** ventral **47** dorsal **48** apical); **49** Schematic course of internal duct system, dorsa. Abbreviations: aEF anterior margin of epigynal field; amLL anterior margin of lateral lobes; C conductor; CD copulatory duct; dRTA dorsal branch of retrolateral tibial apophysis; E embolus; EP embolic projection; FD fertilization duct; LL lateral lobes of epigyne; MF median field of epigyne; pmLL posterior margins of lateral lobes; S spermathecae; SD sperm duct; ST subtegulum; T tegulum; vRTA ventral branch of retrolateral tibial apophysis. Scale bars: 0.5 mm.

Comments. Females of *Pseudopoda lacrimosa* sp. n. could be included in the *P. diversipunctata*-group (Jäger, 2001). Females of this group are characterized by: lateral lobes of epigyne touching each other only at posterior part, the first winding of internal duct system running from laterally to the median line and the loop situated ventrally (Jäger 2001). On the other hand, males of *P. lacrimosa* sp. n. have long embolic projection and tip, which could place them in the *P. latembola*-group (Jäger 2001).

***Pseudopoda robusta* sp. n.**
http://zoobank.org/A77AD9CF-DD57-476B-B402-1C1EDF23C0C3
http://species-id.net/wiki/Pseudopoda_robusta
Figs 50–65

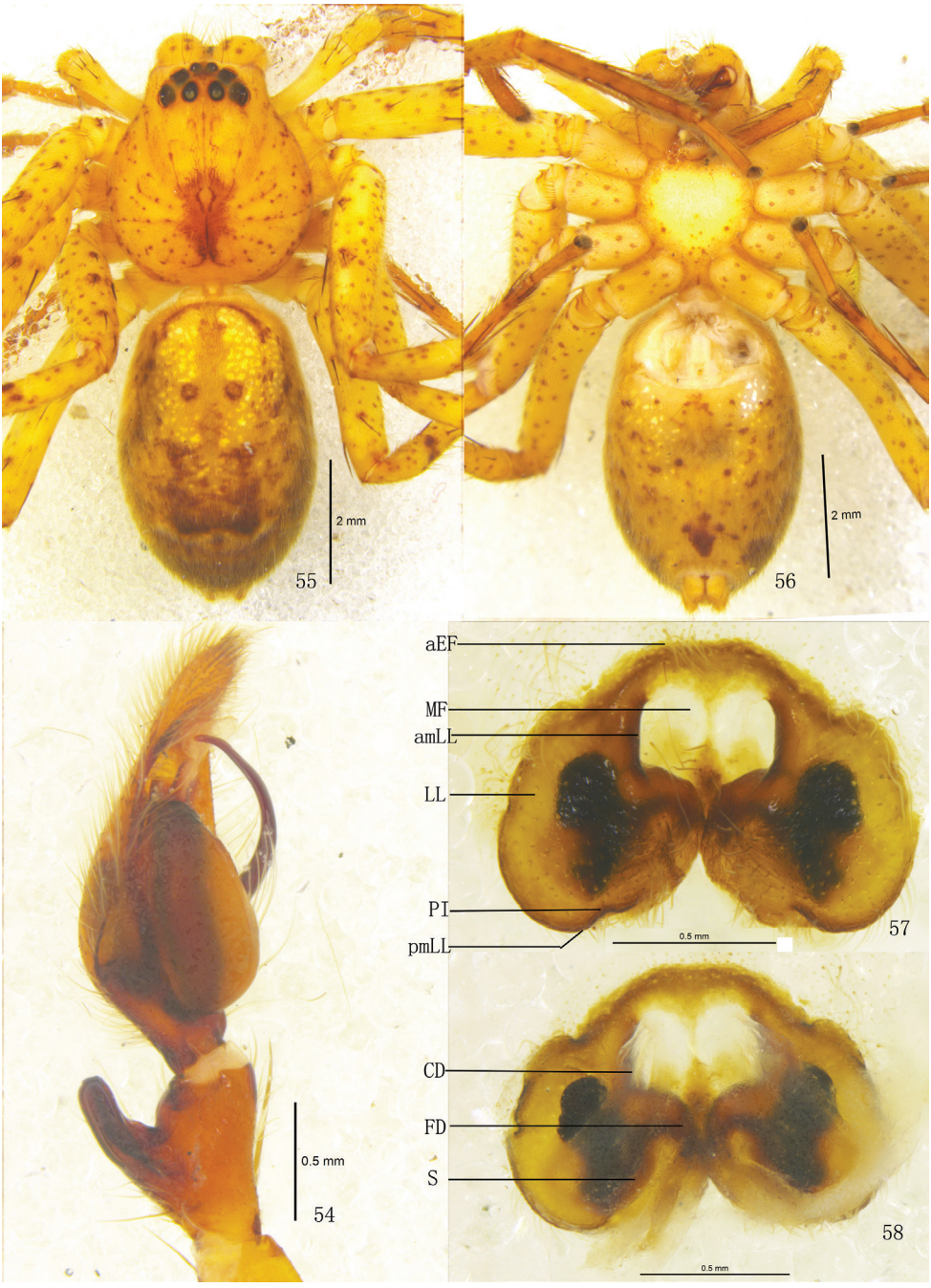
Type material. Holotype ♂ (SP–CQ–08–26), from CHINA: Chongqing Municipality, Jinyun Mountain, native forest, (29°49'N, 106°21'E, 1600 m), 26. IV.2008, Z.S. Zhang leg. (hand collecting), deposited in SWUC. Paratype: 1♂ (SP–CQ–08–27), 4♀♀ (SP–CQ–08–28–31), same data as holotype.

Etymology. The specific name is derived from the Latin word 'robustus, -a, -um', meaning 'strong', referring to the robust retrolateral tibial apophysis; adjective.

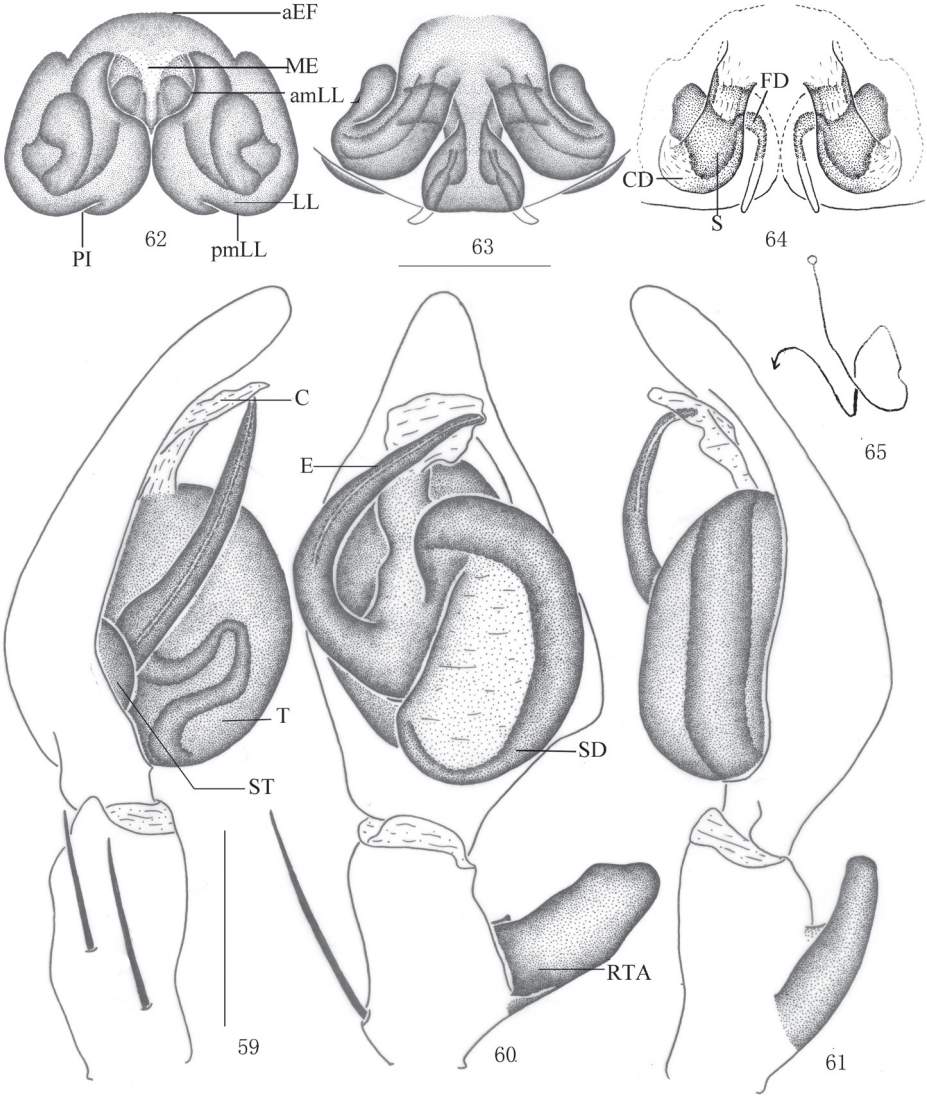
Diagnosis. Males of *P. robusta* sp. n. resemble those of *P. sinapophysis* Jäger & Vedel, 2007 by the simple embolus conformation, but can be distinguished by the following combination of characters: embolus large and long, flagelliform (Figs 52–53, 59–60); RTA massive in ventral view, with blunt tip (Figs 53–54, 60–61). Females of *P. robusta* sp. n. resemble those of *P. diversipunctata* group by: lateral lobes of epigyne touching each other only at posterior part; anterior edges of lateral lobes constrict, but can be distinguished from other species of this group by: median field of epigyne wider than long, distinctly U-shaped (Figs 57, 62); anterior margin of the LLs pointing anteriorly (Figs 57, 62); internal duct system with visible lateral loops in dorsal view (Figs 58, 63–64), the first winding wide, its length twice its width (Figs 58, 63–64).

Description. Male. Holotype (SP–CQ–08–26): total length 6.90; prosoma 3.21 long, 3.02 wide; opisthosoma 3.73 long, 2.12 wide. Fovea long, longitudinal. Coloration: Dorsal shield of prosoma yellow, margin with reddish brown patches. Radial furrows and fovea reddish brown, fovea surrounded with reddish brown patch. Ocular area brown. Chelicerae, labium, gnathocoxae and sternum yellow. Sternum with dark spots and setae. Legs yellow, with dark dots randomly distributed, and especially on the setae and spine bases of coxa, femur, patella and tibia. Dorsal opisthosoma yellow, anterior part with many small white patches, cardiac pattern yellowish brown, muscle impressions dark brown, followed by two longitudinal black patches and a black transverse bar, and with some dark brown patches laterally (Fig. 50); venter yellow, with small black patches and a black patch before spinnerets (Fig. 51). Both eye rows slightly recurved. Eye diameters and interdistances: AME 0.13, ALE 0.29, PME 0.18, PLE 0.26; AME–AME 0.10, AME–ALE 0.04, PME–PME 0.18, PME–PLE 0.29. MOA 0.62 long, anterior width 0.39, posterior width 0.57. Clypeus height 0.23. Chelicerae with three promarginal and four retromarginal teeth, with eleven denticles between them. Leg measurements: I 14.14 (5.01, 1.40, 3.22, 2.82, 1.69), II 15.07 (5.23, 1.43, 3.18, 2.86, 1.75), III 13.30 (4.73, 1.26, 2.89, 2.72, 1.70), IV 13.99 (4.98, 1.37, 3.22, 2.72, 1.70). Leg formula: 2143. Leg spination: palps 131, 101, 2121; femur I–III 323, IV 331; patella I–III 001, IV 000; tibia I 2026, II–IV 2126; metatarsus I–II 2024, III 2026, IV 3036. Male palp. Tegulum almost oval (Figs 53, 60); embolus wide, flagelliform, arising from 9-o'clock-position on tegulum, its tip

Figures 50–53. *Pseudopoda robusta* sp. n., Male (SP–CQ–08–26): **50–51** Body (**50** dorsal **51** ventral) **52–53** Left palp (**52** prolateral **53** ventral). Abbreviations: E embolus; EP embolic projection; RTA retrolateral tibial apophysis; SD sperm duct; ST subtegulum; T tegulum. Scale bars: 1 mm (**50–51**); 0.5 mm (**52–53**).



Figures 54–58. *Pseudopoda robusta* sp. n., **54** Left palp of male (retrolateral). **55–58** Female (SP–CQ–08–28): **55–56** Body (**55** dorsal **56** ventral) **57–58** Epigyne (**57** ventral **58** dorsal). Abbreviations: aEF margin of epigynal field; amLL anterior margin of lateral lobes; CD copulatory duct; FD fertilization duct; LL lateral lobes of epigyne; MF median field of epigyne; pmLL posterior margins of lateral lobes; PI posterior incisions; S spermathecae; Scale bars: 2 mm (**55–56**); 0.5 mm (**54, 57–58**).



Figures 59–65. *Pseudopoda robusta* sp. n., **59–61** Male (SP–CQ–08–26): Left palp (**59** prolateral **60** ventral **61** retrolateral) **62–65** Female (SP–CQ–08–28): **62–64** Epigyne (**62** ventral **63** dorsal **64** apical) **65** Schematic course of internal duct system, dorsa. Abbreviations: aEF anterior margin of epigynal field; amLL anterior margin of lateral lobes; C conductor; CD copulatory duct; E embolus; EP embolic projection; FD fertilization duct; LL lateral lobes of epigyne; MF median field of epigyne; pmLL posterior margins of lateral lobes; RTA retrolateral tibial apophysis; S spermathecae; SD sperm duct; ST subtegulum; T tegulum. Scale bars: 0.5 mm.

pointing retrolaterally (Figs 52–53, 59–60); sperm duct inverted C-shaped, running along retrolateral margin of tegulum (Figs 53, 60); RTA strong, rod-like, arising medially from tibia, with blunt tip (Figs 53–54, 60–61).

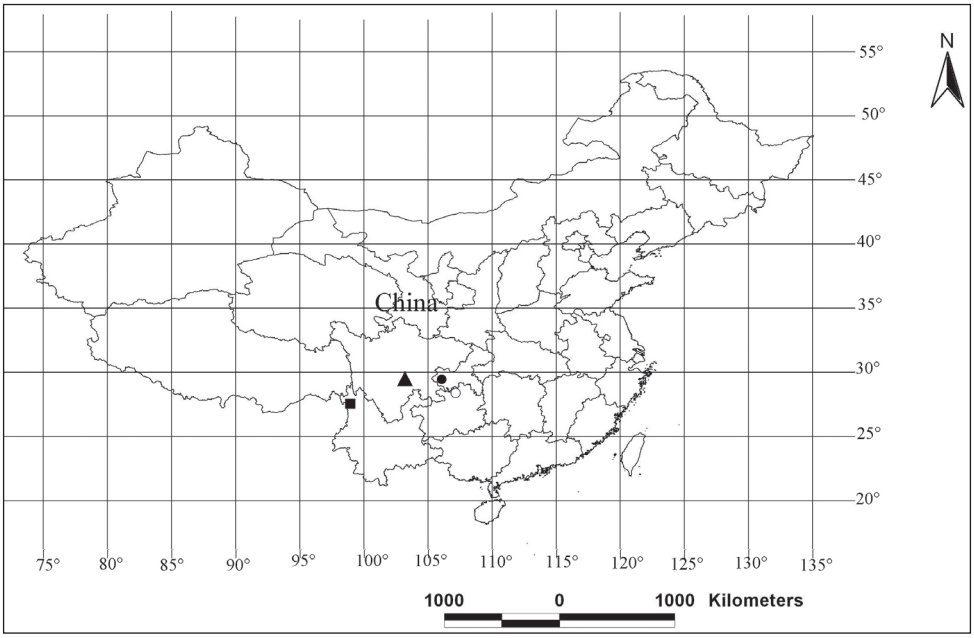


Figure 66. Distribution patterns of the new species of the genus *Pseudopoda* in China. ○ *P. acuminata*; ▲ *P. emei*; ■ *P. lacrimosa*; ● *P. robusta*.

Females. Paratype (SP–CQ–08–28): total length 7.40; prosoma 3.61 long, 3.22 wide; opisthosoma 3.82 long, 2.72 wide. Color and markings of body lighter than in male (Figs 55–56). Eye diameters and interdistances: AME 0.18, ALE 0.31, PME 0.23, PLE 0.30; AME–AME 0.16, AME–ALE 0.05, PME–PME 0.23, PME–PLE 0.34. MOA 0.68 long, anterior width 0.51, posterior width 0.73. Clypeus height 0.23. Leg measurements: I 12.08 (3.72, 1.23, 2.81, 3.09, 1.23), II 12.28 (3.76, 1.23, 2.98, 3.03, 1.28), III 11.53 (3.65, 1.21, 2.62, 2.85, 1.20), IV 11.85 (3.68, 1.23, 2.75, 2.99, 1.20). Leg formula: 2143. Leg spination: palps 131, 101, 2121, 2112; femur I–II 323, III 322, IV 331; patella I–III 001, IV 000; tibia I–II 2026, III–IV 2126; metatarsus I–II 2024, III 2026, IV 3036. Epigyne. Median field of epigyne distinctly U-shaped, anterior margin distinct, without longitudinal bands (Figs 57, 62); width of LLs equal to length, touching each other only slightly, posterior margins of LLs with distinct posterior incisions (Figs 57, 62); posterior end of first winding of internal duct system freely visible, spermathecae situated ventrally, space between fertilization duct and first winding smaller than width of first winding (Figs 58, 63).

Variation. Male total body length from 6.90–6.96, and female from 7.32–7.40. Femur length of male: I from 5.01–5.04, II from 5.23–5.24, III from 4.73–4.75, IV from 4.98–4.99. Femur length of female: I from 3.70–3.72, II from 3.75–3.76, III from 3.64–3.65, IV from 3.66–3.768.

Distribution. Jinyun Mountain, Chongqing Municipality, China, type locality.

Comments. Females of *Pseudopoda robusta* sp. n. could be included in the *P. diversipunctata*-group by: lateral lobes of epigyne touching each other only at posterior part. On the other hand, males of *P. robusta* have simple embolus conformation, which could be considered really different and not similar to any group.

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Description of the hemipenial morphology of *Tupinambis quadrilineatus* Manzani and Abe, 1997 (Squamata, Teiidae) and new records from Piauí, Brazil

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Abstract

Few data are available on the morphology of the hemipenis of teiid lizards, especially those of the recently-defined genus *Tupinambis*, a widely-distributed group of large-bodied lizards. This study provides an illustrated description of the hemipenis of *Tupinambis quadrilineatus*, which is similar to that of other representatives of the Tupinambinae subfamily. New records of the species from the state of Piauí, in northeastern Brazil, are also presented.

Keywords

Hemipenis, systematics, Tupinambinae, *Tupinambis*, new records

Introduction

The genus *Tupinambis* Daudin (Teiidae) comprises a group of large (maximum SVL of 400 mm) Neotropical lizards, which are distinguished from all other teiids by the combination of smooth dorsal scales, a single loreal, a gap in the granular scales separating the femoral from the abdominal pores, and a cylindrical tail with complete annuli alternating with annuli divided on the dorsal and lateral sides (Harvey et al. 2012). In a recent review of the Teiidae, Harvey et al. (2012) resurrected the genus *Salvator* Duméril and Bibron to refer to the species of the "southern clade" (*sensu* Fitzgerald et al. 1999) previously included in *Tupinambis*. These species are now known as *Salvator merianae* (Duméril & Bibron, 1839), *S. rufescens* (Günther, 1871) and *S. duseni* (Lönnberg, 1896). According to this scheme, the genus *Tupinambis* currently includes only the four species of the northern or "Amazonian" clade (*sensu* Fitzgerald et al. 1999) – *Tupinambis longilineus* Avila-Pires, 1995, *Tupinambis palustris* Manzani & Abe, 2002, *Tupinambis quadrilineatus* Manzani & Abe, 1997, and *Tupinambis teguixin* (Linnaeus, 1758). The genus *Tupinambis* is found in Colombia, Venezuela, Trinidad and Tobago, the Guyanas, the Amazon basin, and the savannas of Bolivia and Brazil (Harvey et al. 2012). Despite the conspicuous size of these lizards, zoogeographic data are sketchy, and new localities have been recorded recently for some species, such as *T. longilineus* (Lima and Pimenta 2008, Costa et al. 2008) and *T. quadrilineatus* (Ferreira et al. 2009, Silveira 2009).

Tupinambis quadrilineatus is endemic to the Cerrado savannas of central Brazil. The species was described in 1997, based on four specimens from Goiás, Mato Grosso, and Tocantins (Manzani and Abe 1997, Silveira 2009). Almost simultaneously, Colli et al. (1998) described the same form under the junior-synonym *Tupinambis cerradensis*. A number of other specimens were collected subsequently in the Brazilian states of Goiás, Minas Gerais, Mato Grosso, Maranhão, Tocantins, Piauí, Pará and the Distrito Federal (Barreto et al. 2007, Ferreira et al. 2009, Silveira 2009, Dal Vechio et al. 2013). The geographic range of the species is extended further in the present study.

The hemipenis of *T. quadrilineatus* is also described here for the first time. The hemipenial morphology of teiid lizards is poorly known (Harvey et al. 2012). Cope (1896) analyzed the hemipenis of the genera *Dracaena*, *Tupinambis, Ameiva*, and *Cnemidophorus* and concluded that the morphology of these typical teiid species consist of numerous delicate, imbricate, transverse laminae, which are closely attached to one another. Dowling and Duellman (1978, figure 83.2) published an illustration of the sulcate surface of the hemipenis of a species referred to as *Tupinambis nigropunctatus* Spix, 1825, however they did not provide a museum number, nor did they describe the organ. Presently, *T. nigropunctatus* is considered as a synonym of *Tupinambis teguixin* (Linnaeus, 1758), and its drawing exihibited a slightly bilobed and relatively long hemipenis, with distal laminae. In addition, the hemipenial morphology of 13 teiid species was described by Böhme (1988), but the author did not examine nor describe the hemipenis of *Tupinambis*.

Besides, Harvey et al. (2012) reviewed the taxonomy and phylogeny of the teiids and included descriptions of the hemipenes of a number of species of the subfamily Tupinambinae, including *Crocodilurus amazonicus* Spix, 1825 and *Salvator merianae*. This study shows that the hemipenis in the Tupinambinae can be characterized as an organ with transverse laminae, a pair of apical awns, and catchment folds. Awns are usually prominent subcylindrical structures, rounded at their distal ends, located at the apex of the lobes. The most elaborate sulcate catchment fold can be observed in *Crocodilurus* and *Salvator*, in which the portion of the fold closest to the sulcus projects outward as a prominent triangular flap. A summary of the hemipenial characters for the Teiidae subfamilies presented by Harvey et al. (2012) is shown in Table 1. The hemipenial morphology of *Tupinambis* nevertheless remains unknown, and the present paper provides a first detailed description of the organ in this genus.

Methods

Specimens were collected from a locality in the Cerrado savanna of the state of Maranhão and different phytophysiognomies in Piauí. The material examined is deposited in the herpetological collections of the Coleção de História Natural of the Universidade Federal do Piauí, Floriano, Piauí (CHNUFPI, curator: L. S. Carvalho) and the Museu Paraense Emílio Goeldi, Belém, Pará (MPEG, curator: A. L. C. Prudente). Museum abbreviations follow Levington et al. (1980). Scale counts, body measurements, and color pattern are based on the schemes of Manzani and Abe (1997) and Colli et al. (1998). The sex of the specimens was determined by the presence or absence of a hemipenis verified through an incision at the base of the tail. Hemipenis terminology follows Savage (1997), Myers et al. (1993) and Harvey et al. (2012), and the specimens were prepared as in Pesantes (1994), Manzani and Abe (1988) and Zaher and Prudente (2003).

Table 1. Hemipenial characters of teiid lizards of three subfamilies of Teiidae (Harvey et al. 2012).

Subfamilies	Proximal laminae	Distal laminae	Discontinuous laminae	Awns	Apical sulcate Structures	Apical asulcate structures
Callopistinae	6	19	Present	Absent	Large Flat Expansions	Absent
Teiinae	0–50	5–24	Absent (in most species)	Present	Catchment Fold/ Papillate/ Subtriangular or Rounded Lobes	Rounded Lobes/ High semicircular or Straight Ridges (Flap)/ Subtriangular Flaps/ Papillate/ Rounded Lobes
Tupinambinae	27–40	44–71	Absent	Absent/ Styloid	Catchment Folds with Triangular Flaps	Rounded Lobes

Taxonomy

***Tupinambis quadrilineatus* Manzani & Abe, 1997**
http://species-id.net/wiki/Tupinambis_quadrilineatus

Tupinambis quadrilineatus Manzani & Abe, 1997: 2 (adult male holotype deposited in the Museu de Zoologia of the Universidade Estadual de Campinas, ZUEC 1963, type-locality: Fazenda Bandeirantes, Municipalty of Baliza, Goiás, Brazil (16°13'S, 51°25'W, SAD69), not examined).

Tupinambis cerradensis Colli, Péres & Cunha, 1998: 479 (adult male holotype deposited in the Coleção de Herpetologia of the Universidade de Brasília, CHUNB 00468, type-locality: Rosário Oeste, Mato Grosso, Brazil (14°50'S, 56°25'W, SAD69), not examined).

Tupinambis quadrilineatus; Taylor 2003: 44, Langstroth 2005: 106, Silva Jr. et al. 2005: 81,Vitt et al. 2005: 8, Werneck and Colli 2006: 1987, Guimarães et al. 2007: 353, Recoder and Nogueira 2007: 270, Silveira 2009: 442, Ferreira et al. 2009: 355, Moreira et al. 2009: 187, Recoder et al. 2011: 275.

Diagnosis. *Tupinambis quadrilineatus* differs (see Table 2 for scale counts and measurements) from the other species of the genus in the presence of 11–18 femoral pores (15–18 in *T. teguixin*, 20–22 in *T. longilineus*, 18–26 in *T. palustris*), 94–118 scales around the mid-body (94–124 in *T. teguixin*, 90–98 in *T. longilineus*, 112–119 in *T. palustris*), 113–138 dorsal scales (102–126 in *T. teguixin*, 110–121 in *T. longilineus*, 111–122 in *T. palustris*) and the coloration. In *T. quadrilineatus*, the upper lateral stripe is well-defined along the flanks, whereas in other species, it is indistinct or absent (Avila-Pires 1995, Colli et al. 1998, Manzani and Abe 2002, Harvey et al. 2012).

Hemipenial morphology. The hemipenis of three specimens of *T. quadrilineatus* (CHNUFPI 0036, CHNUFPI 0038 and MPEG 30139) were prepared for analysis. The organ is relatively long, robust and slightly bilobed, with a total length of 5.0 cm and a width of 2.0 cm in the distal portion of the body (Figure 1). When inverted, the organ extends as far as the fifteenth subcaudal scale. Sulcus spermaticus bifurcated, deep and centripetal. Edge of the sulcus spermaticus pronounced along its entire length. The point of bifurcation of the lobes extends inwardly towards the central region of the styloid process. A pair of short and prominent lobes (about 16% of the total size of the organ) in the form of styloid process are present on either side of the sulcate and asulcate surface, with a pair of catchment folds (extensions of the lips of the sulcus, in the form of prominent sulcal flaps, with rounded edges) coating the styloid process. The region between the lobes is smooth on both the sulcate and asulcate surfaces. Naked sulcate and asulcate expansion pleat. Between 35 and 38 distal laminae (mean = 36 ± 1, n = 3), arranged in a transverse row on each side, extending from just below the apical folds to the base of the lobes. A lateral sulcus separates the distal laminae from the sulcate and asulcate surfaces. Fifteen to 17 proximal laminae (mean = 16 ±1, n = 3). Basal region smooth on the sulcate surface, and wrinkled on the asulcate surface. Discontinuous laminae and basal papillae absent.

Table 2. Scale counts of the specimens of *Tupinambis quadrilineatus* analyzed in the present study and the known range of values for the species, according to Manzani and Abe (1997) and Colli et al. (1998).

Character	CHNUFPI 0036	CHNUFPI 0037	CHNUFPI 0038	MPEG 16817	MPEG 16845	MPEG 30139	MPEG 30140***	MPEG 30141	Known range of values
Sex	Male	Male	Male	Female	Female	Male	Immature male	Male	
Femoral pores*	11	10	12	10	10	11	11	11	11–18
Pre-cloacal pores*	10	8	10	8	9	8	8	8	5–11
Dorsal scales	127	118	119	115	116	109	111**	117	113–138
Scales around midbody	116	105	120**	112	116	90**	103	98	94–118
Ventral scales in a transverse row	24	24	25	25	26	23	24	25	20–28
Lamellae under fourth finger	15	13	15	14	15	14	15	14	12–17
Lamellae under fourth toe	29	30	30	33	34**	27	32	27	26–33
Loreal scale	1	1	1	1	1	1	1	1	1
Supralabial scales*	17**	15	17**	16	16	-	-	-	13–16
Infralabial scales*	14	14	16	14	14	-	-	14	13-17
Snout-vent length (mm)	260	260	227	245	235	260	135	255	88-270
Body width (mm)	49.56	54.48	48.36	59.98	51.27	58.66	-	55.98	17.92-61.86
Body height (mm)	36.58	37.20	30.46	42.09	36.03	44.59	-	40.66	13.95-51.98
Head length (mm)	55.66	55.92	51.29	52.05	52,80	54.32	-	52.39	24.10-62.04
Head width (mm)	42.73	44.98	34.98	41.61	33.91	39.44	-	40.22	15.16-44.28
Head height (mm)	30.20	28.37	28.26	35.47	30.35	36.23	-	29.69	11.60-38.40

* Total number on both sides.

** Exceeds maximum value recorded in previous studies.

***This specimen has a damaged head and part of the body, which prevented the withdraw of the remaining measures.

The hemipenial morphology of *T. quadrilineatus* is similar to that of other Tupinambinae in the ornamentation of the body, which are bilobed and have lamelae (Cope 1896, Dowling and Duellman 1978, Harvey et al. 2012). As in *Salvator merianae, Tupinambis teguixin* and *Crocodilurus amazonicus* (Dowling and Duellman 1978, Harvey et al. 2012), the hemipenis of *T. quadrilineatus* lacks the discontinuous distal laminae seen in *Ameiva ameiva* and *Ameivula ocellifera*. However, *S. merianae*, formerly considered to be a member of the genus *Tupinambis*, has a relatively long

Figure 1. Right hemipenis of *Tupinambis quadrilineatus* (CHNUFPI 0036). **A** sulcate surface **B** asulcate surface **C** lateral region. Scale bar = 1 cm.

hemipenis, which lacks the lateral and medial expansion pleats and has more laminae (distal laminae: 56–71 and proximal laminae: 33–40) than other teiids (Harvey et al. 2012). See Table 1 for the differences in the hemipenial morphology of three subfamilies of Teiidae (Harvey et al. 2012). The morphology and ornamentation of the hemipenis play an important role in the diagnosis of species, and have proven to be an excellent indicator of the phylogenetic relationships among taxa (Cope 1896, Böhme 1988, Harvey et al. 2012). Harvey et al. (2012) concluded that the relationships among the genera of Tupinambinae, especially *Tupinambis* and *Salvator*, require further study, and that a more detailed analysis of hemipenial morphology, as well as muscles and osteology, may contribute to a more definitive understanding of the systematics of the group.

Measurements. Based on eight specimens. Snout-vent length 135–260 mm (mean = 234.9 mm); body width 48.4–60.0 mm (mean = 54.0 mm), body height 30.5–44.6 mm (mean = 38.5 mm), head length 51.3–55.9 mm (mean = 53.6 mm), head width 33.9–45.0 mm (mean = 39.7 mm), head height 28.3–36.2 mm (mean = 31.2 mm). See Table 1 for a complete list of the measurements and scale counts recorded in the present study and those available in the literature (Manzani and Abe 1997, Colli et al. 1998, Silveira 2009).

Geographic distribution. The *Tupinambis* specimens available in Brazilian collections were examined together with the eight *T. quadrilineatus* specimens collected

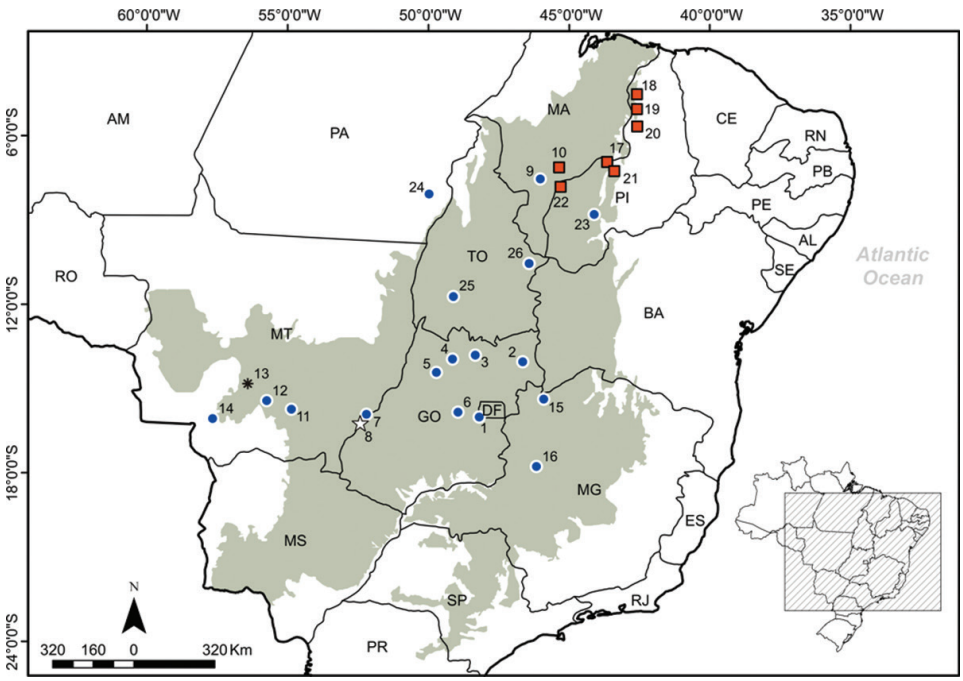

Figure 2. Known localities for *Tupinambis quadrilineatus* in Brazil. Distrito Federal (DF): Brasília, Gama (**1**). Goiás (GO): Iaciara (**2**) Minaçu (**3**) Mara Rosa (**4**) Santa Terezinha de Goiás (**5**) Pirenópolis (**6**) Aragarças (**7**) Baliza (**8**). Maranhão (MA): Balsas (**9**) São Raimundo das Mangabeiras (**10**). Mato Grosso (MT): Primavera do Leste (**11**) Chapada dos Guimarães (**12**) Rosário Oeste (**13**) Cáceres (**14**). Minas Gerais (MG): Chapada Gaúcha (**15**) João Pinheiro (**16**). Piauí (PI): Guadalupe (**17**) Lagoa Alegre (**18**) Altos (**19**) Monsenhor Gil (**20**) Amarante (**21**), Ribeiro Gonçalves (**22**) Uruçuí (**23**). Pará (PA): Santa Maria das Barreiras and Redenção (**24**). Tocantins (TO): Gurupi (**25**) Mateiros (**26**). The localities recorded in the present study are represented by red squares. The type-locality of *T. quadrilineatus* is shown as an asterisk, the type-locality of its junior-synonym (*Tupinambis cerradensis*) is shown as a star and remaining records from the literature are shown as blue circles (Manzani and Abe 1997; Colli et al. 1998; Guimarães et al. 2007; Silva Jr. et al. 2005; Vitt et al. 2005; Mesquita et al. 2006; Recoder and Nogueira 2007; Ferreira et al. 2009; Silveira 2009; Recoder et al. 2011; Dal Vechio et al. 2013). The Cerrado savanna biome is highlighted in gray.

during the present study, in Maranhão and Piauí (Figure 2). The localities reported here represent the northernmost known records of *T. quadrilineatus*, and extend the known distribution of the species at least 500 km from the nearest locality, in Balsas, Maranhão (Barreto et al. 2007). This is the northernmost record of the occurrence of the species.

Five *T. quadrilineatus* specimens were examined in the collection of the Goeldi Museum. In 1993, specimen MPEG 16817 was collected in Balsas, Maranhão (reported by Barreto et al. 2007), and specimen MPEG 16845 was captured in the municipality of Lagoa Alegre, Piauí. In 2009, three specimens were collected during the Parnaiba Project in Ribeiro Gonçalves (MPEG 30139), and Uruçuí (MPEG 30141), in the state of Piauí, and São Raimundo das Mangabeiras (MPEG 30140), in Maranhão.

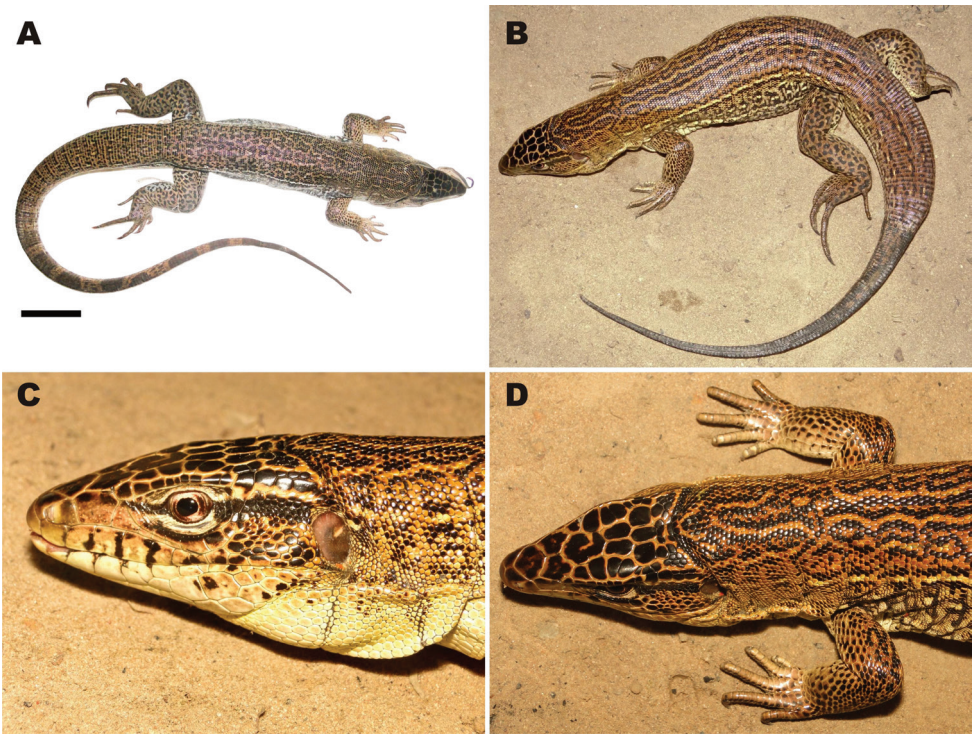

Figure 3. Adult male *Tupinambis quadrilineatus*. **A** specimen collected in the Palmares National Forest, Altos, Piauí (CHNUFPI 0036; Scale 5cm) **B** specimen collected with pit-fall traps at Guadalupe, Piauí (CHNUFPI 0038) **C** lateral view of the head and **D** dorsal view of the anterior region of the body (CHNUFPI 0036).

The herpetological collection of the Universidade Federal do Piauí provided specimens or records of *T. quadrilineatus* from a number of sites in Piauí. Specimen CHNUFPI 0036 (Figure 3A) was collected in 2010 in the Palmares National Forest (05°02'55"S, 42°35'59"W, SAD69), in the municipality of Altos. The vegetation of this area is semi-deciduous tropical forest typical of the Cerrado, an ecotonal region between Cerrado and Amazonia biomes, similar to that found in Lagoa Alegre. *Tupinambis quadrilineatus* occurs in syntopy with *S. merianae* in this area, as recorded at a number of other sites (Colli et al. 1998, Silveira 2009). Also in 2010, a roadkilled specimen of *T. quadrilineatus* (CHNUFPI 0037) was collected in the municipality of Monsenhor Gil (05°39'56"S, 42°35'28"W, SAD69). In May 2011, the third and final *T. quadrilineatus* specimen held in the collection (CHNUFPI 0038; Figure 3B–D) was collected in a pitfall trap installed in the vicinity of a small stream within an area dominated by Cerrado savanna (*sensu strictu*) in the municipality of Guadalupe (05°2'55"S, 42°35'59"W, SAD69). Two other specimens were observed in the municipality of Amarante (06°14'43"S, 42°46'46"W and 06°2'1"S, 43°3'40"W, SAD69) in 2009 and 2011, but specimens were not collected. In this area, the vegetation was dominated by secondary semi-deciduous tropical forest, mixed with patches of Cerrado *sensu strictu*.

These findings expand the geographic distribution of *T. quadrilineatus* is northwards, and encompass the the region between the states of Piauí and Maranhão, which is dominated by Cerrado *sensu strictu* and/or forested patches of the Cerrado–Amazon ecotone. In this region, *T. quadrilineatus* also occurs in syntopy with *Salvator merianae*, which was previously classified as a member of the genus *Tupinambis*.

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Appendix

Material analyzed

Table of localities. *Tupinambis quadrilineatus*: **Maranhão**: MPEG 16817 (Rio Matões, right bank tributary of the Rio Balsas, Balsas), MPEG 30140 (São Raimundo das Mangabeiras), **Piauí:** CHNUFPI 0036 (Palmares National Forest, Altos), CHNUFPI 0037 (Monsenhor Gil), CHNUFPI 0038 (Fazenda São Pedro, Guadalupe), MPEG 16845 (Lagoa Alegre), MPEG 30139 (Ribeiro Gonçalves), MPEG 30141(Estação Ecológica de Uruçuí-Una, Uruçuí).

Collection	Collection number	Family	Genus	Species	Locality	Municipality	State	Latitude	Longitude	Coordinate origin
MPEG	MPEG 16817	Teiidae	*Tupinambis*	*quadrilineatus*	Near Matões River, tributary of the Balsas Rive	Balsas	Maranhão	7°31'S	46°2'W	Google Earth
MPEG	MPEG 30140	Teiidae	*Tupinambis*	*quadrilineatus*		São Raimundo das Mangabeiras	Maranhão	7°1'S	45°28'W	A. O. Maciel
CHNUFPI	CHNUFPI 0036	Teiidae	*Tupinambis*	*quadrilineatus*	Palmares National Forest	Altos	Piauí	05°02'55"S	42°35'59"W	GPS
CHNUFPI	CHNUFPI 0037	Teiidae	*Tupinambis*	*quadrilineatus*	BR 343	Monsenhor Gil	Piauí	05°39'56"S	42°35'28"W	GPS
CHNUFPI	CHNUFPI 0038	Teiidae	*Tupinambis*	*quadrilineatus*	São Pedro Farm	Guadalupe	Piauí	5°2'55"S	42°35'59"W	GPS
MPEG	MPEG 16845	Teiidae	*Tupinambis*	*quadrilineatus*		Lagoa Alegre	Piauí	4°26'S	42°35'W	Google Earth
MPEG	MPEG 30139	Teiidae	*Tupinambis*	*quadrilineatus*		Ribeiro Gonçalves	Piauí	7°33'S	45°14'W	A. O. Maciel
MPEG	MPEG 30141	Teiidae	*Tupinambis*	*quadrilineatus*	Uruçuí-Una Ecological Station	Uruçuí	Piauí	7°14'S	44°33'W	Google Earth
Not collected	Not collected	Teiidae	*Tupinambis*	*quadrilineatus*	BR 343	Amarante	Piauí	6°14'43.49"S	42°46'46.02"W	GPS