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Author(s) :Hermes E. Escalona and Adam Ślipiński

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STICHOLOTIS RUFICEPS WEISE: NEW SYNONYMIES AND DESCRIPTION OF ITS MATURE LARVA (COLEOPTERA: COCCINELLIDAE: STICHOLOTIDINI)

HERMES E. ESCALONA^{1,2} and ADAM ŚLIPIŃSKI²

¹Museo del Instituto de Zoología Agrícola "Francisco Fernández Yépez" (MIZA),
Facultad de Agronomía, Universidad Central de Venezuela;
e-mail: hermesescalona@gmail.com

²CSIRO Entomology, GPO Box 1700, Canberra, ACT 2601, Australia;
e-mail: Adam.Slipinski@csiro.au

Abstract.— The adult and larval stages of a scale insect predator, *Sticholotis ruficeps* Weise, 1902 are described and illustrated. *Sticholotis madagassa* Weise, 1909 and *Mesopilo soufrierensis* Duverger, 2001 are synonyms of *S. ruficeps* (new synonyms). *S. ruficeps* has been used in biocontrol programs against various scale insects and it is here recorded from USA (Hawaii), Guadeloupe, Madagascar, Mascarene and Mauritius (Réunion Islands), Singapore, Indonesia, New Caledonia, Australia (Christmas and Cocos-Keeling Islands) and Cook Islands.



Key words.— biological control, Coccinellidae, Hemiptera, introduced species, larvae, scale insects, Sticholotidini, taxonomy.

INTRODUCTION

The ladybird genus *Sticholotis* Crotch, 1874 originally described from Japan, is the largest genus of Sticholotidini with about 70 described and many more undescribed species, mostly occurring in the Oriental Region (Miyatake 1994). The genus lacks a modern taxonomical revision, and most of the species are known only from the original descriptions, mostly from the late 19th century. Ślipiński (2004, 2007) redescribed the genus and revised the Australian species; recent further descriptions of regional *Sticholotis* species were provided by Poorani and Booth (2006) and Tomaszewska and Łącznyński (in press).

Sticholotis ruficeps Weise, 1902 was described from Malaysia and redescribed and illustrated by Bielawski (1960) based on the type series. Later Chapin (1965), Pang and Mao (1979) and Hoang (1982) recorded its broader distribution in Asia and the Pacific.

According to Leeper (1976) this species (misidentified as *S. punctata* Crotch, 1874) was introduced to Hawaii from China and Japan, where it was established feeding on *Eriococcus araucariae* Maskell, 1879 (Eriococcidae, Hemiptera) and *Pinnaspis buxi* (Bouche, 1851) (Diaspididae, Hemiptera).

Chazeau *et al.* (1974) redescribed *Sticholotis madagassa* Weise, 1909 and since then it was recorded as a predator of the sugarcane scale *Aulacaspis tegalensis* (Zehntner, 1898) (Diaspididae, Hemiptera) in Mauritius (Réunion Islands) and Tanzania (Williams and Greathead 1990). Recently it was suggested (Poorani 2002) that *S. madagassa* could be a junior synonym of *S. transversa* (Motschulsky, 1866) from India.

This species, recorded as *S. ruficeps* or *S. madagassa*, has been used in biocontrol of scale insects like *Melanaspis glomerata* Green (Diaspididae, Hemiptera) in India (Singh 2004, Birthal and Sharma 2004), the pineapple mealybug *Dysmicoccus* spp.

(Pseudococcidae, Hemiptera) in Hawaii, USA (González-Hernández *et al.* 1999) and also liberated as a control agent in Rarotonga, Cook I. (Walker and Deitz 1979). Another introduction was attempted in Florida, USA apparently as biocontrol of the scale insect *Pseudaulacaspis* spp. (Diaspididae, Hemiptera) (Frank and McCoy 1993).

While working on a world revision of the *Sticholotini*, we have examined a large amount of material and types of many species and discovered that *S. ruficeps* and *S. madagassa* are the same widely distributed species. To our surprise, *Mesopilo soufrierensis* Duverger, 2001, described from Guadeloupe, turned out to belong to this species as well.

To facilitate further research on this biological control agent, we provide a summary of its distribution records, along with a detailed description of adult morphology and mature larvae associated with adults.

MATERIAL AND METHODS

Morphological terminology follows Ślipiński (2004, 2007) and the Coccinellidae classification is adapted from Ślipiński and Tomaszewska (2010). Entire beetles as well as male and female genitalia were dissected, cleared in 10% KOH and rinsed with water before being transferred to glycerol and examined on slides. Photographs of whole beetles and dissected details were made with a JVC digital camera attached to microscopes; the software AutoMontage was used for measurements and to create composite images.

Specimens are deposited in the following collections:

- ANIC – Australian National Insect Collection, CSIRO, Canberra, Australia;
- CMN – Canadian Museum of Nature, Ottawa, Canada;
- CAS – California Academy of Sciences, San Francisco, USA;
- FMNH – Field Museum of Natural History, Chicago, USA;
- QMB – Queensland Museum, Brisbane, Australia;
- MNHN – Muséum National d'Histoire Naturelle, Paris, France;
- NMWA – Naturhistorisches Museum, Wien, Austria;
- NZAC – New Zealand Arthropods Collection, Auckland, New Zealand;
- SAM – South Australia Museum, Adelaide, Australia;
- TMB – Természettudományi Múzeum, Budapest, Hungary;
- ZMHB – Museum für Naturkunde, Berlin, Germany.

TAXONOMY

Sticholotis Crotch, 1874

Sticholotis Crotch, 1874: 200. Type species, original designation, *Sticholotis substriata* Crotch, 1874; Japan. – Ślipiński, 2004: 390; 2007: 58.

Mesopilo Duverger, 2001: 95. Type species, monotypy, *Mesopilo soufrierensis* Duverger, 2001; Guadeloupe. **New synonym.**

Remarks. For a detailed generic description see Ślipiński (2004; 2007). We consider the following characters diagnostic for the genus. Head with supraorbital sulci (Fig. 20). Ocular canthus (Fig. 19) poorly developed, as long as or slightly longer than diameter of antennal insertion. Clypeus often emarginated around antennal insertions (Figs 4, 19). Subantennal grooves absent (Fig. 21). Terminal maxillary palpomere elongate, conical or subparallel, apex truncated diagonally (Figs 7, 22). Antennal insertions exposed (Fig. 19). Prosternum lobed in front of coxae and prosternal process broad (Fig. 26). Epipleuron (Fig. 31) complete or almost complete. Tarsi 4-4-4. Abdomen (Fig. 28) with 5 ventrites, postcoxal lines incomplete (Fig. 29) and approaching posterior margin of ventrite 1.

Recently Wang *et al.* (2010) revalidated *Nesolotis* Miyatake, 1966 (synonymised with *Sticholotis* by Ślipiński 2004) based on a suite of variable characters, e.g. degree of body convexity, presence of wings, number of antennal segments, length of anterior prosternal lobe, depth of epipleural fovea and anterior tibia shape. None of the above mentioned characters can be used as apomorphy for *Nesolotis* when *Sticholotis* species from the whole distribution range are considered, as already discussed by Ślipiński (2004, 2007).

Sticholotis ruficeps Weise, 1902

(Figs 1–47)

Sticholotis ruficeps Weise, 1902: 511. Malaysia, Kuala Lumpur (TMB, examined). – Bielawski, 1960: 44 (lectotype designation, redescription, male genitalia figs. 24–26); Chapin, 1965: 245 (redescription, male genitalia figs. 41 f-g); Pang and Mao, 1979: 24 (male genitalia fig. 18); Hoang, 1982: 89 (male genitalia fig. 18 (1–4)).

Sticholotis madagassa Weise, 1909: 124. Madagascar, Montagne d'Ambre (ZMHB, examined). – Chazeau *et al.*, 1974: 266 (redescription, male genitalia figs. 1–4). **New synonym.**

Mesopilo soufrierensis Duverger, 2001: 96 (male genitalia figs. 3–6). Guadeloupe (MNHN, examined). **New synonym.**

Diagnosis. Dorsum dark brown, elytra (Figs 1–3) with four reddish to orange spots, the basal ones very close to anterior edges and elytral suture. Dorsal surface covered with dense and coarse punctures. Head and pronotum with sparse short setae, becoming denser and longer on head. Clypeus broadly emarginate (Figs 4, 19). Male genitalia as in Figs 15–18, 34–36.

Adult. Measurements (in mm except ratios): Length: 1.6–2.1. Width: 1.3–1.8. Pronotal length, from center of anterior margin to margin of basal foramen: 0.3–0.4. Pronotal widest: 0.9–1.2. Pronotum ratio (length/width): 0.33; Elytral length along suture, including scutellum: 1.3–1.7. Elytral ratio (length/width): 0.90. Convexity, from highest point of elytra to metaventricle: 0.8–1.2.

Body moderately compact, hemispherical, convex (Figs 1–3). Covered with dense, coarse punctures, larger on elytra. Dorsal surface between punctures smooth, polished; head and ventral side covered with setae, on elytra and pronotum sparse, more obvious laterally. Elytral and pronotal margins (Fig. 1) moderately explanate, entirely visible from above.



Figures 1–3. *Stichotolis ruficeps*, adult. (1) Dorsal view; (2) head; (3) lateral view.

Dorsum dark brown to black (Fig. 1); head, lateral edges of pronotum, elytra, epipleura and ventral side lighter; mouthparts and legs yellowish. Elytra (Fig. 1) with four reddish to orange spots, two anterior very close to anterior edges and elytral suture, and two posterior more or less in the apical third, broadly separated from the elytral edges.

Head (Figs 4, 19–20) uniformly punctate, apex of clypeus with transverse row of long setae. Frons (Figs 4, 19), between the eyes about 3.6 times eye transverse diameter. Antenna (Figs 9–10, 25) 0.9 times length of head capsule, 11 segmented, with 3 segmented club, antennomere 11 truncate diagonally. Anterior clypeal margin emarginate (Figs 4, 19). Mouthparts as in Figs 5–8, 22–24.

Pronotum with uniform punctures and sparse, short setae. Prosternal process (Figs 11, 26) as wide as transverse coxal diameter, surface with irregular microsculpture and coarse punctures. Mesoventricle (Figs 12, 27) at center 1.20 times as wide as transverse coxal diameter; surface flattened with sparse fine punctures.

Elytral surface polished (Figs 3, 31–33); with few erect short setae; covered with uniform punctures, about one diameter apart. Epipleura (Figs 31, 33) uniform in lateral view, with sparse fine setae. Wings present. Metaventricle (Figs 12, 27), covered with sparse uniform punctures. Hind leg as in Fig. 30.

Abdomen (Figs 13–14, 28–29) covered with fine sparse setiferous punctures, setae denser apically.

Male terminalia. Spiculum ventrale poorly developed. Phallobase, penis guide and parameres symmetrical (Fig. 16). Parameres well developed (Figs 15–16), as long as penis guide, slightly narrowing to apex, apex with fine sparse apical setae. Penis guide slightly curved, apex narrowed and acute in lateral view. Penis (Figs 17–18, 36) curved and long.

Female genitalia. Coxites triangular, 2.7 times as long as broad. Styli highly reduced. Spermatheca not observed.

Larva. Length: 2.32 mm. Width: 1.24 mm. Body fusiform (Fig. 37); more or less parallel sided, widest at abdominal segments 2–3, slightly narrowing posteriorly; convex in lateral view. Dorsum covered with microtrichia and with sparse short setae, longer and stouter at sides, lateral sides with setose lobes (strumae); ventral surface with sparse setae. Ground color not well preserved but dorsum yellowish white with slightly darker head and pronotum.

Head capsule (Fig. 38) 1.2 times as broad as long, sides rounded, with sparse long setae. Three stemmata, two anterior and one postero-superior. Epicranial stem and median endocarina absent; frontal arms weakly marked, lyriform, anteriorly reaching antennal insertions; basal portion of frontal arms fused. Antenna (Fig. 39) relatively short, 0.5 times head width,

3-segmented; antennomere I short annular, antennomere II two times as long as I; antennomere III, 0.8 times as long as II, with long and broad apical sensillum. Labrum as in Fig. 40. Mandibles (Figs 41–42) bidentate apically; molar area reduced with narrow, curved lobe. Maxillary palp 3 segmented (Fig. 43); palpomere I annular, palpomere II–III similar in length, and gradually narrowing; palpomere III conical with truncate distal sensory surface; palpifer distinct. Mala reaching base of palpomere III. Labial palps two segmented (Fig. 43), separated at base by 0.9 times width of palpomere I; palpomere I annular; palpomere II elongate and conical, longer than palpomere I. Submentum (Fig. 43) weakly sclerotised with two basal setae.

Pronotum (Fig. 37) 2.1 times as wide as long, lateral margins with elongate lobe, base broadly rounded; dorsal plates absent, margins with long erect setae anteriorly. Meso and metanota transverse, without plates but lateral sides with denser microtrichia, with at least six setae in more or less transverse line; pleural regions with prominent lobes (strumae), covered with long erect setae. Legs (Figs 44–45) moderately long, 1.3–1.5 times as long as head capsule, fore tibiotarsus 0.5 times length of head capsule. Femur and tibiotarsus of hind leg longer than those of middle and fore legs; apex of tibiotarsus setose, setae clubbed (Fig. 45). Claw as in Fig. 45.

Abdomen (Fig. 37) segments 1–8 transverse, each with transverse rows of about 6 long setae mixed with more abundant and shorter ones; lateral lobes (strumae) on each segment prominent bearing several long setae. Segments 8–9 fused, segment 9 with an apical lobe (struma).

Thorax and abdomen (Fig. 37) with 8 pairs of dorsal glandular openings, from metathorax to abdominal segment 7, one pair per segment, forming two parallel rows near lateral borders.

Remarks. *Sticholotis ruficeps* resembles several species of *Sticholotis* bearing four reddish to orange spots on elytra, e.g. *S. rugicollis* Korschefsky, 1934 or *S. quadrimaculata* (Blackburn, 1892); the definitive diagnosis between these species is the form of the male genitalia.

Label records show that this species has been collected on or under bark of different trees, including orange trees and pineapple plantations in Hawaii (USA). Adults and larvae were collected in abundance in Christmas Island (Australia) on bark surfaces at night.

Material examined. **Australia. Christmas Island:** 10.28S 105.42E, Lilly beach road, 13–15-iv-1989, J. F. Lawrence, on bark surfaces at night, 10 specimens, including larvae (ANIC); 10.28–29S 105.3940E, vic. of Grants Well, 13-28-iv-1989, J. F. Lawrence, pyrethrin fogging, 1 specimen (ANIC); 10.30S 105.41E, nr. Greta Beach, 16, 19, 26-iv-1989, J. F. Lawrence, pyrethrin

fogging tree trunks, 5 specimens (ANIC); 10.27S 105.33E, nr. North-West Point, 13-28-iv-1989, J. F. Lawrence, F.I.T. ANIC 1106 closed forest terrace, 1 specimen (ANIC); 10.29S 105.37-38E, nr. Central Area Workshop, 13-28-iv-1989, J. F. Lawrence, on lichen covered bark mainly at night, 13 specimens (ANIC). **West Island Cocos-Keeling Islands:** 30-iii-1952, TG Campbell, 1 specimen (ANIC); 7-vi-1952, 1 specimen (ANIC). Cocos-Keeling Is., W. R. Pennifould, 3 specimens (SAM). **Cook Islands.** Rarotonga: 20-xi-1974, Bullingham orchard, 2 specimens (NZAC). In bark crevices, 27-iii-1975, *Citrus sinensis*, P. Maddison, UNDP/FAO pest and Disease Survey, 1972-1978, 3 specimens (NZAC). Ararva, 20-iv-1977, on of white-fld. *Acalypha hispida*, UNDP/FAO pest and Disease Survey, 1 specimen (NZAC). Arorangi, 17-iii-1983, Uri Gerson, Bark with chaff scales, 6 specimens (NZAC). *Citrus* orchard, 5-iv-1981, C. H. Wearing, 3 specimens (NZAC). Atiu, 21-iii-1983, Uri Gerson, on *Diaspis boisduvalii*, 1 specimen (NZAC). Totokoitu, 21-x-1975, A. K. Walker, opposite Bc. Site under bark lesions citrus trees, 3 specimens (NZAC). Totokoitu Biological Control Site, 18-x-1975, A. K. Walker, on Valencia orange trees, 1 specimen (NZAC); x-1975, A. K. Walker, under bark of Valencia orange trees, 1 specimen (NZAC); 23-x-1975, under bark of Valencia orange trees, 4 specimens, *S. ruficeps* Det. Chazeau (NZAC). Totokoitu Biological opp. Control Site, under bark lesions of *Citrus* trees, 3 specimens (NZAC). **New Caledonia.** 8900, 21°07'S 164°57'E, Tia Reserve, 30 m, 26-xi-2001 31-i-2002, Burwell-Monteith, Malaise, 3 specimens (QMB); 8667, 21°07'S 164°57'E, Tia Reserve, 30 m, 4-5-xi-2001, C. Burwell and G. Monteith, pyrethrin trees logs, 2 specimens (QMB); 8906, 20.58S 165.17E, Pic d' Amoa, N slopes, 31-i-2002, G. Monteith, pyrethrum, trees, logs, 1 specimen (QMB); 11453, 20°37'S 164°20'E, Koumac caves, 50 m, 1-2-xii-2003, G. Monteith, hand collection, rainforest, 1 specimen (QMB); 11451, 20°37'S 164°20'E, Koumac caves, 50 m, 2-xii-2003, G. Monteith, Pyr. Trees and logs, rainforest, 1 specimen (QMB); 11442, 20°19'S 164°26'E, Col d'Amoss Picnic Area, 29-xii-2003, G. Monteith, Pyr. Trees and logs, rainforest, 1 specimen (QMB). **Singapore.** Coll. Weise, Singapore, Biró 1898, **TYPE**, *Sticholotis ruficeps*, 1 specimen (here labeled as Paralectotype) (ZMHB). **Indonesia.** SE Sulawesi, Kendari Airport 11–14.2, 30 km W. of Kendari 1994, leg. M. Strba and I. Jenis, 1 specimen (NMWA). **Réunion Islands: Mascarene:** 16-19-xii-1991, Bras des Chévettes, J. Janák Lgt., Zool. Mus. Berlin, one specimen det. by H. Fürsch 1993 like *S. madagassa*, 2 specimens (ZMHB). **Mauritius:** La Val Nature Park, 9-x-1997, E. Heiss, ex. coll. H. Fürsch, 1 specimen (CNHM). **Madagascar.** Madag.? 1 specimen (ZMHB). *Sticholotis madagassa*, **TYPE**, 92450, 63, Weise det., Amber Gebirge, Nd. Madagascar, H. Rolle, Berlin, SW 11, 1 specimen (ZMHB). **Guadeloupe.** *S. soufrierensis*

Duverger, 2001, dissected on slide (MNHN). USA. **Hawaii:** PQ, A51 (8), Ex. pineapple 30-vi-1968, K. H. Henderson, 1 specimen, "*S. madegassa*" Det. Watt, *S. ruficeps* Det. Chazeau (NZAC); A2457, *Ananas comosus*, E. Baigent, 1-x-1977, *Sticholotis ruficeps* Weise det. S. Higa, 1 specimen (NZAC); O'ahu I.: N. Halawa Valley, NW of Honolulu, 150 m, 21°24'N, 157°53'W, 11-vi-1991, mixed exotic forest, beating foliage, A. Newton and M. Thayer, 6 specimens (FMNH); Aiea Heights, 23-iii-1989, H. and A. Howden, 6 specimens (CMN). **California:** Panama (?) San Francisco, Bananas (?), Panama, 6-viii-1934, Willard H. Nutting Collection, Donated to CAS, May 1990, 1 specimen (CAS).

Distribution. Guadeloupe, China, Mariana Islands, USA (Hawaii, California?), Mascarene and Mauritius (Réunion I.), Australia, Madagascar, Seychelles and New Caledonia (France), Vietnam, Malaysia, Singapore, Indonesia and Micronesia. The distribution Figs 46-47 are based only on specimens examined by us.

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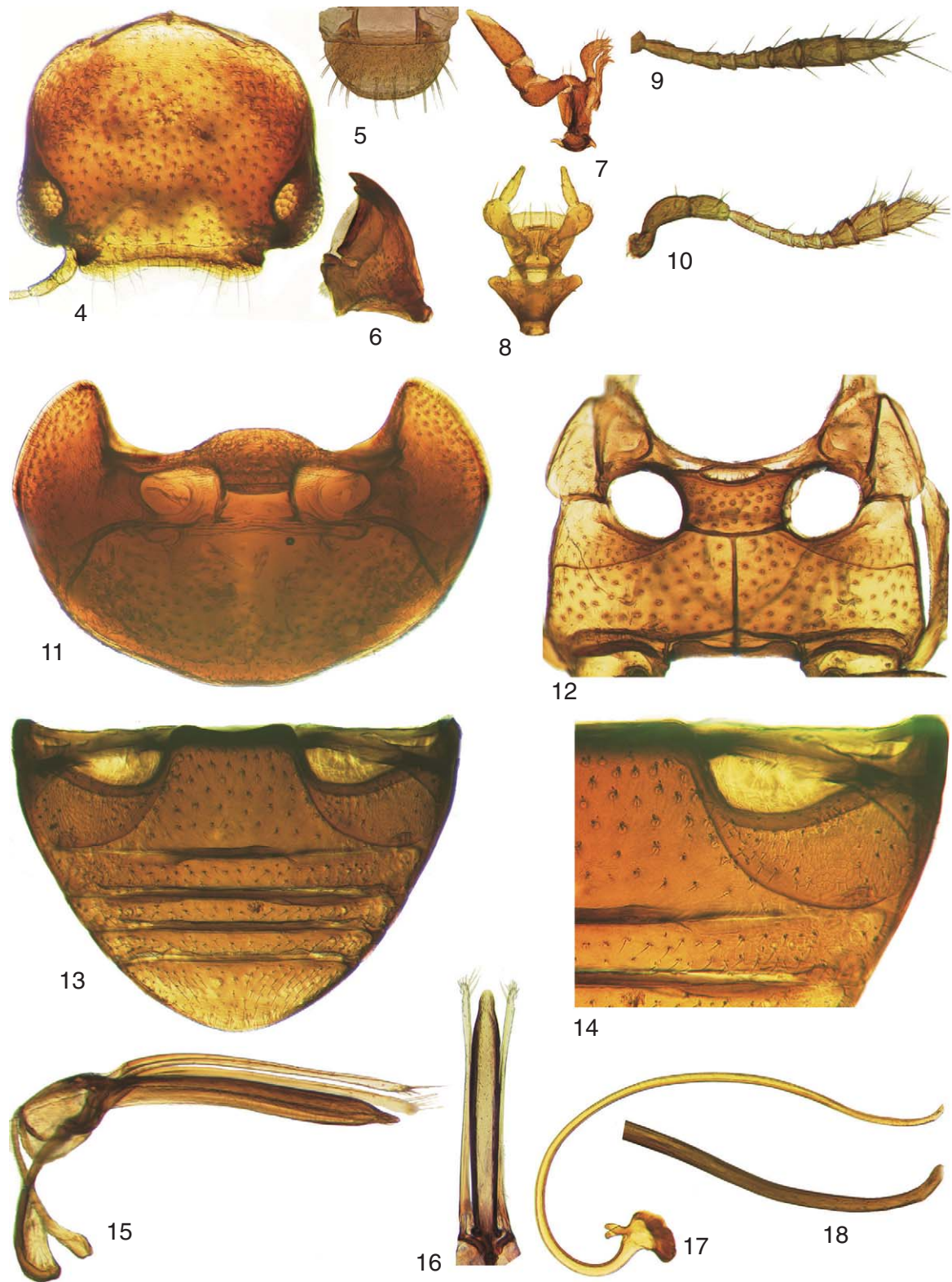
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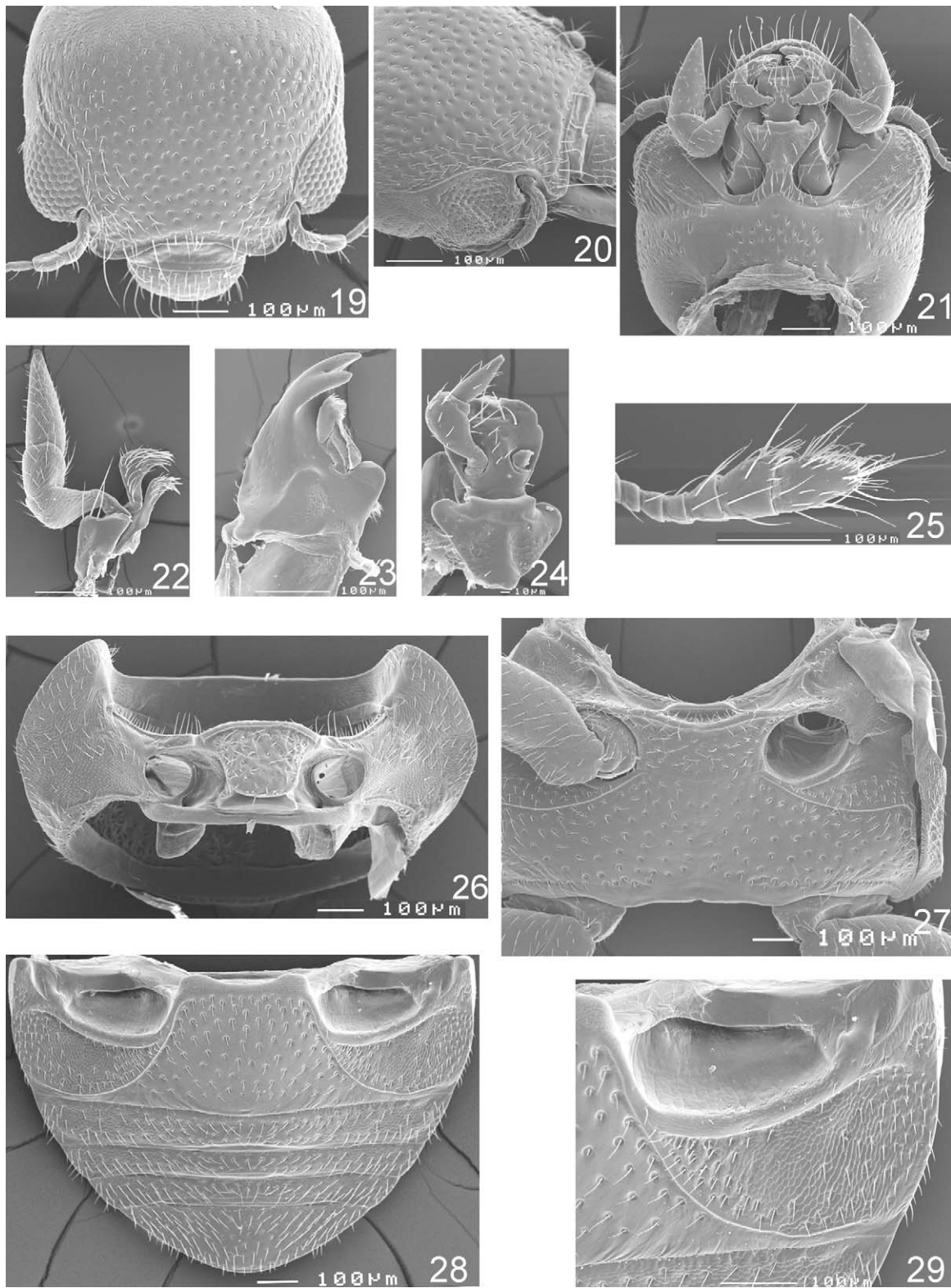
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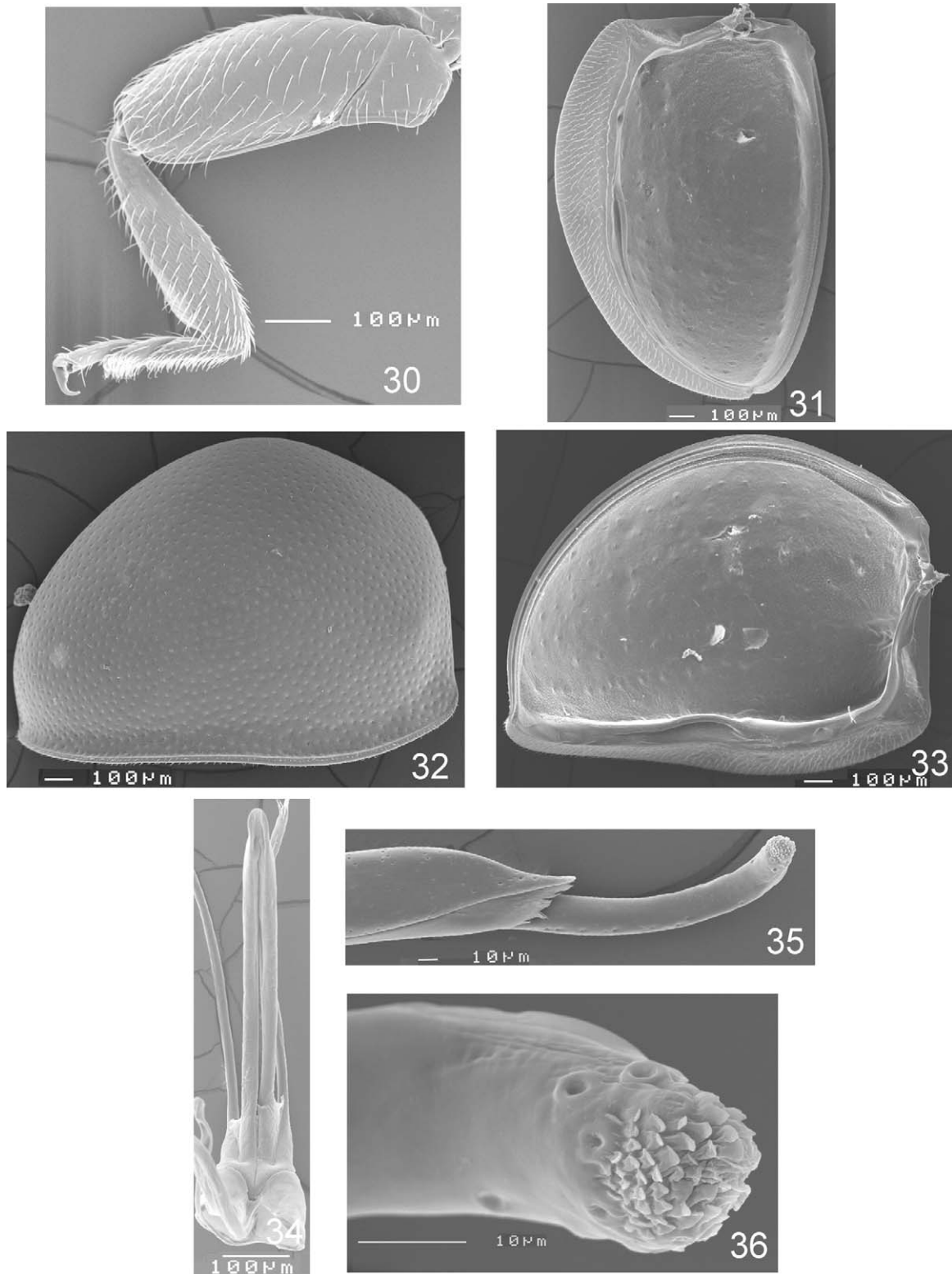
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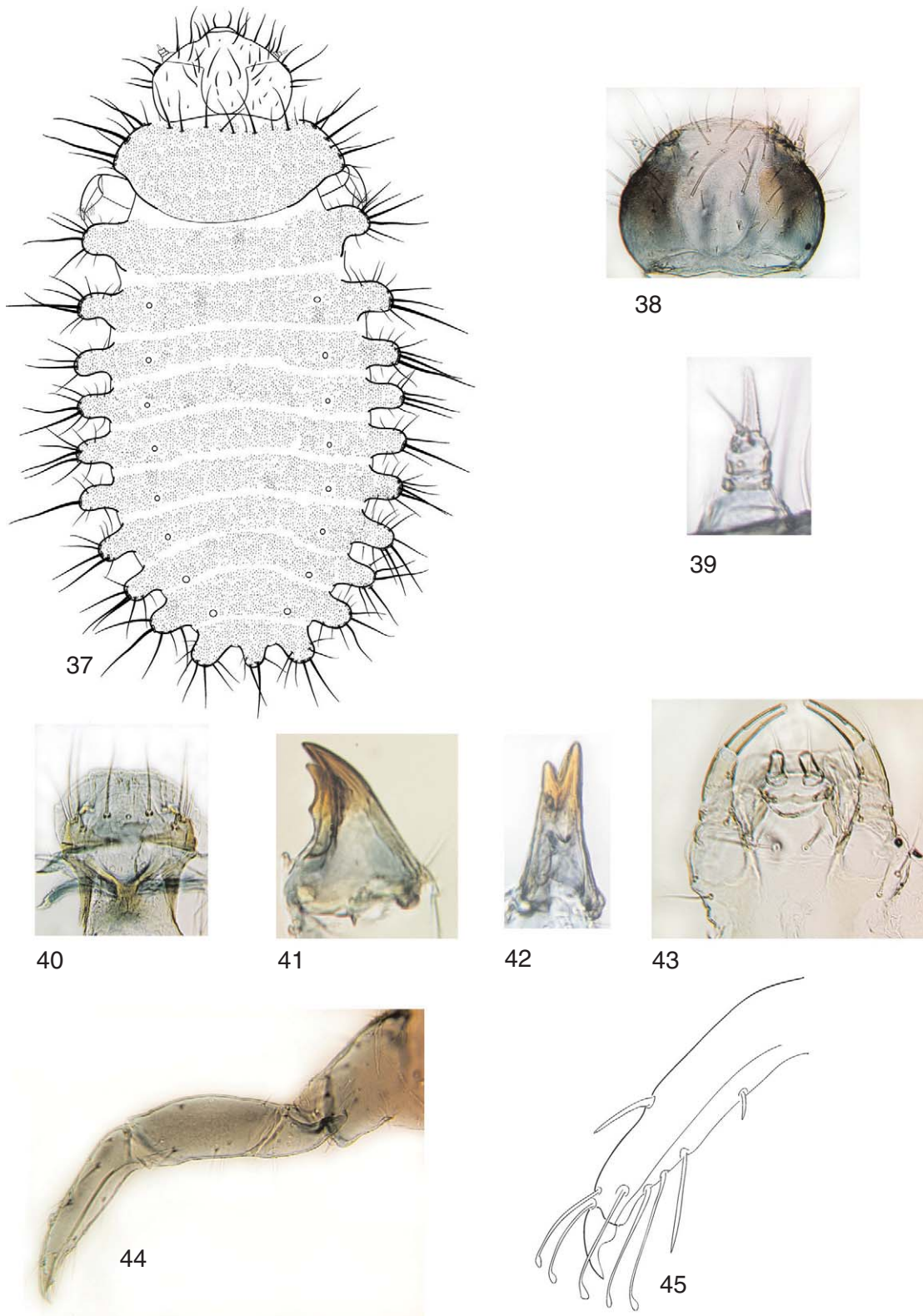
Figures 4–18. *Sticholotis ruficeps*, adult. (4) Head, frontal view; (5) labrum; (6) mandible; (7) maxilla; (8) labium; (9–10) antenna; (11) prothorax, ventral view; (12) meso- and metaventricle; (13) abdomen; (14) abdomen, detail; (15) tegmen, lateral view; (16) tegmen, ventral view; (17) penis, lateral view; (18) penis, detail in lateral view.



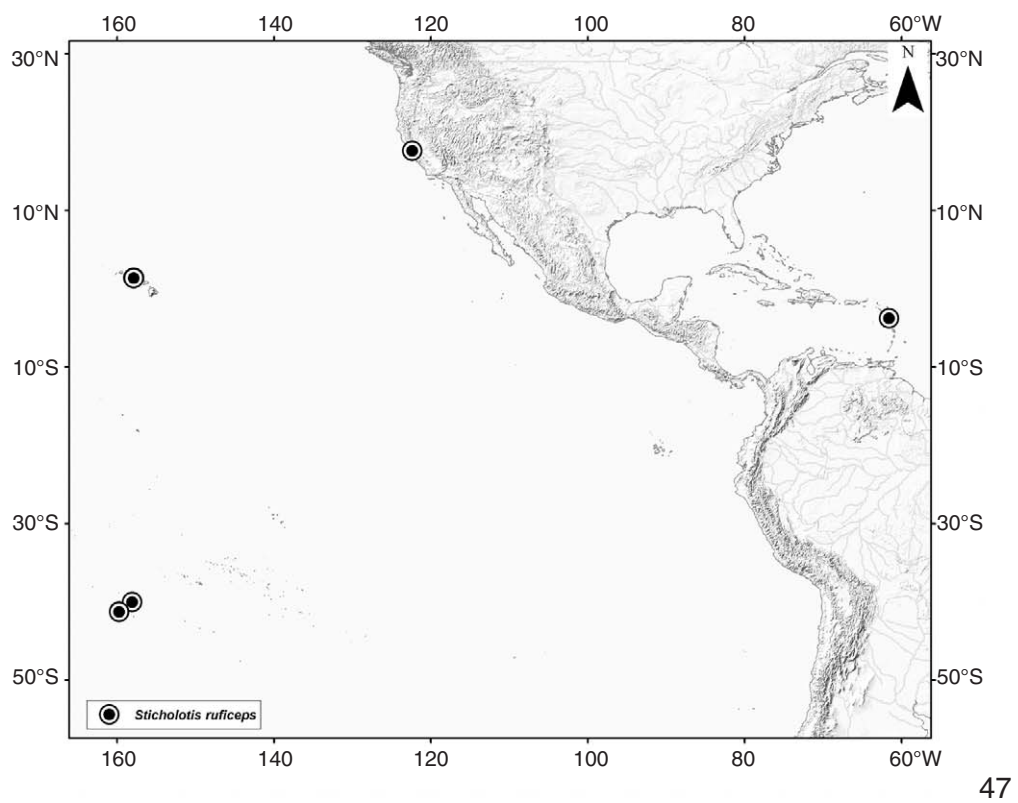
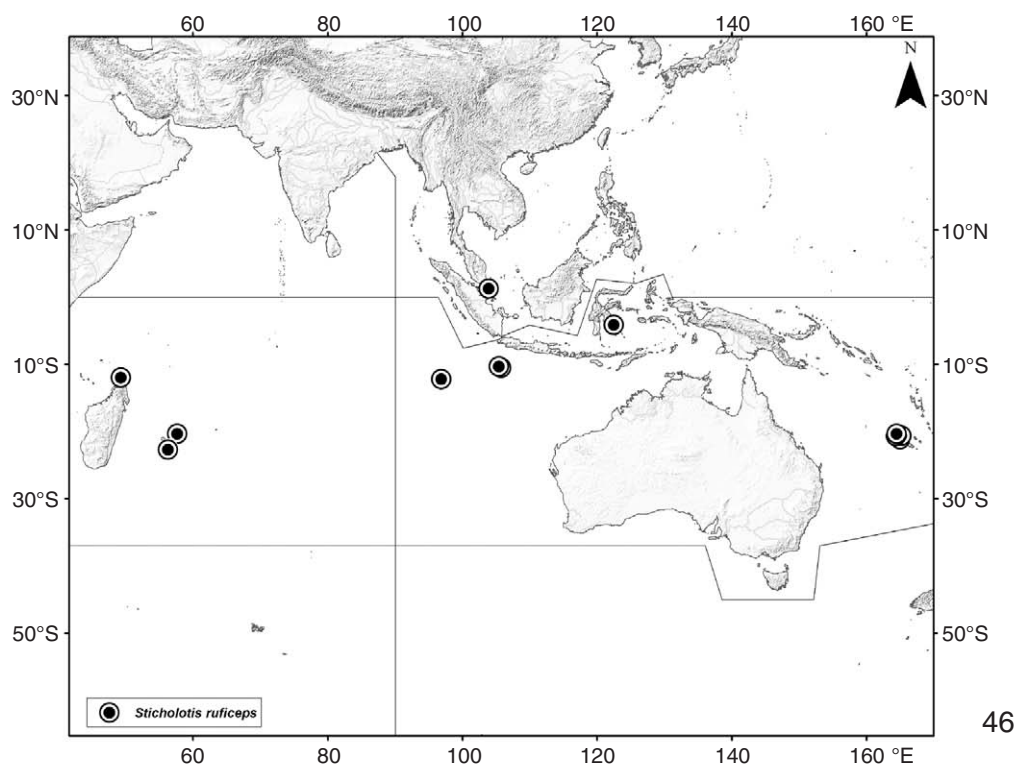
Figures 19–29. *Stichotolis ruficeps*, adult. (19) Head, dorsal view; (20) head, lateral view; (21) head, ventral view; (22) maxilla; (23) mandible; (24) labium; (25) antenna; (26) prothorax, ventral view; (27) meso- and metaventrite; (28) abdomen; (29) abdomen, detail.



Figures 30–36. *Stichtotis ruficeps*, adult. (30) hind leg; (31) elytron, epipleura; (32) elytron lateral view; (33) elytron internal view; (34) penis guide, ventral view; (35) penis, apex; (36) penis, apex detail.



Figures 37–45. *Sticholotis ruficeps*, larva. (37) Habitus; (38) head; (39) antenna; (40) labrum; (41) mandible, ventral view; (42) mandible, mesal view; (43) mouthparts; (44) middle leg; (45) middle leg detail.

Figures 46–47. *Sticholotis ruficeps* distribution maps.