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First record of *Acrocyrtus* Yosii, 1959 (Collembola, Entomobryidae) from Chinese mainland

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Abstract

The genus *Acrocrytus* is reported from Chinese mainland for the first time, with description of two new species *Acrocyrtus zhujiensis* **sp. n.** and *Acrocyrtus finis* **sp. n.** from Zhejiang Province, East China. They can be separated from other species of this genus by colour pattern, unscaled appendages (antennae, legs and ventral tube), interocular chaetae, labial basal chaetae, bothriotrichal complex chaetae on Abd. II–IV, microchaeta a2 on Abd. II, im on Abd. III and C1p on Abd. IV. Illustrations and a table showing main differences with closest *Acrocyrtus* species are provided.

Keywords

A. zhujiensis sp. n., *A. finis* sp. n., chaetotaxy, China

Introduction

Acrocyrtus was established by Yosii 1959 as a subgenus of *Lepidocyrtus* Bourlet, 1839 for *Lepidocyrtus (Acrocyrtus) malayanus* Yosii, 1959 having pointed dental tubercle. Yoshii and Suhardjono (1989) raised it to generic level and established three subgenera (*Acrocyrtus, Onerocyrtus, Carocyrtus*) based on scales distribution of ventral tube. Christiansen and Bellinger (1991) analyzed the phylogenetic relationships among Hawaiian *Lepidocyrtus s. l.* species and questioned the reliability of dental tubercle. Later, Soto-Adames (2000) made a phylogenetic analysis of Neotropical members of the genus, disagreeing with the previous conclusion and considering that this character has phylogenetic information useful in defining Yoshii's subgenera; he also suggested that dental tubercle should be used in combination with other characters. Considering the availability of this character in most literature descriptions and how easily it can be observed in practice, we considered that its use at generic level is relevant.

Acrocyrtus is characterized by the presence of conical pointed dental tubercles, rounded and finely striated scales on body and ventral side of furcula, 8+8 ommatidia (G and H smaller), 4-segmented antennae and apical bulb absent on Ant. IV, bidentate mucro with or without accessory spinelet. It is widely distributed in Southeast Asia, such as Singapore, Malay and Indonesia. So far, more than 26 species of the genus *Acrocyrtus* were described all over the world (Pan et al. 2011). Only one species *Acrocyrtus heterolepis* Yosii, 1959 was recorded from Hong Kong (Yosii 1966) and Taiwan (Yoshii 1982), China. Recently, an unidentified species assigned to "cf. *Acrocyrtus*" was also recorded from a cave in Huanjiang (Guangxi) by Deharveng et al. (2008). The two new species of *Acrocyrtus* that are studied here represent the first ones described from mainland of China.

Materials and methods

The specimens were cleared in lactic acid, mounted under a coverslip in Marc André II solution, observed using Leica DM2500 and Nikon 80i microscopes. The photographs were taken with Nikon SM1000 microscope using a mounted Nikon DS-Fi1 camera and enhanced with Photoshop CS2. Length data were measured with NIS-Elements Documentation (Nikon). Dorsal cephalic chaetae were designated after Gisin's system (1967), interocular chaetae after Mari-Mutt (1979, 1986), labial palp chaetae after Fjellberg (1998), labial chaetae after Gisin (1964), dorsal body chaetae after Szeptycki (1979).

Abbreviations. Th. -thoracic segment; Abd. -abdominal segment; Ant. -antennal segment; ms -specialized S-microchaeta(e); S-chaeta(e) -specialized chaeta(e) (including ms); mac -macrochaeta(e); mic -microchaeta(e).

Taxonomy

***Acrocyrtus zhujiensis* sp. n.**
urn:lsid:zoobank.org:act:D8F04C9C-6364-44CF-AA8E-B5B86580D831
http://species-id.net/wiki/Acrocyrtus_zhujiensis
Figs 1–27, Table 1

Holotype. ♀ on slide, Shaoxin City, Zhuji Country, Dongbaihu, Zhejiang Province, CHINA, 29°34.18'N, 120°24.06'E, 3.X.2009, collection number S4014, collected by Zhi-Xiang Pan & Chen-Chong Si, deposited in Taizhou University.

Paratypes. 6 ♀ and 1 ♂ on slide and 10 in alcohol, same data as holotype. 4 paratypes (2 ♀ on slide and 2 in alcohol) deposited in School of Life Sciences, Nanjing University and others in School of Life Sciences, Taizhou University, China.

Etymology. Named after the type locality.

Description. Body length up to 0.93 mm.

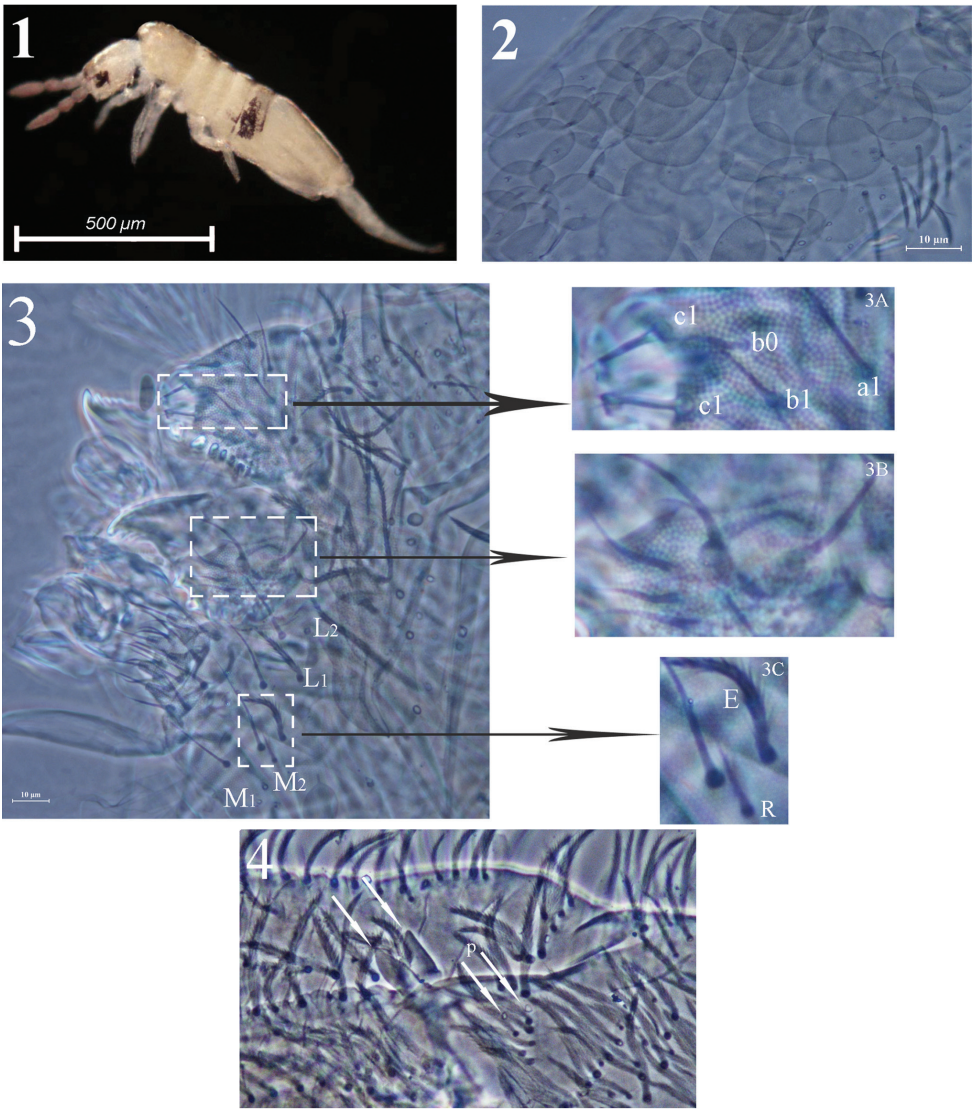
Colour pattern. Ground colour pale yellow, with a pair of dark patches present on lateral Abd. III. Violet pigment distributed on antennae and gradually darker towards tip. Eye patches dark (Fig. 1). Scales hyaline, oval to circular (Fig. 2), present on head, body tergites, ventral side of furcula; antennae, ventral tube and legs unscaled.

Head. Ommatidia 8+8, G and H smaller than others. Interocular chaetae as **p**, **r**, **t**, **q**, **s**, **v**; chaeta **s** smooth, chaetae **r** and **v** transformed to scales, chaetae **p**, **t** and **q** ciliate (Fig. 5). Antennae 1.5–2.4 times as long as cephalic diagonal. Antennal segmental ratio as I:II:III:IV = 1:1.3–1.4:1.2–1.9:1.9–3.1. Ant. I with 3 dorsal and 3 ventral basal spiny mic (Fig. 6). Ant. II with 4 basal tiny spiny mic, 1 distal rod-like

Table 1. Main differences between three similar species of *Acrocyrtus.*

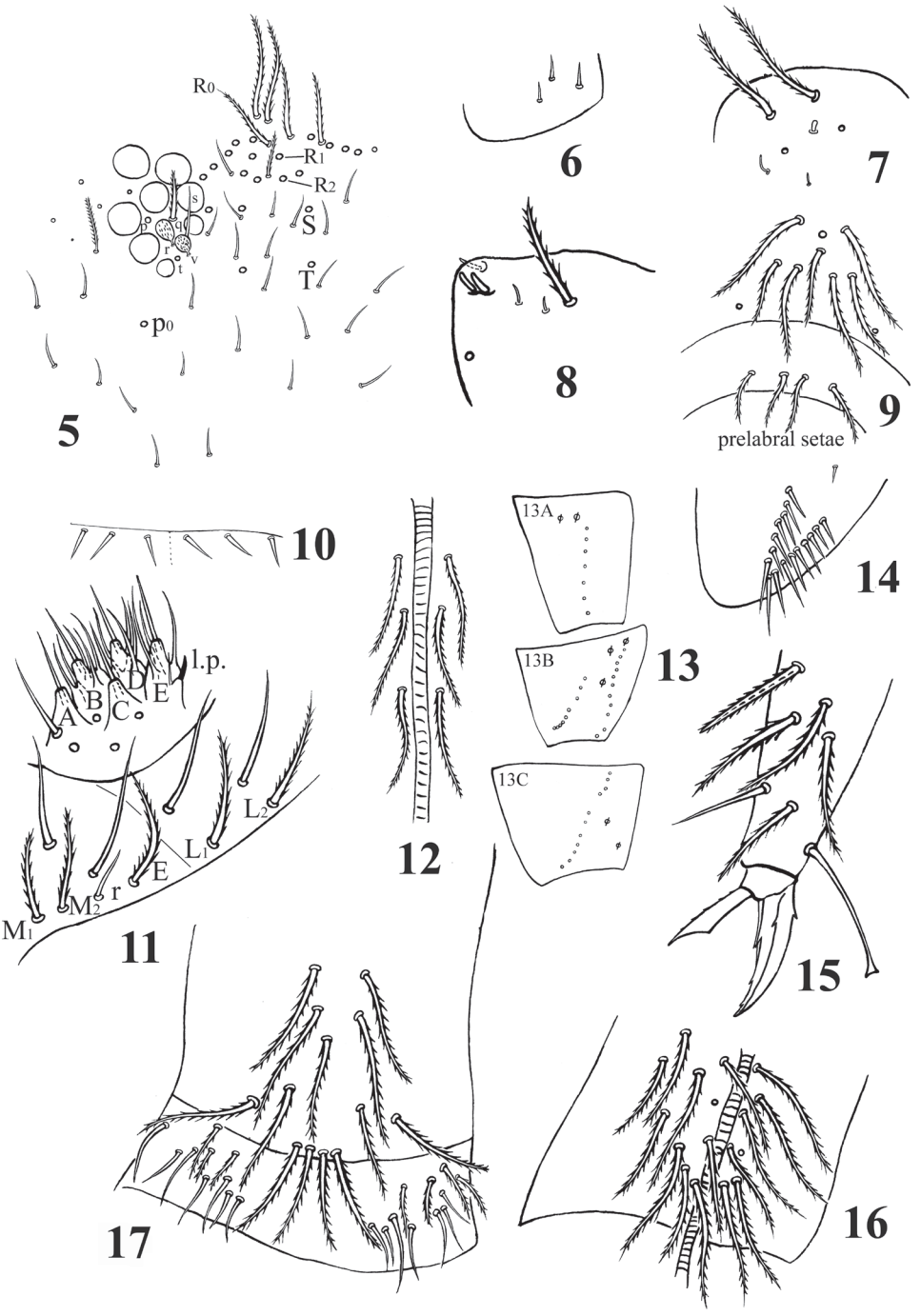
	***A. zhujiensis* sp. n.**	***A. finis* sp. n.**	***A. baii***
Dark patches laterally on Abd. II	absent	absent	present
Dark patches postero-laterally on Abd. IV	absent	present	present
Apical bulb of Ant. IV	absent	absent	present
Number of labral papillae	4	4	0
Chaeta $\mathbf{M_2}$ on labial base	ciliate	ciliate	smooth
Chaeta **R** on labial base	slightly ciliate	slightly ciliate	reduced
Chaetae $\mathbf{EL_1L_2}$ on labial base	ciliate	ciliate	smooth
Inner teeth on unguis	4	4	3
Smooth chaetae on posterior ventral tube	0+0	0+0	1+1
Chaeta **a2** on Abd. II	ciliate	smooth	?
Chaetae **m3** and **m5** on Abd. II	not expanded	expanded	?
Chaeta **a2** on Abd. III	not expanded	expanded	?
Chaeta **im** on Abd. III	ciliate	smooth	?
Chaeta **C1p** on Abd. IV	ciliate	smooth	?
Distribution	China	China	Vietnam

?: character not provided in original description

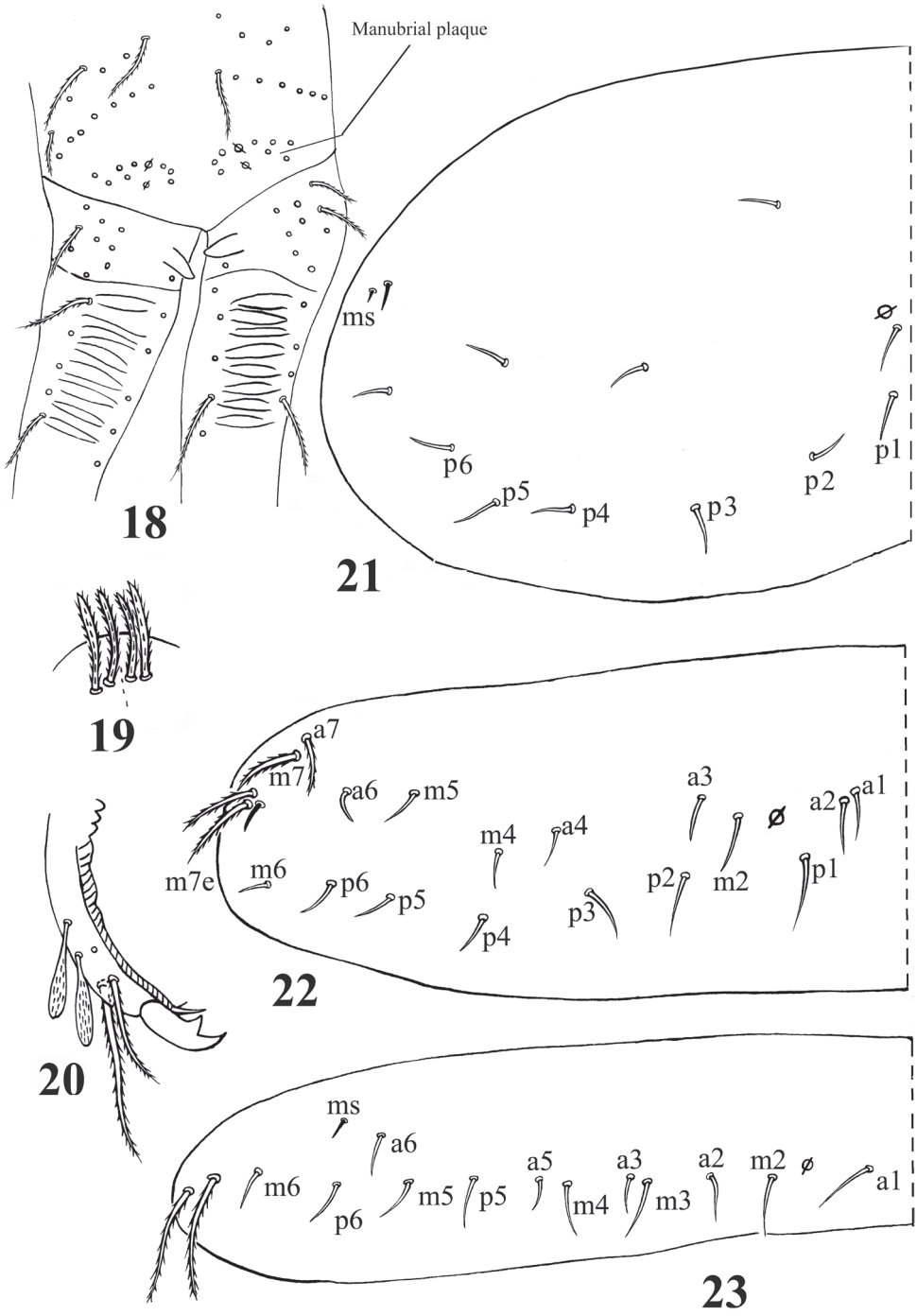


Figures 1–4. *A. zhujiensis* sp. n. **1** colour pattern, lateral view **2** body scale **3** labium and labrum (**3A** labral intrusion **3B** maxillary outer lobe **3C** labial basal chaetae R and E) **4** apical manubrium and basal dentes.

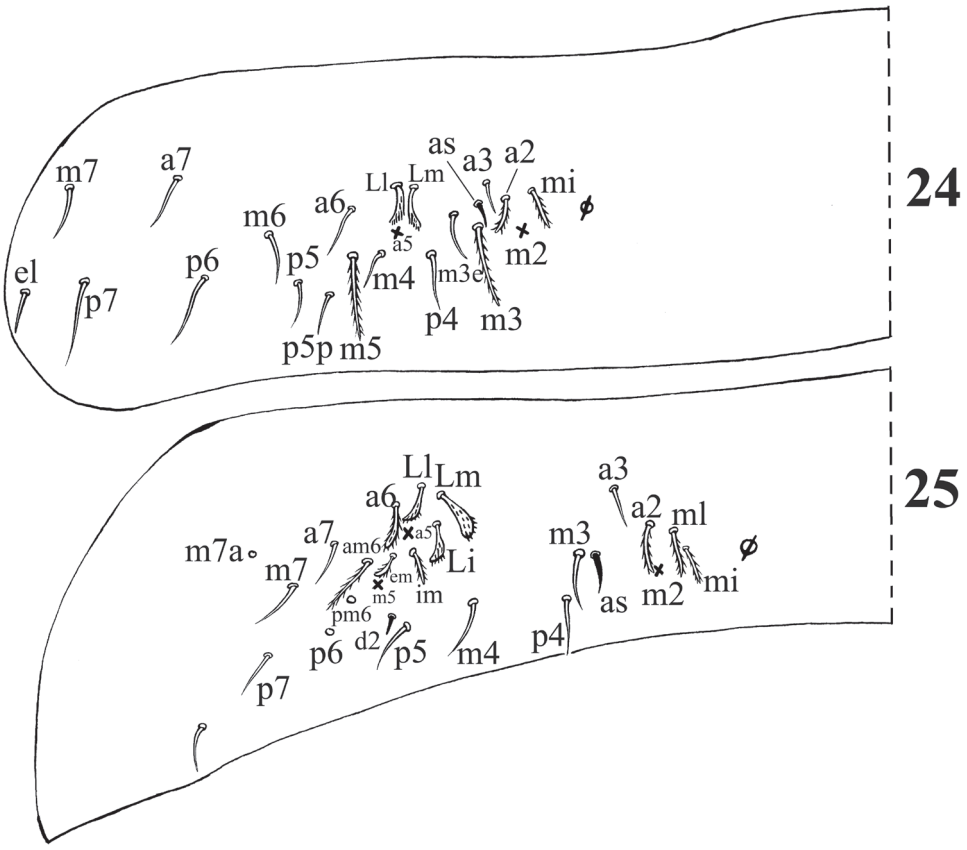
and 12–15 normal S-chaetae (Fig. 7). Ant. III organ with 2 rod-like S-chaetae (Fig. 8). Ant. IV without apical bulb. Anterior part of head with many long, ciliate chaetae but not claviform (Fig. 5). Prelabral and labral chaetae as 4/5, 5, 4, prelabrals ciliate and others smooth, labral intrusion V-shaped, chaetae of c-row thicker than those in other rows; labral margin with 4 conical papillae (Fig. 3). Clypeal chaetae as 3-1-4, without scales between them (Fig. 9). Cervical chaetae as 16 spiny chaetae, lateral two slightly longer than others (Fig. 10). Subapical chaeta of maxillary outer lobe subequal to apical one, 3 smooth sublobal hairs on sublobal plate. Labial palp with 5 papillae



Figures 5–17. *A. zhujiensis* sp. n. **5** head cheatotaxy **6** basal Ant. I **7** three kinds S-chaetae on Ant. II **8** Ant. III organ **9** clypeal chaetae **10** cervical chaetae **11** labial base and labial palp **12** cephalic groove **13** coxal macrochaetae (**13A** fore legs **13B** mid legs **13C** hind legs) **14** trochanteral organ **15** hind claw **16** anterior side of ventral tube **17** posterior side and lateral flap of ventral tube.



Figures 18–23. *A. zhujiensis* sp. n. **18** distal manubrium and basal dens **19** distal part of ventral manubrium **20** mucro **21–23** dorsal chaetotaxy **21** Th. II **22** Th. III **23**. Abd. I.

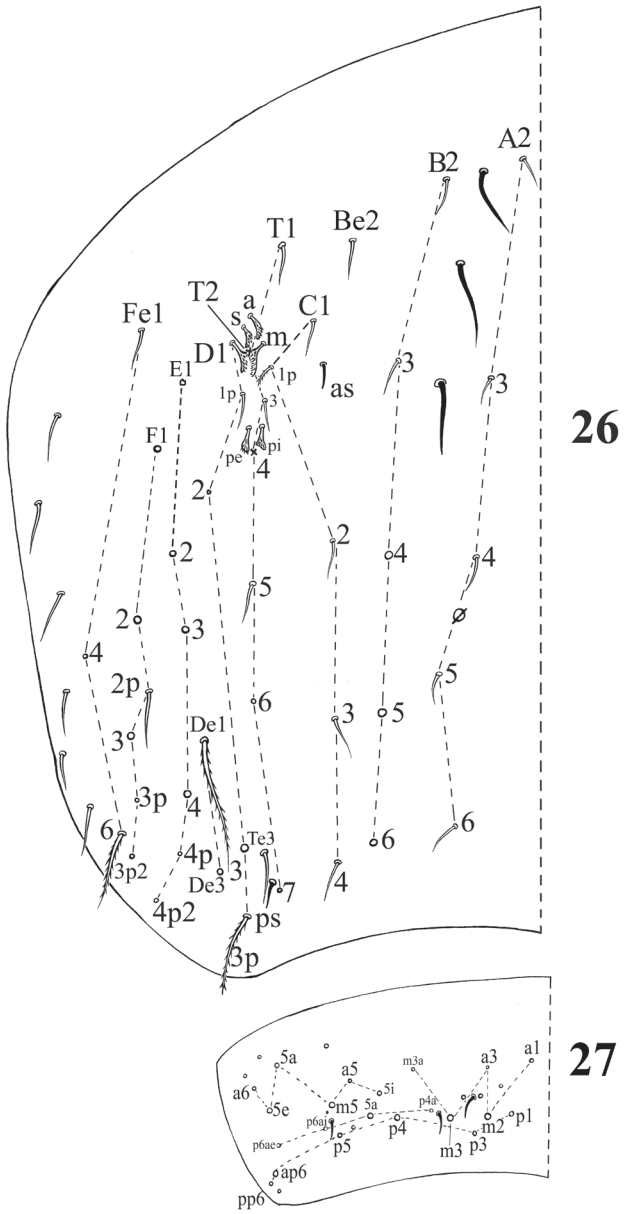


Figures 24–25. Dorsal chaetotaxy of *A. zhujiensis* sp. n. **24** Abd. II **25** Abd. III (as: antero-lateral S-chaeta).

as A–E, respectively with 0, 5, 0, 4, 4 guard chaetae; lateral process (l.p.) of labial palp straight, thick and blunt with tip not reaching apex of papilla E. Chaetotaxy of labial base as $\mathbf{M_1M_2REL_1L_2}$, all ciliate, chaeta **R** shorter than others (Fig. 11). Chaetal row along labial groove with 3 ciliate chaetae, and other postlabial chaetae ciliate (Fig. 12). Mandible with 4+5 (left+right) teeth (Fig. 3).

Leg. Coxae: I, with 7 ciliate mac and 2 pseudopores; II, with 7–8 ciliate mac in the anterior row, 8–11 ciliate mac in the posterior row and 3 pseudopores; III, with 9–11 ciliate mac and 2 pseudopores (Fig. 13). Trochanteral organ with 12–17 smooth spines (1–2 inner) (Fig. 14). Unguis with 4 inner teeth (paired ones at 1/3, middle one at 2/3 and apical one at 3/4 distance from base), 2 lateral teeth (at 1/4 distance from base) and 1 outer tooth (at 1/5 distance from base). Unguiculus slender and truncate with outer edge serrate. Tenent hair clavate, subequal to inner edge of unguis in length, and slightly longer than unguiculus. A distal smooth chaeta on tibiotarsus III subequal to unguiculus in length (Fig. 15).

Ventral tube. Anterior face with 14+14 ciliate chaetae; posterior face without smooth chaeta (Fig. 16); lateral flap with 6–8 smooth and 2–4 ciliate chaetae (Fig. 17).



Figures 26–27. Dorsal chaetotaxy of *A. zhujiensis* sp. n. **26** Abd. IV **27** Abd. V (ps: postero-sublateral S-chaeta).

Furcula. Manubrial plaque with 2–3 inner, 4–6 outer ciliate chaetae and 2 pseudopores. Dental tubercles conically pointed (Figs 4, 18). Ventral terminal manubrium with 2+2 ciliate chaetae (Fig. 19). Distal smooth part of dentes 2.1–2.5 times as long as mucro. Mucro bidentate, mucronal basal spine reaching subapical tooth with an accessory spinelet (Fig. 20).

Chaetotaxy. Dorsal cephalic mac as $\mathbf{R_0R_1R_2STP_0}$; R_{1s} absent. Body mac as 00/0100+3, S-chaetae as 21/11253, ms as 10/10100. Th. II slightly protruded over head, with 1–2 rows of ciliate "collar" mac, 2 antero-lateral S-chaetae (ms external to another S-chaeta), 6 (**p1–6**) smooth mic and 5 anterior unclear homology smooth mic (Fig. 21). Th. III with 1 S-chaeta external to **m7**; 15 (**a1–4**, **a6**, **m2**, **m4–6** and **p1–6**) smooth mic, 3 (**a7**, **m7** and **m7e**) ciliate mac and a lateral unclear homology ciliate chaeta (Fig. 22). Abd. I with 1 ms, 12 (**a1–3**, **a5–6**, **m2–6** and **p5–6**) smooth mic and 2 lateral unclear homology ciliate chaetae (Fig. 23). Abd. II with 1 central S-chaeta (**as**), 1 (**a2**) ciliate mic, 13 (**a3**, **a6–7**, **m3e**, **m4**, **m6–7**, **p4–7**, **p5p** and **el**) smooth mic, 1 ciliate and slightly modified mic (**mi**), 2 (**Lm** and **Li**) ciliate, modified and fan-shaped mic, 2 (**m3** and **m5**) ciliate mac; chaetae **a2p** and **ml** absent (Fig. 24). Abd. III with 1 central S-chaeta (**as**) and 1 lateral ms, 5 (**mi**, **ml**, **a2**, **im**, **em** and **am6**; **ml** sometimes present on one side) ciliate and slightly modified mic, 4 (**Li**, **Lm**, **Ll** and **a6**) strongly modified and fan-shaped mic, 8 (**a3**, **a7**, **m3**, **m7**, **p3–5** and **p7**) smooth and subequal mic, 3 (**pm6**, **m7a** and **p6**) ciliate mac (Fig. 25). Abd. IV with 1 anterior (**as**) and 1 posterior (**ps**) short S-chaetae and 3 median elongate S-chaetae, 22 (**A2–6**, **B2–3**, **Be2**, **C1–4**, **T1**, **T3**, **T5–6**, **Te3**, **D2–3**, **D1p**, **E1** and **Fe1**) smooth mic, 2 (**C1p** and **T7**) ciliate mic, 6 (**m**, **a**, **s**, **D1**, **pi** and **pe**) ciliate, strongly modified and fan-shaped mic, 13 (**B4–6**, **De1**, **De3**, **D3p**, **E2–4**, **F2–3**, **F3p2**, **Fe4** and **Fe6**) ciliate mac, 4 (**E4p**, **E4p2**, **F2p** and **F3p2**) mic (Fig. 26). Abd. V with 3 S-chaetae (Fig. 27).

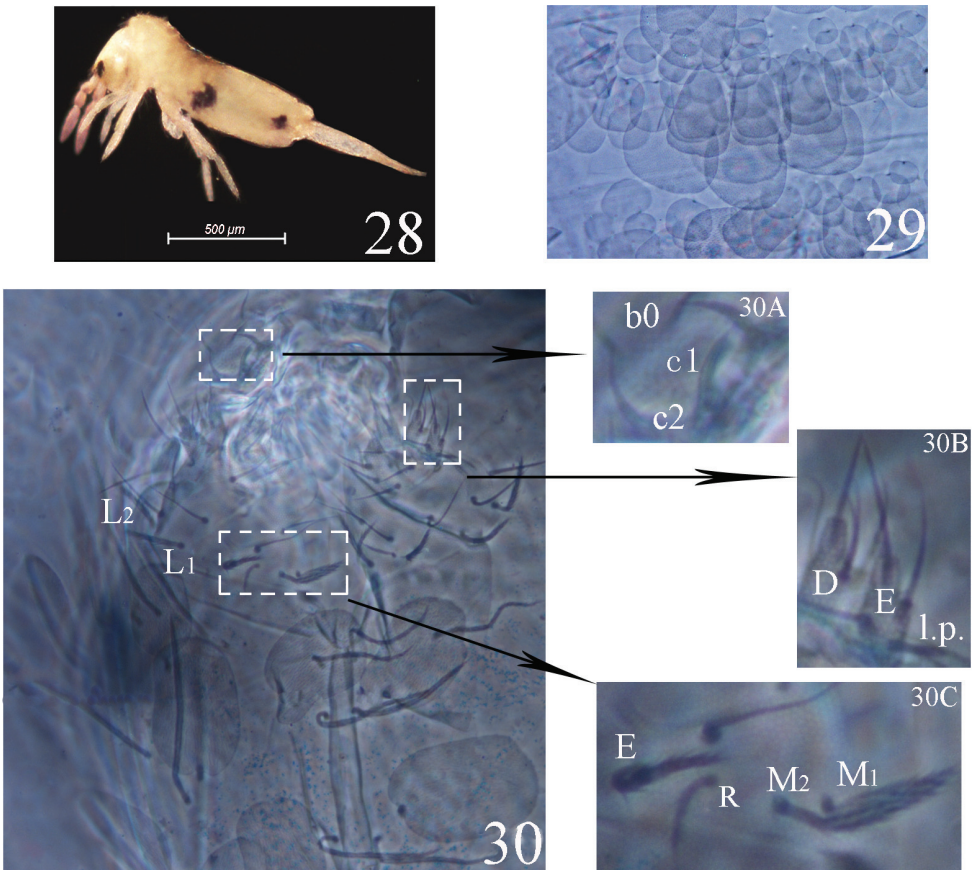
Ecology. In the leaf litter of *Cunninghamia lanceolata*, *Cinamomum camphora* along a lake.

Remarks. This new species is characterized by colour pattern, clavate tenent hair, unscaled appendages (antennae, legs and ventral tube), 4 conical labral papillae, ventral tube with ciliate chaetae present on lateral flap and without smooth chaeta on posterior side, and ciliate mic **a2** on Abd. II.

It is similar to Vietnamese *Acrocyrtus baii* Nguyen, 2005 in clavate tenent hair, claw, unscaled appendages (antennae and ventral tube). However, it can be easily distinguished from it by pigment absent on Th. II–III and Abd. II (versus present), ciliate labial chaetae $\mathbf{EL_1L_2}$ (versus smooth), $\mathbf{M_1}$ subequal to $\mathbf{M_2}$ on labial base (versus $\mathbf{M_1}$ smaller than $\mathbf{M_2}$), absence of smooth chaetae on posterior face of ventral tube (versus 1+1 smooth chaetae) and unscaled legs (versus scaled).

***Acrocyrtus finis* sp. n.**
urn:lsid:zoobank.org:act:0E689089-71E5-4FD4-AD50-3A2B23CE5595
http://species-id.net/wiki/Acrocyrtus_finis
Figs 28–37, Table 1

Holotype. 1 ♀ on slide, Taizhou City, Dalei Mountain, Zhejiang Province, CHINA, 29°02.25'N, 120°53.03'E, 25.X.2009, collection number S4023, collected by Zhi-Xiang Pan, deposited in Taizhou University.



Figures 28–30. *A. finis* sp. n. **28** colour pattern, lateral view **29** body scale **30** labium and labrum (**30A** labral intrusion **30B** labial papillae D, E and l.p. **30C** labial base).

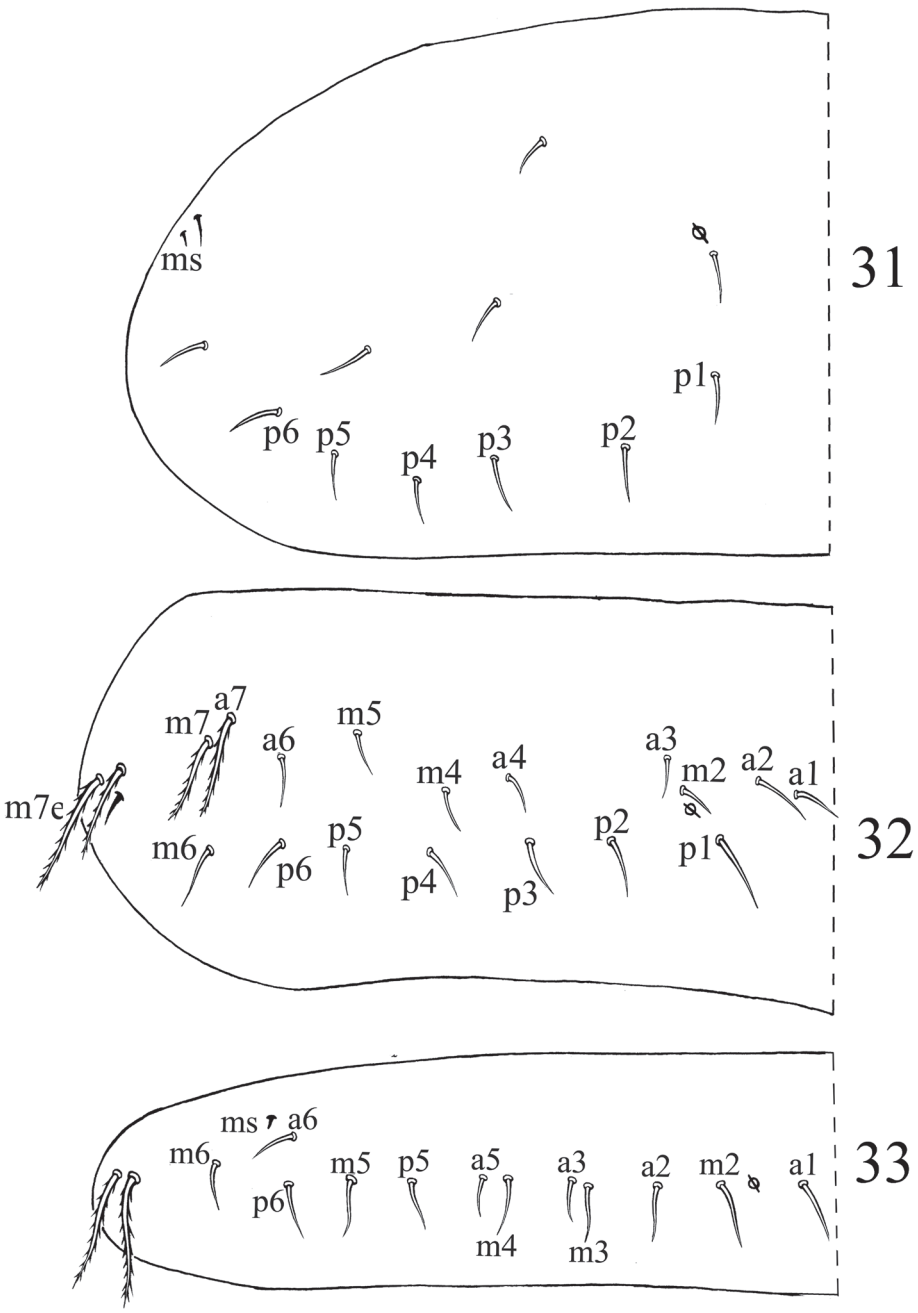
Paratypes. 11 ♀ on slide and 15 in alcohol, same data as holotype. 4 paratypes (2 ♀ on slide and 2 in alcohol) deposited in School of Life Sciences, Nanjing University and others in School of Life Sciences, Taizhou University, China.

Etymology. Named after the type locality, which is the border (latin word "finis") of the three adjacent cities.

Description. Body length up to 1.2 mm.

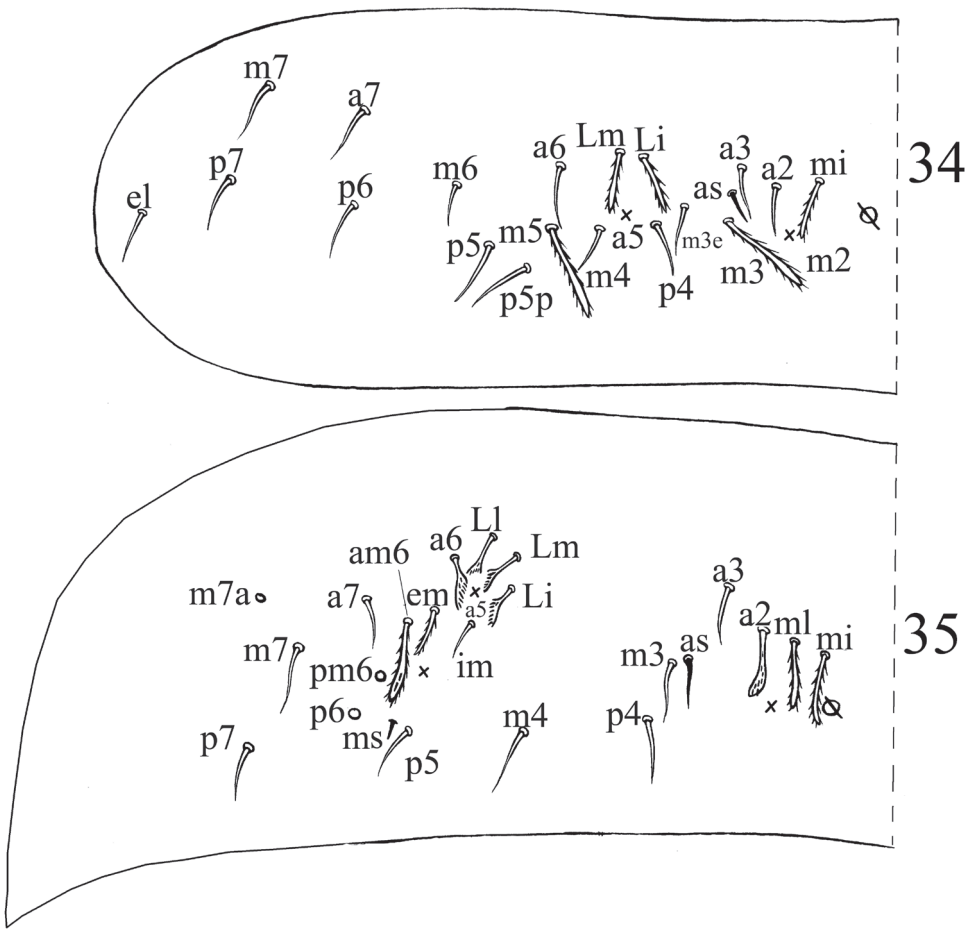
Colour pattern. Ground colour from yellow to slightly brown, a pair of dark lateral patches of Abd. III and a pair of dark postero-lateral patches of Abd. IV, slightly violet pigment distributed on antennae and gradually darker towards tip, eye patches dark (Fig. 28). Scales hyaline, oval to circular (Fig. 29), present on head, body tergites and ventral side of furcula, and absent on antennae, legs and ventral tube.

Head. Ommatidia 8+8, G and H smaller than others, interocular chaetae as **p**, **r**, **t**, **q**, **s**, **v**; chaeta **s** smooth, chaetae **p**, **t**, **q** ciliate, chaetae **r** and **v** transformed to scales. Antennae 1.4–2.0 times as long as cephalic diagonal. Antennal segmental ratio as I:II:III:IV = 1:1.3–1.9:1.5–2.5:2.5–5.0. Ant. I with 3 dorsal and 3 ventral basal



Figures 31–33. Dorsal chaetotaxy of *A. finis* sp. n. **31** Th. II **32** Th. III **33** Abd. I.

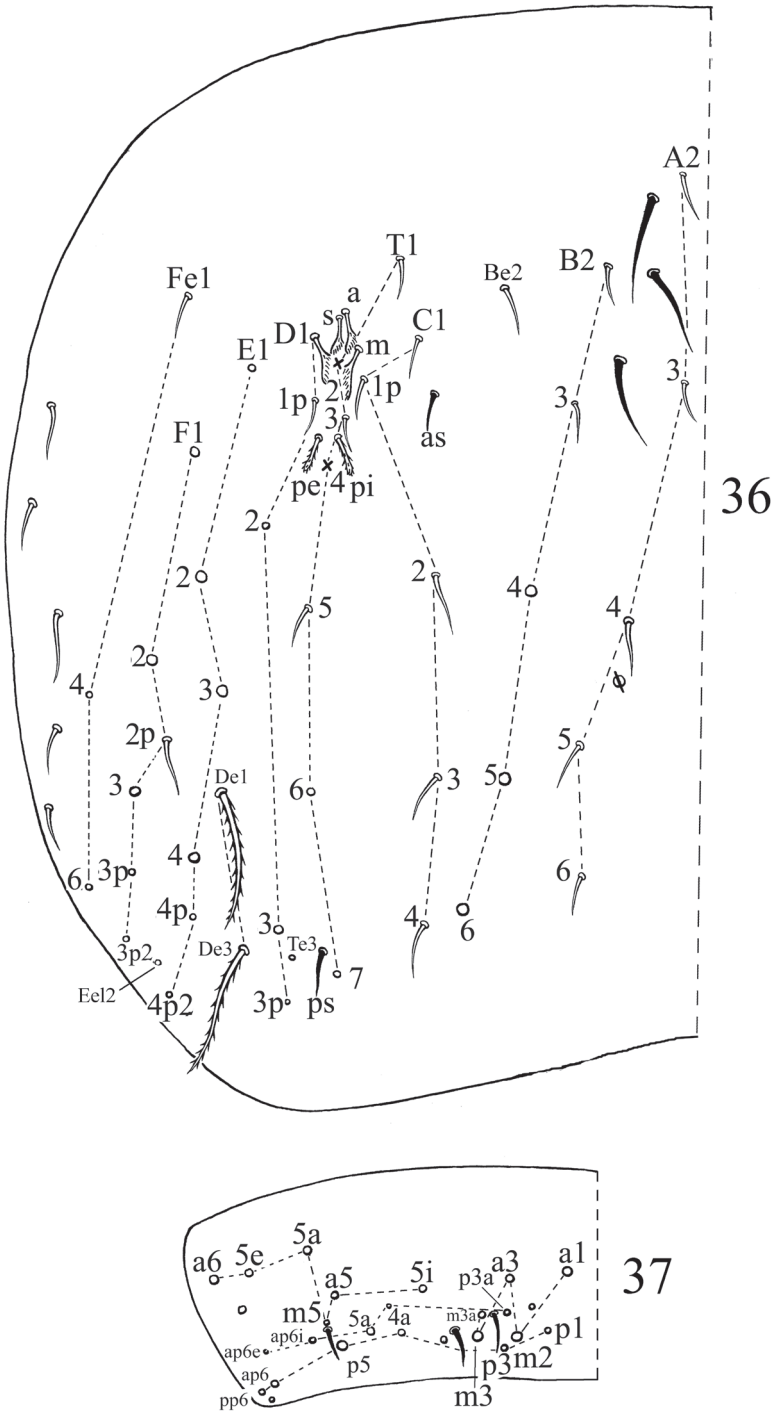
spiny chaetae. Ant. II with 4 basal tiny spines, 11–14 short and 1 distal rod-like S-chaetae. Ant. III organ with 2 rod-like S-chaetae. Ant. IV without apical bulb. Anterior part of head with many ciliate and long, but not claviform chaetae. Cervical with 16



Figures 34–35. Dorsal chaetotaxy of *A. finis* sp. n. **34** Abd. II **35** Abd. III.

spiny chaetae, all subequal in length. Prelabral and labral chaetae as 4/5, 5, 4, prelabrals ciliate and others smooth, chaetae of c-row thicker than other row chaetae; labral intrusion V-shape; labral margin with 4 papillae. Clypeus without scales. Subapical chaeta of the maxillary outer lobe subequal to apical chaeta, 3 smooth sublobal hairs on sublobular plate. Labial palp with five papillae as A–E, respectively with 0, 5, 0, 4, 4 guard chaetae; lateral process of labial palp straight, thick with tip not reaching apex of papilla E. Chaetotaxy of labial base as $\mathbf{M_1M_2RL_1L_2}$, all ciliate, chaeta **r** shorter than others. Chaetal row along labial groove with 3 ciliate chaetae, and other postlabial chaetae ciliate. Mandible with 4+5 (left+right) teeth (Fig. 30).

Leg. Coxae: I, with 5–7 ciliate mac and 2 pseudopores; II, with 6–7 ciliate mac in the anterior row, 7–9 ciliate mac in the posterior row and 3 pseudopores; III, with 6–7+3 ciliate mac and 2 pseudopores. Trochanteral organ with 10–14 smooth spiny chaetae. Unguis with 1 outer (at 1/5 distance from base), 2 lateral (at 1/4 distance from



Figures 36–37. Dorsal chaetotaxy of *A. finis* sp. n. **36** Abd. IV **37** Abd. V.

base) and 4 inner teeth (paired ones at 1/3, middle one at 2/3 and apical one at 3/4 distance from base to apical inner unguis), all tiny. Unguiculus slender and truncate with outer edge slightly serrate. Tenent hair clavate, subequal to inner margin of unguis, and slightly longer than unguiculus. Supraempodial chaeta subequal to unguiculus.

Ventral tube. Anterior face with 9–15 larger ciliate chaetae; posterior face without smooth chaetae; lateral flap with 6–7 smooth and 2–3 ciliate chaetae.

Furcula. Manubrial plaque with 2–3 inner, 4–6 outer ciliate chaetae and 2 pseudopores, ventral manubrium with 2+2 ciliate terminal chaetae. Dental tubercles conically pointed. Distal smooth part of dentes 1.5–2.0 times as long as mucro. Mucro bidentate, mucronal basal spine reaching subapical tooth with two accessory spinelets.

Chaetotaxy. Dorsal cephalic mac as **$R_0R_1R_2$TS**, **P_0** sometime absent. Body mac as 00/0100+3, S-chaetae as 21/11253, ms as 10/10100. Th. II slightly protruded over head, with 2 antero-lateral S-chaetae (ms postero-external to another one), 6 (**p1–6**) smooth and subequal mic and 5 anterior smooth mic of unclear homology (Fig. 31). Th. III with 1 S-chaetae external to **m7**, 15 (**a1–4**, **a6**, **m2**, **m4–6** and **p1–6**) smooth mic, 3 (**a7**, **m7** and **m7e**) mac and one other mac of unclear homology (Fig. 32). Abd. I with 1 ms external to **a6**, 12 (**a1–3**, **a5–6**, **m2–6** and **p5–6**) smooth mic and 2 lateral ciliate mac of unclear homology (Fig. 33). Abd. II with 1 central S-chaetae (**as**), 1 (**mi**) ciliate and blunt mic, 14 (**a2–3**, **a6–7**, **m3e**, **m4**, **m6–7**, **p4–5**, **p5p**, **p6–7** and **el**) smooth and subequal mic, 2 (**Lm** and **Li**) ciliate and slightly expanded mic, 2 (**m3** and **m5**) ciliate mac with tip expanded, chaetae **a2p** and **ml** absent (Fig. 34). Abd. III with 1 central S-chaeta (**as**) and 1 lateral ms, 5 (**a2**, **mi**, **ml**, **em** and **am6**) ciliate mic with tip expanded, 4 (**Li**, **Lm**, **Ll** and **a6**) ciliate modified and fan-shaped mic, 9 (**im**, **a3**, **a7**, **m3**, **m7**, **p3–5** and **p7**) smooth mic, 3 (**pm6**, **m7a** and **p6**) ciliate mac (Fig. 35). Abd. IV with 1 anterior (**as**) and 1 posterior (**ps**) short S-chaetae and 3 elongate median S-chaetae, 22 (**A2–6**, **B2**, **B3**, **Be2**, **C1–4**, **C1p**, **T1**, **T3**, **T5–6**, **D1p**, **D2–3** and **Fe1**) smooth mic, 15 (**B4–6**, **T7**, **D3p, De1**, **De3**, **E1–4**, **F1–3**, **Fe4** and **Fe6**) ciliate and mac, 5 (**Te3**, **E4p**, **E4p2**, **F3p** and **F3p2**) as mic, 4 (**m**, **a**, **s** and **D1**) ciliate and strongly fan-shaped mic, 2 (**pi** and **pe**) ciliate mic with tip expanded (Fig. 36). Abd. V with 3 S-chaetae (Fig. 37). Abd. IV:Abd. III = 2.6–4.1:1.

Ecology. In leaf litter of *Pinus massoniana, Schima superba* and *Cinamomum camphora,* in bryophyta and on farmland.

Remarks. The new species is easily distinguished from other *Acrocyrtus* by 4 abdominal lateral patches, morphology of interocular chaetae **v**, **r** and **s**, cephalic mac as **$R_0R_1R_2$ST**, 4 papillae and thicken c-row chaetae on labrum, smooth mic **a2**, **im** and **C1p** on Abd. II, Abd. III and Abd. IV, respectively, unscaled appendages (antennae, ventral tube and legs).

The species is most similar to *Acrocyrtus zhujiensis* sp. n. in cephalic chaetotaxy, labral papillae, claw, furcula, macrochaetotaxy and S-chaetotaxy. However, the two species are different in colour pattern, morphology of chaetae **a2**, **m3** and **m5** on Abd. II, **a2** and **im** on Abd. III, **C1p** on Abd. IV. Main differences between two new species are listed in Table 1.

Discussion

Dental tubercles are pointed in *Acrocyrtus* and rounded in *Ascocyrtus*. However, it is sometimes uneasy to recognize the shape of dental tubercles. Their shape maybe wrongly observed in different visual angles, pointed in lateral view but "rounded" in facial view. They need to be observed under various angles. Another interesting point is that some species of Yoshii (1982, 1989) with colour patterns similar to our species (pigment on Abd. III) were assigned to *Ascocyrtus* rather than *Acrocyrtus*. Our new species would be placed in *Ascocyrtus* due to habitus compared with those Southeast Asia taxa (Deharveng, personal communication). Actually, more Chinese species with similar patterns in our collection have pointed and relatively long dental tubercles. Since the works of Yosii, no significant advance has been made for the classification of *Lepidocyrtus* s. l. Molecular tools are expected to help discriminate Lepidocyrtinae genera in the future.

Acknowledgements

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RESEARCH ARTICLE

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Description of *Lentistivalius philippinensis*, a new species of flea (Siphonaptera, Pygiosyllomorpha, Stivaliidae), and new records of Ascodipterinae (Streblidae) on bats and other small mammals from Luzon, The Philippines

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Abstract

During May 2009 and July 2011, we collected 357 mammals and examined each for ectoparasites. Among the ectoparasites collected, a new species of flea was discovered. This new species, *Lentistivalius philippinensis*, is described from the male sex only. Two males were recovered from two specimens of the soricid *Crocidura grayi* Dobson in Municipality Maria Aurora, Aurora Province, Luzon, Philippines. Additional fleas included *Thaumapsylla breviceps orientalis* Smit, *Thaumapsylla longiforceps* Traub, and *Ischnopsyllus indicus* Jordan. Although the latter species is common in Japan and documented in Guam (as well as mainland Southeast Asia) also on *Pipistrellus javanicus* (Gray), *I. indicus* represents a new record in the Philippine Islands. The ascodipterinae (Streblidae) *Maabella stomalata* and *Ascodipteron speiserianum* Muir collected from *Rhinolophus inops* K. Andersen and *Rhinolophus subrufus* K. Andersen, respectively, also represent new host records. A key to the species of the flea genus *Lentistivalius* Traub is provided.

Keywords

Ascodipteron, bat flies, fleas

Introduction

During May 2009 and July 2011, we collected 357 mammals representing 57 species from the Philippines and examined each for ectoparasites. All but one of these mammals were collected from the island of Luzon in the northern Philippines. One bat was collected on the island of Negros in the southern Philippines. Bat flies in the families Nycteribiidae and Streblidae (Diptera) were present on many of the bat specimens, including one unusual group of endosomic flies in the subfamily Ascodipterinae (Streblidae). In addition to the ascodipterons, several species of bat fleas and a new species of flea in the Siphonapteran suborder Pygiopsyllomorpha are reported in this study. Molecular and morphological analyses of nycteribiid and other non-endosomic streblid flies from bats will be reported in a separate paper.

Materials and methods

Mammals and their ectoparasites were surveyed at 12 field sites on the island of Luzon (Fig. 1), and one bat was collected from the island of Negros. A map for the island of Negros is not included. Mammals were captured and euthanized according to guidelines of the American Society of Mammalogists (Gannon et al. 2007). Mist nets and harp traps were set in the forest and at, or near cave entrances to capture bats. Bats were processed for ectoparasites in accordance with Hastriter and Bush (2006). Terrestrial mammals were captured with Sherman traps or snap-traps. Each mammal was subjected to a thorough post-mortem visual examination: the face and ears were carefully searched and parasites were removed with forceps. In addition, the fur was systematically searched with the aid of a fine-toothed metal comb (LiceMeister™, National Pediculosis Association, Needham, MA). All ectoparasites recovered were preserved in 95% ethanol for later processing and identification in the laboratory. All associated hosts were prepared as museum specimens and were deposited in the Kansas Museum of Natural History (KUMNH), Lawrence, KS, U.S.A. Siphonaptera and Ascodipterinae were deposited in the Monte L. Bean Life Science Museum, Brigham Young University, Provo, UT, U.S.A.

Results

Diptera
Streblidae: Ascodipterinae

***Ascodipteron speiserianum* Muir, 1912**
http://species-id.net/wiki/Ascodipteron_speiserianum

Material examined. Philippines, Luzon Island, Aurora Province: Sitio Minoli, Municipality San Louis (15.680°N, 121.529°E), elev. 520m, *Rhinolophus sub-*

Figure 1. Sampling locations on the island of Luzon (n = number of mammals examined at each site). Stars indicate the location of ascodipterons and fleas discussed in this paper. **a** Mt. Pao (n=38) and Mt. Cabacan (n=38) **b** Mt. Cagua site 1 (n=62) and Mt. Cagua site 2 (n=32) **c** Casiguran (n = 16) **d** Maria Aurora (n=34) **e** Sitio Minoli (n=56) and nearby field site (n=24) **f** Zabali (n=39) **g** Tower site (n=14) **h** Angat (n=3); and **i** Burdeos (n=1). Photo courtesy of S. Villa.

rufus K. Andersen (JAE2961), 13 VI 2009, K. Dittmar (1dealate ♀ w/o caudal disc, P-2661).

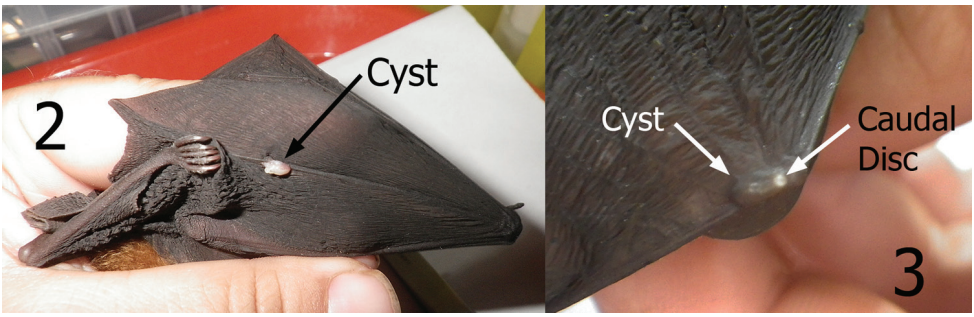
Remarks. Only one *A. speiserianum* was collected from the 19 *R. subrufus* specimens that were examined. *Ascodipteron speiserianum* was documented in the Philippines in Hastriter (2007) from Rizal Province, Luzon from a "bat". The site of attachments of *A. speiserianum* is commonly at base and behind ear pinna (less commonly on the body) on species of the bat genus *Miniopterus* Bonaparte. Its presence on *R. subrufus* represents a new host record.

Maabella stomalata Hastriter & Bush, 2006

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

Material examined. Philippines, Luzon Island, Cagayan Province: Mt. Cagua 2, Magrafil Barangay (18.236°N, 122.104°E), elev. 680m, *Rhinolophus inops* K. Anderson (JAC093), 20 VII 2011, S. Villa and S. Knutie, (1 dealate ♀ w/o caudal disc, P4631); same data except *R. inops* (JAC094) (1dealate ♀ with caudal disc, P4632); same data except *R. inops* (JAC096) (1 dealate ♀ w/o caudal disc and 1 dealate ♀ with caudal disc, P4640); and same data except *R. inops* (JAC097) (1dealate ♀ with caudal disc, 2 dealate ♀♀ w/o caudal discs, P4636).

Remarks. *Maabella* is a widespread monotypic genus. Hastriter and Bush (2006) described *Maabella stomalata* from China and Vietnam with records from *Rhinolophus affinis* Horsfield, *Rhinolophus macrotis* Blyth, and *Rhinolophus paradoxalophus* (Bourret). Subsequently Hastriter (2007) documented a *M. stomalata* in Borneo, Java, Moluccas, Malaysia, Myanmar, Papua New Guinea, Philippine Islands, and West Papua and cited the additional bat host species of *Rhinolophus acuminatus* Peters, *Rhinolophus euryotis* Temminck, *Rhinolophus megaphyllus* Gray, *Rhinolophus rufus* Eydoux and Gervais, *Hipposideros calcuratus* (Dobson), *Hipposideros cervinus* (Gould), and *Rousettus amplexicaudatus* (E. Geoffroy). Although our study does not expand the distribution of *Maabella*, *R. inops* represents a new host record. Members of the bat family Rhinolophidae are the preferred hosts of *M. stomalata*. Its occurrence on *R. amplexicaudatus* is probably an accidental association. The site of penetration of neosomes has commonly been found on the leading edge of the wing and over the joints of the front part of the wings (Hastriter, 2007). Our specimens were also found over wing bones and joints (Figs 2–3) with occasional specimens in the skin or "patagia" of the wings unassociated with bones. Locations over the bones/joints of the wing might be an adaptation of *Maabella* to prevent suffocation by the host's skin from blocking the spiracles that protrude through the host's thin skin via the caudal disc. The underlying wing bones are also more open to surface air when wings are folded during rest/sleep. Note in Figs 2 and 3 that the neosomes within the cysts lay horizontal to the surface. *Ascodipteron* species that occupy body tissues penetrate deeper and arrange themselves (*in situ*) perpendicular to the skin surface (not horizontal).



Figures 2–3. Cysts containing neosomes of *Maabella stomalata*. **2** Cyst located on dorsal surface directly over wing digit number five of *Rhinolophus* sp. (species undetermined) **3** Cyst located on dorsal surface directly over the radius-ulna/thumb joint of *Rhinolophus inops*. Arrow depicts caudal disc (spiracle breathing structure) protruding through the skin.

Siphonaptera
Ischnopsyllidae, Thaumapsyllinae

***Thaumapsylla breviceps orientalis* Smit, 1954**
http://species-id.net/wiki/Thaumapsylla_breviceps_orientalis

Material examined. Philippines, Luzon Island, Aurora Province: Sitio Minoli, Municipality San Louis (15.680°N, 121.529°E), elev. 520m, *Eonycteris robusta* Miller (JAE2944), 12 VI 2009, K. Dittmar, (1♂, P2650); same except *Eonycteris spelaea* Dobson (JAE3021), 16 VI 2009 (1♀, P2766); same except *E. spelaea* (JAE3023) (1♀, P2770); same except *R. amplexicaudatus* (JAE3027) (1♀, P2775); same except *E. spelaea* (JAE3040) (1♂, P2779); Luzon Island, Ilocos Norte Province, Adams village, Mt. Pao, (18.438°N, 120.878°E), elev. 750m, *R. amplexicaudatus* (NCA049), 22 VI 2011, S. Villa, (2♀♀, P4196); Luzon Island, Ilocos Norte Province, Adams village, Mt. Cabacan, (18.449°N, 120.894°E), elev. 475m, *R. amplexicaudatus* (NCA125), 30 VI 2011, S. Villa, (1♀, P4318); Luzon Island, Cagayan Province, Barangay Magrafil (closest city Gonzaga), Mt. Cagua, (18.219°N, 122.111°E), elev. 780m, *R. amplexicaudatus* (JAC036), 11 VII 2011, S. Villa and S. Knutie, (1♂, P4496).

Remarks. The two populations of *Thaumapsylla breviceps* are recognized (*Thaumapsylla breviceps breviceps* Rothschild, 1907 and *Thaumapsylla breviceps orientalis* Smit, 1954). The nominate species is found in southern portions of Africa and the other in the Oriental and Australasian regions. Beaucournu and Kock (1994) provide a distributions map of *T. b. orientalis*. There has been some controversy regarding the validity of *T. b. orientalis*. Smit (1954) erected *T. b. orientalis* after studying material from both geographical regions and reported only one distinguishing character in males: the presence of a convex margin along the apex of the basimere in the nominate subspecies vs. a slight concavity along the margin in the other subspecies. He found no differences in females from the respective regions and considered them indistinguishable. All three males examined in our study present a distinct concavity in the apex of the basimere.

Females are identified based only on geographic distribution. Material reported by Hastriter and Bush (2010) as "*Thaumapsylla breviceps* Rothschild", belong to *T. b. orientalis* Smit, 1954. These two subspecies parasitize fruit bats of the genus *Rousettus* in both regions. Although *T. b. orientalis* was found on four *Rousettus* and four *Eonycteris* bats, the prevalence of this flea was highest on *Rousettus* bats. Of 11 *Rousettus* specimens examined, 36% harbored this flea, whereas only 18% of the 22 specimens of *Eonycteris* were infested.

None of the three species on which *T. b. orientalis* occurred represent new host records.

***Thaumapsylla longiforceps* Traub, 1951**

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

Material examined. Philippines, Luzon Island, Ilocos Norte Province, Adams village, Mt. Pao, (18.438°N, 120.878°E), elev. 750m, *E. robusta* (NCA055), 23 VI 2011, S. Villa, (1♂, P4222); Luzon Island, Ilocos Norte Province, Adams village, Mt. Cabacan, (18.449°N, 120.894°E), elev. 475m, *E. robusta* (NCA081), 27 VI 2011, S. Villa, (1♀, P4253); same data except *R. amplexicaudatus* (NCA125), 30 VII 2011, S. Villa, (1♀, P4318).

Remarks. *Thaumapsylla longiforceps* is not as widespread in the Oriental region as *T. b. orientalis*. These two species may occur on the same host as we found a female of each flea species on host NCA125 (*R. amplexicaudatus*). This species commonly occurs on pteropodid bats (fruit bats) but has also been documented on vespertilionid and rhinolophid bats.

Ischnopsyllidae, Ischnopsyllinae

***Ischnopsyllus* (*Hexactenopsylla*) *indicus* Jordan, 1931**

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

Material examined. Philippines, Negros Island, Mt. Bungal, Northern Negros Natural Park (10.674°N, 123.189°E), elev. 1200m, *Pipistrellus javanicus* (Gray) (JAE3252), 23 VII 2009, J. Esselstyn, (1♂).

Remarks. *Ischnopsyllus indicus* has been documented in China, Taiwan, Vietnam, India, Guam, Sri Lanka, and Japan from a number of vespertilionid bat species; however, this is the first record of *I. indicus* in the Philippines. Finding this flea in the Philippines is no surprise, since *I. indicus* was documented in Guam by Jordan (1941), in Japan by Hopkins and Rothschild (1956), and is very common in Japan according to Sakaguti and Jameson (1962) on the same host species (*P. javanicus*) on which we found this species. *Pipistrellus javanicus* is widely distributed in eastern Russia, China, south and central Japan, Southeast Asia through the Sunda Islands, and in the Philippines (Wilson and Reeder 2005). Several differences should be noted in our specimen and those illustrated in the original male description by Jordan (1941) and

subsequently copied by Hopkins and Rothschild (1956). The telomere appears more oblique at its apex. There are a pair of flat ribbon-like, long curved setae at the apex (one pair on each side) of S-VIII. This does not appear illustrated as such by either Jordan or Hopkins and Rothschild. These ribbon-like setae are absent in all other species of the subgenus *Hexactenopsylla*. The illustrations of Sakaguti and Jameson (1962) more accurately depict the features of our single male from Luzon.

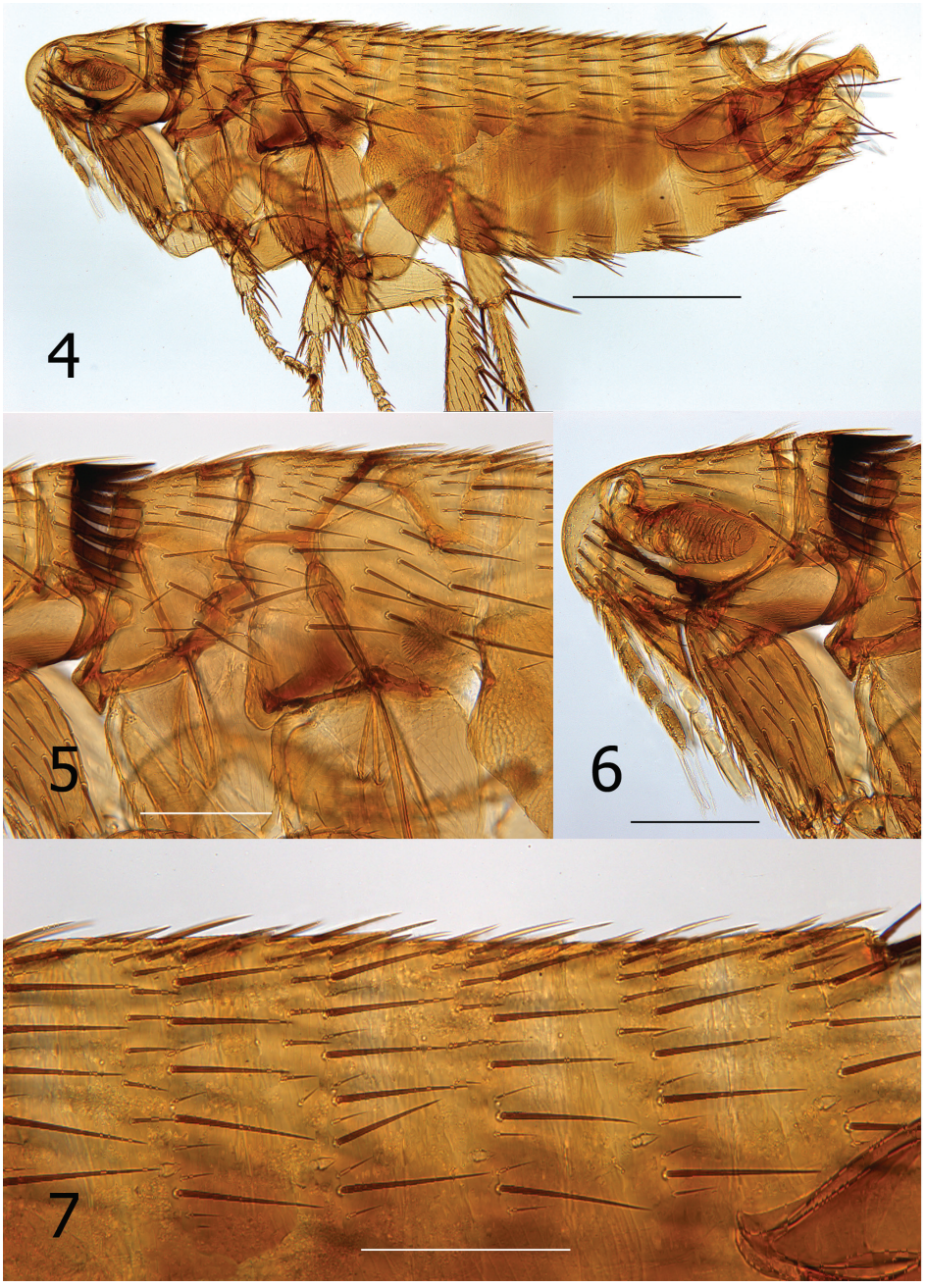
Stivaliidae, Stivaliinae

***Lentistivalius philippinensis* Hastriter & Bush, sp. n.**
urn:lsid:zoobank.org:act:5E6F547E-51A0-40C2-A292-DDEB2B2A2D12
http://species-id.net/wiki/Lentistivalius_philippinensis
Figs 4–15

Type material. Holotype male (P2316), Philippines, Luzon Island, Aurora Province: Camp 1, Municipality Maria Aurora (15.685°N, 121.343°E), elev. 507m, *Crocidura grayi* Dobson (JAE2825), 25 V 2009, K. Dittmar and V. Tkach; 1♂ paratype (P2211), same data except *C. grayi* (JAE2785), 22 V 2009. Holotype deposited in the Carnegie Museum of Natural History, Pittsburgh, PA and male paratype in the Brigham Young University flea collection, Monte L. Bean Life Science Museum, Provo, UT.

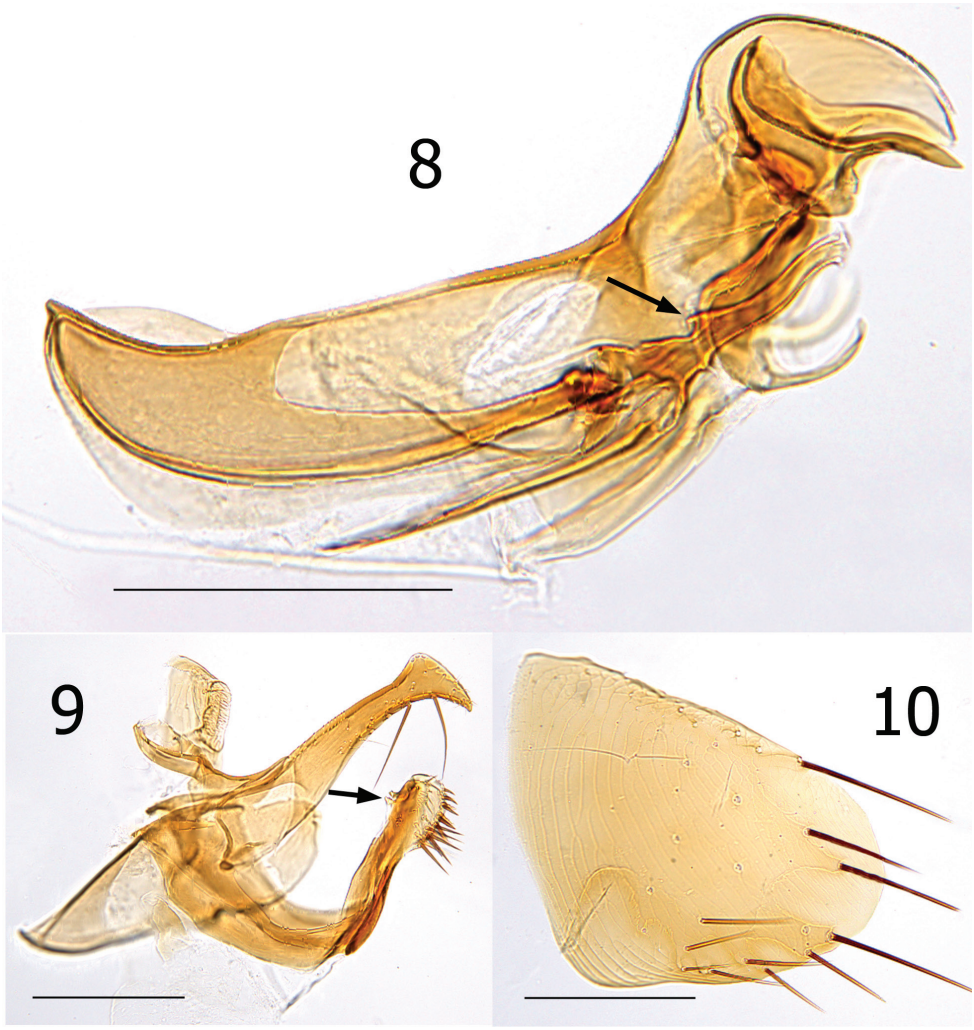
Diagnosis. Female unknown. Male easily distinguished from all species except *Lentistivalius aestivalis* by the presence of a prominent spur along dorsal margin at base of sclerotized inner tube (Fig. 8). Further distinguished from *L. aestivalis* by the narrow width of the distal half of the crochet (Fig. 8); width does not exceed width of sclerotized inner tube in the new species whereas it does in *L. aestivalis*. Other distinguishing features include the shapes of the distal arm of S-IX, crochet, and Ford's sclerite (Figs 8–9).

Description. Numbers of setae described indicate only one side unless otherwise stated. Head (Figs 4, 6). Frons smoothly rounded; punctate area extensive anterior to frontal row of six moderately heavy setae. Ocular and genal rows: three setae each. Seven supernumerary setae between frontal row and ocular row. Two labral setae. Four minute setae line ventral rim of antennal fossa anterior to eye. Maxillary palpus extends to mid coxa; labial palpus of five segments (excluding basal segment); apical segment longest. Labial palpus extending ¾ length of forecoxa. Darkly pigmented eye contiguous with genal margin; with ventral sinus. Post-antennal area with four rows setae (3, 4, 1, 5 + intercalaries). Numerous setulae along antennal fossa. Four lateral setae on scape; four short apical setae on pedicel. Clavus not extending beyond caudal margin of head. Thorax (Figs 4, 5). Pronotum with 18 ctenidia (both sides); each outside tooth much smaller than others. Longest ctenidia twice length pronotum, about equal vertical length pronotum; each tooth divergent, curved dorsally. Two rows setae; anterior row with two setae. Meso- and metanota each with three rows setae. Metanotum with single sharp hyaline spine at ventrocaudal margin. Prosternosome without notch for 1st link-plate;



Figures 4–7. *Lentistivalius philippinensis* sp. n. (P2316) **4** Overview, male holotype **5** Thorax **6** Head, pronotum, forecoxa **7** Abdominal tergites. (Scale: Fig. **4** = 100 μ; Figs **5–7** = 200μ).

not extended ventrally on ventral margin. Mesosternum reduced; extending ventrally between coxae as triangular projection. Mesepisternum with three setae; mesepimeron with six setae, single posterior seta largest. Pleural rod, bifurcate dorsally. Metasternum



Figures 8–10. *Lentistivalius philippinensis* sp. n., male paratype (P2211). **8** Aedeagus **9** Tergum IX and Sternum IX **10** Sternum VIII. (Scale: 200μ).

rounded; metepisternum with single large seta and single minute seta. Squamulum long, narrow. Pleural arch well developed; pleural ridge more robust dorsally. Well defined suture between lateral metanotal area and metepisternum. Metepimeron with three vertical rows setae (3, 4, 3), all below level pointed spiracular atrium; posterior setae longest. Legs (Figs 12–15). Forecoxa heavily adorned with setae. Anterior margins meso- and metacoxae with numerous setae along lower two thirds. Oblique lateral sulcus of mesocoxa complete. Two setae each guarding femorotibial joints of all three tibiae; outer short, spiniform, inner seta many times longer. Lateral surface of hind femur with coarse horizontal parallel sculpturing; mesal surface with broader vertical parallel sculpturing (perpendicular to longitudinal axis of femur). First tarsal segment of foreleg with unique

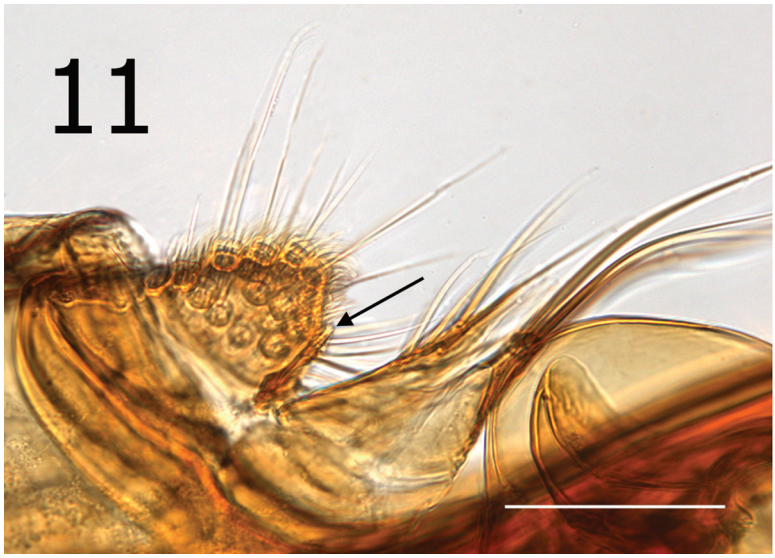
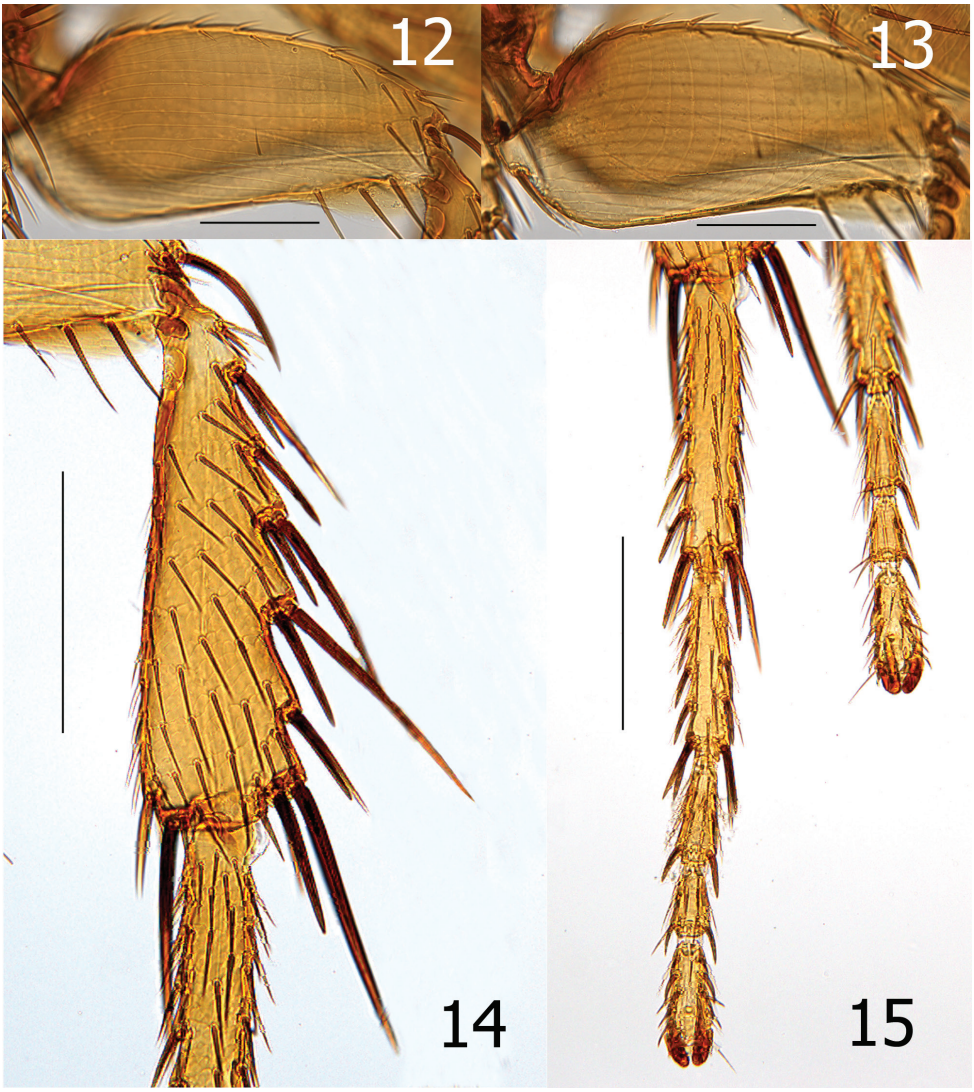


Figure 11. *Lentistivalius philippinensis* sp. n., male holotype (P2316). Sensilium, dorsal and ventral anal lobes, and subsensilial sclerite (arrow). (Scale: 100μ).

set of three long setae along posterior margin. Tarsal segments 1-4 each leg progressively shorter (proximal to distal) than preceding segment. First tarsal segment hind leg nearly as long as segments 2–4. Dorsal margins all tibia with seven notches; setae per notch metatibia (2, 2, 1, 2, 2, 1, 3). Lateral surface metatibia covered with usual setae; none enlarged or shifted towards dorsal notches. Six lateral plantar bristles each distitarsus. Fifth segment of fore and mid distitarsi with four spiniform preapical plantar bristles; hind distitarsus with two small preapical plantar bristles. Three proximal lateral plantar bristles more robust than distal three pairs; third and fourth at same level, third inside and fourth outside. Unmodified Abdominal Segments (Figs 4, 7). Tergites I-VII with three rows setae; anterior row one to two setae. Terga II-V with single apical pigmented spinelet. Two antesensilial bristles; lateral twice length of mesal. Sternum II, three ventral setae; single small seta near rod-like fourth link-plate. Dorsocephalic margin S-II heavily sclerotized; incrassation at fourth link-plate. Sterna III-VII with four setae main row; 5–12 scattered setae preceding main rows. Modified Abdominal Segments (Figs 4, 8–10). Tergum VIII reduced, with two small dorsal setae; spiracle VIII large, equal to convex sensilium. Subsensilial sclerite present; bearing two setae. Sternum VIII largely covering T-IX, S-IX, and aedeagus; numerous setae on apical two thirds. Proximal arm of S-IX apically broad and blunt, fused with manubrium. Distal arm of S-IX strongly sclerotized along ventral margin; apex expanded, club-like. Club with small lateral patch of setulae; oblique line of eight setae (distal six fine, proximal two long, pigmented), ventroapical margin with six setae (distal four short, spiniform, proximal two long, all darkly pigmented). Lacking apical lobe; subapical lobe present on anterior margin. Terminal portion of basimere of T-IX bilobed; L1 modified long extension of apodeme of T-IX paralleling telomere and L2 large rounded lobe bearing two acetabular bristles (ventral short and dorsal long).



Figures 12–15. 12–13 *Lentistivalius philippinensis* sp. n., male paratype (P2211). **12** Lateral of hind femur, longitudinal parallel sculpturing **13** Mesal view of hind femur, vertical parallel sculpturing. **14–15** *Lentistivalius philippinensis*, sp. n., male holotype (P2316) **14** Hind tibia **15** Hind tarsi. (Scale: Figs **12–13** = 100μ; Figs **14–15** = 200μ)

Telomere narrows from proximal to stiva; stiva expanded dorsoapical angle forming a near right angle. Four long setae on ventral margin of stiva. Fulcral sclerite truncate; very developed. Aedeagus (Fig. 8). Aedeagal apodeme broad, upturned apically. Dorsal margin with thick sclerotization preceding arched median dorsal lobe. Crescent sclerite small, capsule small, satellite sclerite thin, short. Y sclerite reduced. Penis rods thick, short; not reaching end of aedeagal apodeme. Virga ventralis short, thick; half length of aedeagal apodeme. Sclerotized inner tube undulate; prominent dorsal spur at base.

Ventral armature absent. Crochet broad at base, abruptly narrowing, scythe-like. Phylax thick, sclerotized. Alpha portion of Ford's sclerite massive; securifer sharp, hook-like. Tendon of phylax and Ford's sclerite visible.

Etymology. The new species bears the name of the country from which it was collected.

Remarks. Seven species of *Lentistivalius* are currently recognized (including this new species). *Lentistivalius* is primarily a parasite of Southeast Asian murids and soricids, although one species (*Lentistivalius insolli*) is definitively a bird parasite documented from 18 different species of birds (Hastriter and Bush 2010). A total of 59 *C. grayi* was examined and only two harbored this new species (one flea on each). This flea may occur in greater numbers in months other than May. Additional collecting from *Crocidura grayi* (and other members of Soricidae) at other times of the year (April through August) is needed to discover the undescribed female sex of *L. philippinensis* and better define the host and seasonal preferences of this new species.

Key to species in the Genus *Lentistivalius*

l	Pronotum with one row of setae	**2**
1'	Pronotum with two rows of setae (anterior row may only be comprised of one or two small setae dorsally)	**7**
2(1)	Males	**3**
2'	Females	**5**
3(2)	Spiniform setae on ventroapical margin of the distal arm of S-IX appear grouped in a dense patch (India, Nepal, Sri Lanka)	***ferinus***
3'	Spiniform setae dispersed evenly in a row	**4**
4(3')	Ventroapical margin of distal arm of S-IX flat in lateral aspect (Tanzania, Zaire)	***alienus***
4'	Ventroapical margin convexly rounded (China)	***occidentayunnanus***
5(2')	Middle lobe on caudal margin of S-VII large and acutely triangular (China)	***occidentayunnanus***
5'	Middle lobe smaller and not acutely triangular	**6**
6(5')	Caudal margin of S-VII with strongly lobed ventral lobe; several setae on lobe (India, Nepal, Sri Lanka)	***ferinus***
6'	Lobe weakly indicated; setae clearly not present on weak lobe (Tanzania, Zaire)	***alienus***
7(1')	Males	**8**
7'	Females (females of *philippinensis* unknown)	**11**
8(7)	Combination of a substantial spur at the base and dorsal surface of the sclerotized inner tube (s.i.t.) and the width of the distal half of the crochet no wider than the width of the s.i.t. (Luzon, Philippines)	***philippinensis* sp. n.**
8'	Sclerotized inner tube with, or without spur; if spur is present, distal half of crochet is distinctly wider than s.i.t.	**9**

9(8') Stiva of telomere with an angular bulge (near right angle) at dorsoapical angle; not rounded as usual (Japan) ..... ***aestivalis***
9' Stiva without angular bulge; evenly rounded..... **10**
10(9') Pronotal ctenidia arranged close together and not noticeably reflexed upward towards their apices (Malaysia, Vietnam) ..... ***insolli***
10' Pronotal ctenidia separated slightly; diverging towards apices (Borneo)... ***vomerus***
11(7') Caudal margin of S-VII without distinct sinus (Malaysia, Vietnam) ... ***insolli***
11' Caudal margin of S-VII with deep sinus (as deep as wide) **12**
12(11') Undulate dorsal lobe on caudal margin of S-VII with single subtending sinus (Borneo) ..... ***vomerus***
12' Dorsal lobe subtended by two sinuses, each separated by a lobe (Japan)..... ..... ***aestivalis***

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We thank N. Antoque, J. A. Cantil, K. Dittmar, S. Knutie, V. Tkach, S. Villa, and J. Esselstyn for assistance in collecting specimens used in this study. We also express our appreciation to J. Esselstyn for providing crucially important mammal identifications. To Scott Villa we are indebted for his permission to use the parasitized bat wing images that he photographed on-site. This study was partially funded by NSF 0743491, Biotic Survey & Inventories to R. Brown, S. E. Bush, D. H. Clayton, and R. G. Moyle.

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RESEARCH ARTICLE

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A key to the Mexican and Central America Genera of Anthonomini (Curculionidae, Curculioninae)

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Abstract

Presently the only keys available for identification of genera of Anthonomini are limited to those of the United States of America and Canada. A dichotomous key is presented to identify all genera of Mexican and Central American Anthonomini. Previous keys do not include the genera *Achia*, *Botanebius*, *Loncophorus*, *Loncophorellus* and *Melexerus*. A brief synopsis is given for each genus and photographs of representative species are included.

Keywords

Coleoptera, Curculionidae, Weevils, dichotomous key

Introduction

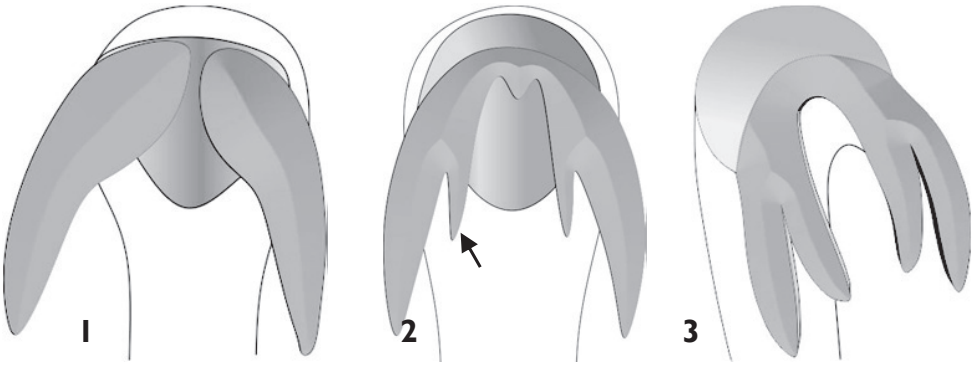
The family Curculionidae of Mexico and Central America is rich in species (Anderson and O'Brien 1996). Although general keys to the subfamilies of Curculionidae are available (Morrone 2000, Anderson 2002, Marvaldi and Lanteri 2005), the absence of regional keys to genera limit the study of Curculionidae in Mexico and Central America (Anderson and O'Brien 1996). Identification of some genera of weevils is possible through the use of the Biologia Centrali-Americana (Sharp and Champion 1911, Champion 1903, 1910) and by using keys for the United States of America and Canada (Kissinger 1964, Anderson 2002); however, material in the Biologia Centrali-

Americana is notably outdated, keys are not always presented, and the North American keys do not include a significant portion of the Mexico and Central American genera, moreover, the taxonomic status of some genera has changed and new genera have been described and recorded for the region.

Anthonomini is a tribe within the subfamily Curculioninae of the Curculionidae (*sensu* Alonso-Zarazaga and Lyal 1999). The tribe is one of the most diverse and complex of the family containing more than 800 described species within 43 genera, 24 of which are from the New World and 17 of these from México and Central America (Alonso-Zarazaga and Lyal 1999). The following characters will aid in placing species in this tribe collected in Mexico and Central America: rostrum free, not received into ventral channel, more or less cylindrical in cross section (Figs 18–24), longer than pronotum; antenna with scape not or just reaching the anterior margin of the eye; eyes nearly round; pronotum wider than long, narrowed in front, lacking postocular lobes (Figs 31–32); mesepimeron not ascended and not visible in dorsal view; elytral variable, generally wider at the base than the pronotum (Figs 27 and 29), striae punctured; pygidium covered by elytra; anterior coxae more or less equidistant from anterior and posterior margins of prosternum; sutures of abdominal ventrites straight and deep, except the first, which is less deeply impressed; tibia with a tooth at apex, usually larger on pro- and mesotibia; tarsi with claws free at base and with basal process or tooth (simple in *Epimechus* and *Brachyogmus* (Fig. 1)) (Dietz 1891, Kissinger 1964, Burke 1976 and Anderson 2002). Several species of Anthonomini are superficially similar to *Smicronyx* (Smicronychini), *Phyllotrox* (Derelomini) or *Tychius* (Tychiini). These taxa can be distinguished from Anthonomini by the following combination of characters: *Smicronyx* have claws connate at base and pronotum with postocular lobes. *Phyllotrox*, femur with ventral margin simple, lacking tooth; procoxae closer to posterior margin than to anterior margin of prosternum. *Tychius*, suture between ventrites 2 and 3 markedly extended posterolaterally, reaching or passing suture between ventrites 3 and 4 (Tanner 1966 and Kissinger 1964).

The host plants or plant associates of Anthonomini represent more than 35 families, including many species of agricultural importance. Two of the best-known pest species are the cotton boll weevil *Anthonomus grandis* Boheman and the pepper weevil *Anthonomus eugenii* Cano; *Anthonomus grandis* is a widespread and well-known pest of cotton. *Anthonomus eugenii* is widely distributed in the Southeastern United States, Hawaii, Mexico, Central America and the Caribbean. It feeds and develops in several species of Solanaceae but is better known as a pest of peppers, *Capsicum* spp. (Clark and Burke 1996). Other pest anthonomine include: *Anthonomus signatus* (strawberry weevil), *A. nigrinus* (potato weevil), *A. musculus* (cranberry weevil), *A. pomorum* (apple blossom weevil) *A. pyri* (pear weevil), *A. fulvipes* (cherry weevil), *A. quadrigibbus* (apple curculio), and *Pseudanthonomus validus* (currant fruit weevil), (Ahmad and Burke 1972, Burke 1976, Clark and Burke 1996, Clark 1987b and Muñiz 2001).

The objective of the key presented here is to allow identification of genera of this tribe in Mexico and Central America.



Figures 1–3. Tarsal claws of Anthonomini species: **1** simple tarsal claws **2** tarsal claws with an acute tooth **3** tarsal claws with a stout tooth.

Methods

A list of genera of Anthonomini reported in Mexico and Central America was compiled from the following works: Champion (1903, 1910), Dietz (1891), Kissinger (1964), O'Brien and Wibmer (1982, 1984a, 1984b), Alonso-Zarazaga and Lyal (1999), Anderson (2002). The original description of each genus was consulted and a data matrix constructed of morphological characters.

Specimens of 1,529 adults of the tribe Anthonomini were examined from collections of the following institutions: Instituto de Ecología, A.C, Xalapa, Veracruz, Mexico. (IEXA), Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Mexico (UAQE), Universidad Autonoma Agraria Antonio Narro, Saltillo, Coahuila, México (UAAAN), Texas A&M University Insects Collection, College Station, Texas, U.S.A. (TAMUIC).

Images of specimens of each genus were captured with the aid of a stereoscopic microscope and digital camera and processed using COMBINEZP software (Hadley 2010). PHOTOSHOP CS3® or CORELDRAW® software programs were used to highlight or draw characters cited in the key. A synopsis of each genus is provided giving: generic name, author and recorded year, total species for New World, number of species occurring in Mexico and Central America, distributions, family placement of associated plants, and bibliographic references to identify species.

Key to genera of Anthonomini occurring in Mexico and Central America

1 Tarsal claw simple, without basal process or tooth (Fig. 1)..... **2**
– Tarsal claw with basal process or tooth (Figs 2 and 3)..... **3**
2 Lateral rostral groove defined near eye (Fig. 22); elytra in lateral view rounded from middle to apex (Figs 48 and 49); metafemur lacking tooth.... ***Epimechus***

– Lateral rostral groove not defined near eye (Fig. 20); elytra sloped slowly from middle to apex (Fig. 41); metafemur with a ventral tooth ..... ***Brachyogmus***

3 Procoxae separated by process of the prosternum; mesocoxae separated by a distance nearly equal to width of one coxa (Fig. 4); antennal funiculus with 6 articles (Fig. 42) ..... ***Huaca***

– Procoxae contiguous (Fig. 6), if separated then profemur with a large and triangular tooth (Fig.17); mesocoxae separated by a distance less than width of one coxa; antennal funiculus with 5,6 or 7 articles **4**

4 Mesocoxae narrowly separated by distance less than 0.2× the width of one mesocoxa (Fig.5); tarsal claw with an acute tooth arising from inner margin slightly distal of base (Figs 2 and 54) ..... ***Madgalinops***

– Mesocoxae widely separated by distance more than 0.2× the width of one mesocoxa; tarsal claw with a stout tooth arising from base of claw (Figs 3 and 6) **5**

5 Rostrum short and moderately stout, equal to or slightly shorter than length of pronotum; elytra, base of interval 3 swollen and toothed; profemur with tooth moderately large (Figs 17, 59 and 60) ..... ***Smicraulax***

– Rostrum slender and longer than length of pronotum (Fig. 19); elytra, interval 3 not swollen and toothed; profemur with ventral tooth various (Figs 11–13) **6**

6 Antennal funiculus with 5 articles; antennal club with basal article glossy, almost glabrous; femur lacking tooth or with a single minute ventral tooth (Fig. 57) ..... ***Neomastix***

– Antennal funiculus with 6 or 7 articles; antennal club various; femur with a small or large ventral tooth (Figs 13–16) **7**

7 Lateral rostral groove with the dorsal margin directed toward ventral margin of eye and the ventral margin directed toward ventral margin of rostrum (Fig. 24) **8**

– Lateral rostral groove directed toward middle of eye (Fig. 19) **11**

8 Antennal funiculus with 7 articles; profemur with a large and triangular ventral tooth, base of tooth equal to width of the protibia; protibia stoutly expanded on inner margin at midpoint (Figs 14, 43 and 44)..... ***Cionomimus***

– Antennal funiculus with 6 articles; profemur with a small ventral tooth, base of tooth less than width of the protibia; protibia only slightly expanded or if expanded, not at midpoint (Fig.13) **9**

9 Pronotum and elytra humpbacked; profemoral tooth curved toward the tibia (Fig. 13); dense and decumbent hair-like scales throughout body and anterior 2/3 of rostrum (Fig. 40) ..... ***Botanebius***

– Pronotum and elytra not humpbacked; profemur with triangular tooth not curved; body and rostrum vestiture various (Figs 55 and 58) **10**

10 Pronotum, elytra and legs densely clothed with scales, intermixed with distinct semierect to erect scattered scales; profemoral tooth smaller than a tarsal claw; metafemur lacking tooth (Fig. 55) ..... ***Melexerus***

– Pronotum, elytra and legs usually with decumbent scales; profemoral tooth nearly equal in length to a tarsal claw; metafemur with a ventral tooth (Fig. 58)..... ***Pseudanthonomus***

11 Profemur expanded, *ca*. 2× stouter than metafemur (Figs 10 and 15); mesocoxae narrowly separated by distance *ca*. ¼ width of one coxa (Fig. 6)..... **12**

– Profemur expanded by less than 2× width of metafemur (Figs 11, 12 and 16); mesocoxae separated by distance more than ¼ width of one coxa **13**

12 Head strongly constricted behind eyes (Fig. 18); eyes prominent, strongly convex; body densely covered with broad to elongate hair-like scales; dark rounded or triangular patch present on disc of elytra at base (Figs 25–27) ..... ***Achia***

– Head subconical, slightly constricted behind eyes (Fig. 21); eyes slightly to moderately convex; vestiture of dense, elongate scales which may be intermixed with semierect, erect or recumbent scales; dark subtriangular patch of scales on each elytron past middle (Figs 45–47) ..... ***Cionopsis***

13 Pro- and mesofemur with an anterior emargination (Figs 9 and 16); profemoral tooth slightly serrate distal to the emargination; elytral disk and declivital area covered by dense, pallid scales (Figs 52 and 53); mesotrochanters trapezoidal (Fig. 7)..... ***Loncophorus***

– Pro- and mesofemur lacking emargination, if present, profemoral tooth not serrate and protibia curved (Fig. 11); elytra various (Figs 28–39); mesotrochanter triangular (Fig. 8) (*Anthonomus* subgenus *Anthonomorphus* males have a trapezoidal shaped mesotrochanter)..... **14**

14 Rostrum densely covered with broad scales to near apex (Fig. 23); eyes small, diameter of each eye nearly equal to width of rostrum at base, slightly or strongly free behind (Fig. 56)..... ***Narberdia***

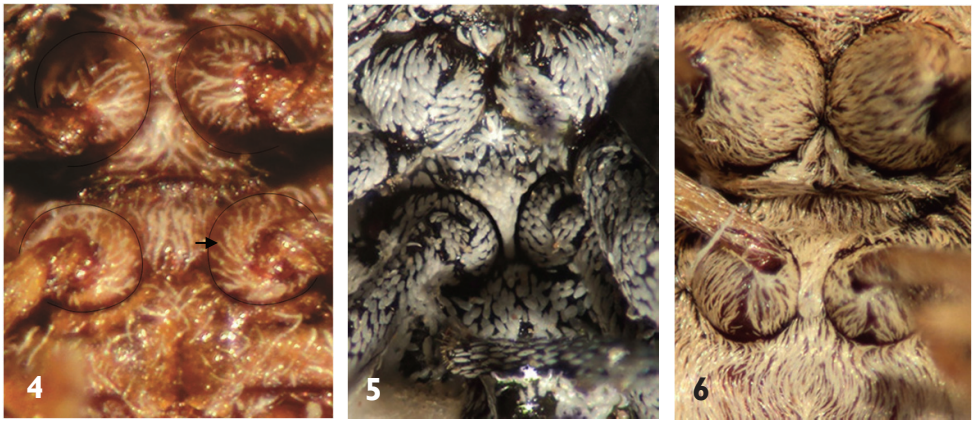
– Rostrum with scales limited to basal half of length; eyes moderately large, diameter slightly or much greater than rostrum at base..... **15**

15 Body with smooth and shining integument with scattered, narrow, white scales; posteromedian sides of pronotum straight; elytra strongly convex dorsomedially or posteromedially, sides convergent to apices (Figs 50 and 51)... ..... ***Lonchophorellus***

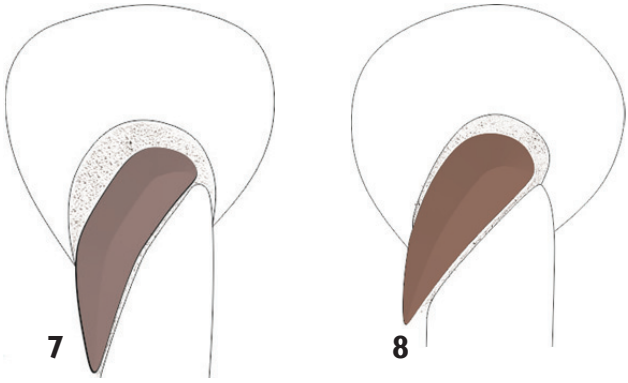
– Body vestiture and shape variable; posteromedian sides of pronotum curved; elytra not strongly convex and apical sides rounded (Figs 28–39) **16**

16 Elytra usually with a transverse basal patch of black scales (Figs 36, 37 and 39); subbasal, anteromedian or posteromedian elevation on even-numbered interstriae usually well-developed; profemur strongly expanded 1.5× wider than metafemur; protibia curved, apical half of inner margin expanded and carinate (Figs 12, 35–39) ..... ***Atractomerus***

– Elytra lacking a transverse basal patch of black scales (Figs 29 and 33); elytral elevation if present limited to odd-numbered interstriae; profemur if 1.5× wider than metafemur then, profemoral tooth usually with shallow to deep anterior emargination (Fig. 11); protibia usually straight and inner margin various (Figs 28–34) ..... ***Anthonomus***



Figures 4–6. Pro- and mesocoxae (➝) of Anthonomini species: **4** *Huaca mudca* **5** *Magdalinops vittipennis* **6** *Achia rhombifera*.



Figures 7–8. Mesotrochanter shape of two Anthonomini genera: **7** Trapezoidal, *Loncophorus* sp. **8** Triangular, *Anthonomus* sp.

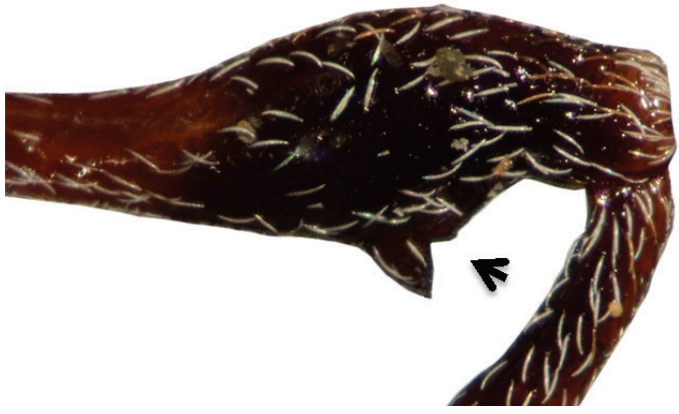
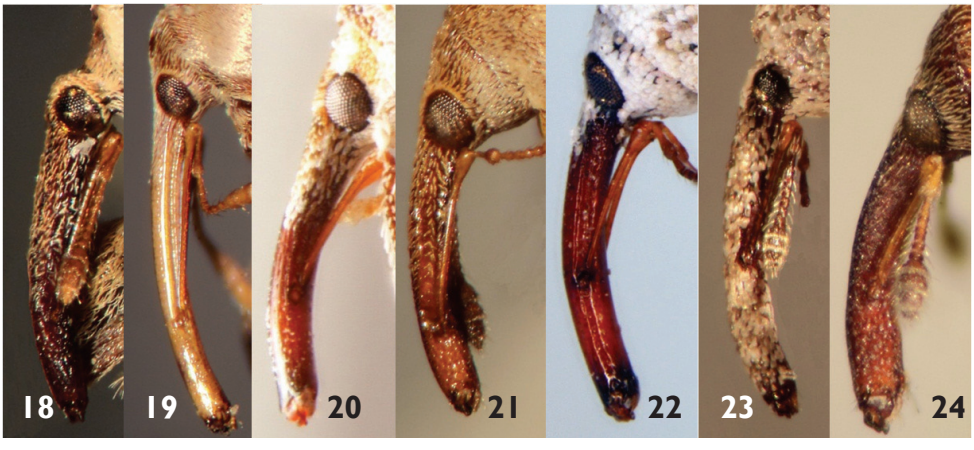
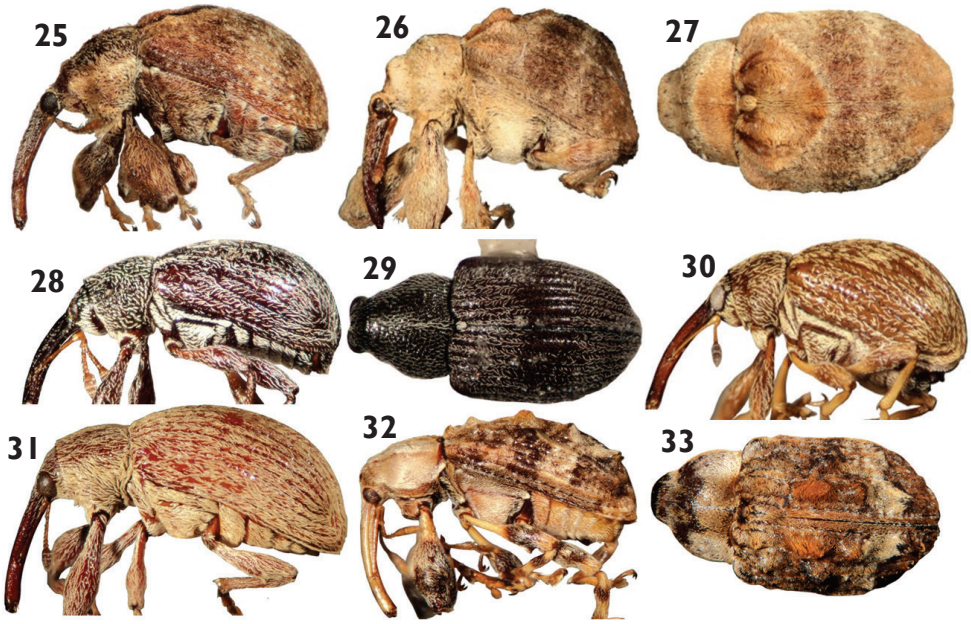


Figure 9. Mesofemoral tooth with an acute emargination, *Loncophorus pustulatus*.

Figures 10–17. Profemora and protibiae of Anthonomini species: **10** *Achia rhombifera* **11** *Anthonomus flavirostris* **12** *Atractomerus nigrocalcaratus* **13** *Botanebius gibbosus* **14** *Cionomimus brevis* **15** *Cionopsis lineolata* **16** *Loncophorus crossi* **17** *Smicraulax nigrinus*.



Figures 18–24. Rostra of Anthonomini species: **18** *Achia rhombifera* **19** *Anthonomus flavirostris* **20** *Brachyogmus ornatus* **21** *Cionopsis lineolata* **22** *Epimechus flavirostris* **23** *Narberdia aridulus* **24** *Pseudanthonomus helvolus*.



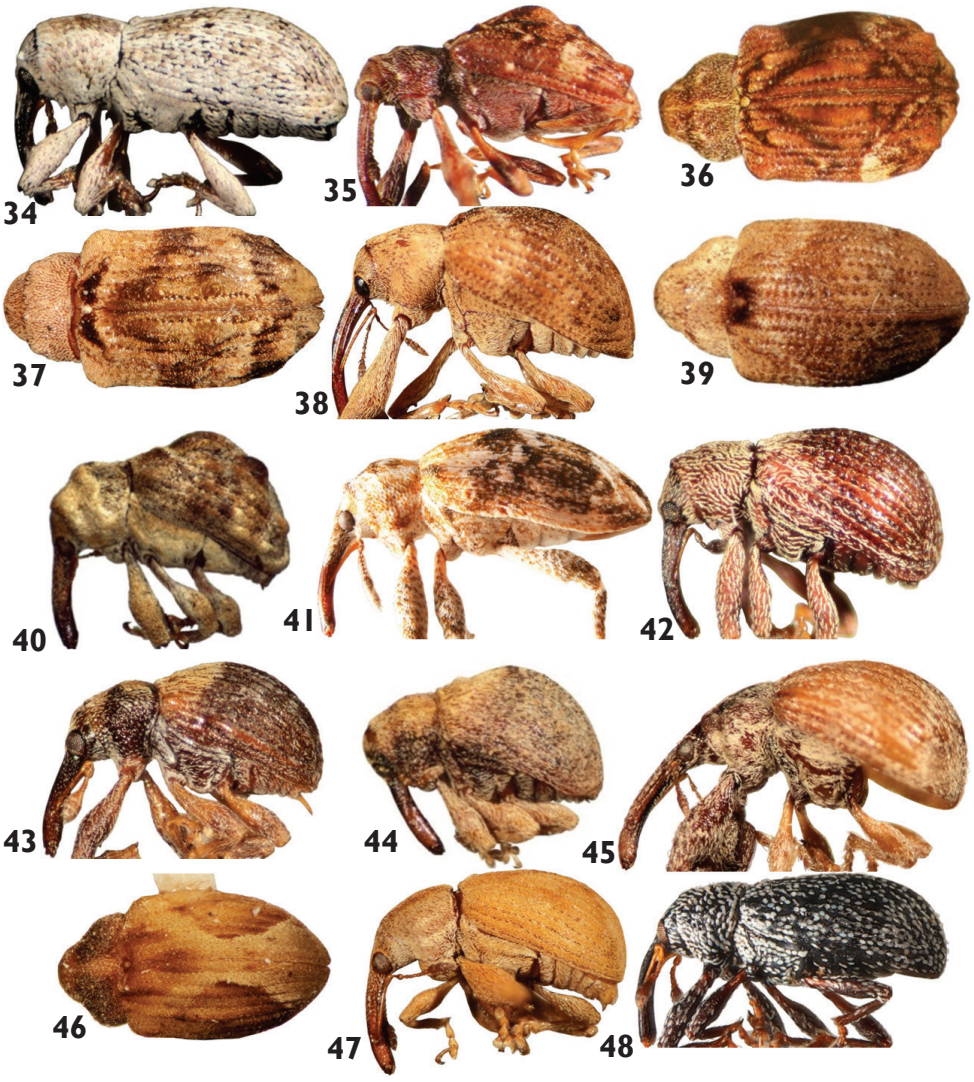
Figures 25–33. Anthonomini species: **25** *Achia serjaniae* **26** and **27** *Achia rhombifera* **28** *Anthonomus aeneolus* **29** *Anthonomus abdominalis* **30** *Anthonomus eugenii* **31** *Anthonomus grandis* **32** and **33** *Anthonomus flavirostris*.

Discussion

The tribe Anthonomini (*sensu* Alonso-Zarazaga and Lyal 1999) was reviewed and delimited by Burke (1976) who considered the systematics of the taxon to be in a "chaotic" state at the tribal and lower levels. From 1976 to the present, Horace R. Burke and Wayne E. Clark have conducted revisionary taxonomic studies on many of the New World genera and species. These taxonomic publications have greatly advanced the systematics of Anthonomini for the region, although much still remains to be resolved within the tribe, especially within the genus *Anthonomus* as there are currently no keys to the various species groups recognized in the studies of Clark. The key presented here allows for the identification of the genera of the tribe reported from Mexico and Central America. Some genera can easily be either recognized by characters or combinations of characters, such as: *Brachyogmus*, *Magdalinops*, *Narberdia*, *Smicraulax* and *Huaca;* however, the intergeneric relationships of several of the species of *Anthonomus, Atractomerus, Loncophorus* and *Lonchophorellus* are not so clearly delimited and may be harder to separate.

Synopsis of Genera list of Mexican and Central America Anthonomini

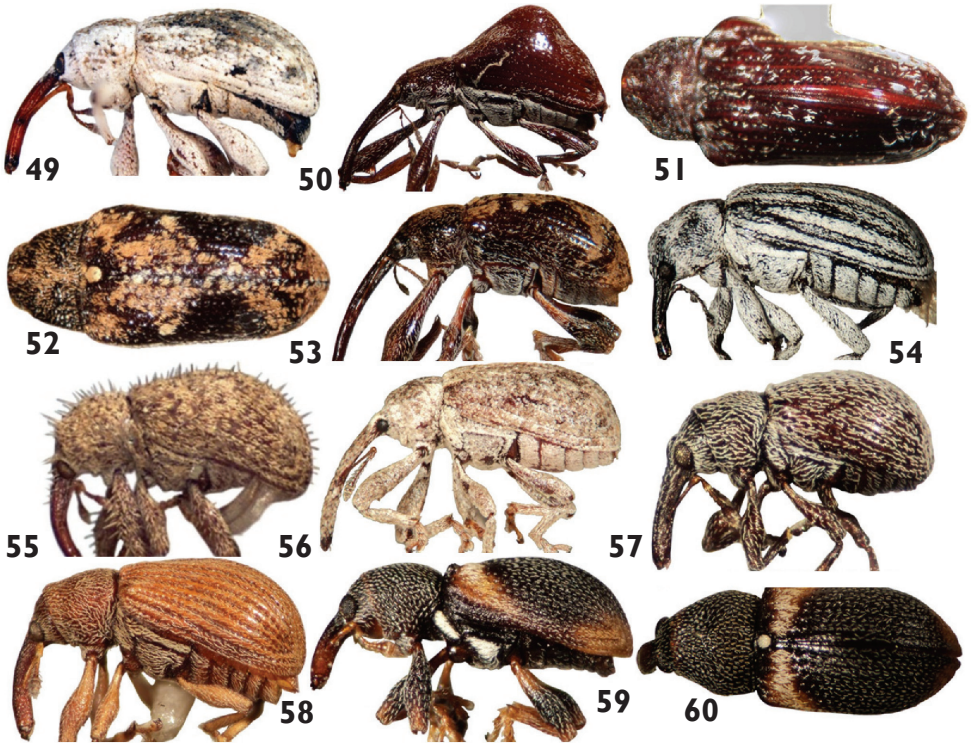
Achia Champion, 1903. New World species 19, with 6 species from Mexico and Central America. Distribution: Bolivia, Brazil, Honduras, Mexico and Panama. States



Figures 34–48. Anthonomini species: **34** *Anthonomus* (*Cnemocillus*) *tenuis* **35** and **36** *Atractomerus albolateralis* **37** *Atractomerus recessus* **38** and **39** *Atractomerus indicivus* **40** *Botanebius gibbosus* **41** *Brachyogmus ornatus* **42** *Huaca mayu* **43** *Cionomimus championi* **44** *Cionomimus insolens* **45** *Cionopsis crispula* **46** *Cionopsis maculata* **47** *Cionopsis lineolata* **48** *Epimechus hesperius*.

of Mexico: Chiapas, Mexico, Guerrero, Michoacan, Morelos, Nayarit, Oaxaca, San Luis Potosí, Tamaulipas and Veracruz. Families of associated plants include: Sapindaceae, Mimosoideae, Lauraceae, Bromeliaceae. See Burke and Kovarik (1986) and Clark et al. (2007) to separate species.

Anthonomus Germar, 1817. New World species 491, with 172 species from Mexico and Central America. Distribution: worldwide in all geographical regions



Figures 49–60. Anthonomini species: **49** *Epimechus flavirostris* **50** *Lonchophorellus scyla* **51** *Lonchophorellus callosus* **52** *Loncophorus crossi* **53** *Loncophorus pustulatus* **54** *Magdalinops vittipennis* **55** *Melexerus hispidus* **56** *Narberdia aridulus* **57** *Neomastix spatium* **58** *Pseudanthonomus helvolus* **59** and **60** *Smicraulax tuberculatus*.

except Antarctica. Associated plant families include: Asteraceae, Combretaceae, Cupressaceae, Euphorbiaceae, Fabaceae, Juglandaceae, Kramericeae, Malpighiaceae, Malvaceae, Myrtaceae, Rosaceae, Rutaceae, Rhizophoraceae, Sapindaceae, Solanaceae and Vitaceae. See Burke1962, 1964, 1979, 1984, Burke and Cate 1979, Clark 1987a, 1987c, 1987d, 1988a, 1988b, 1989b, 1990a,1990b, 1990c, 1990d, 1991a, 1991b, 1991c, 1992a, 1992b, 1993b, 1993c, 1993d, 1994, Clark and Burke 1985, 1986a, 1986b, 1996, 2005 and Jones and Burke 1997 to separate species.

Atractomerus Duponchel and Chevrolat ,1849. New World species 45, with 17 species from Mexico and Central America. Distribution: Bolivia, Brazil, French Guyana, Costa Rica, Guatemala, Mexico and Panamá; states of Mexico: Chiapas, Mexico, San Luis Potosí, Tabasco, Tamaulipas and Veracruz. Associated plant families include: Myrtaceae and Melastomataceae. See Clark (1989c) to separate species.

Botanebius Schoenherr, 1836. New World species 2, with 1 species from Mexico and Central America. Distribution: Colombia, Venezuela, Cuba, Belize, Honduras, Mexico and Panama; states of Mexico: Chiapas. Associated plant is unknown.

Brachyogmus Linell 1897. New World species 1, monotypic genus, *B. ornatus* Linell 1897. Distribution: United States of America and Mexico; states of Mexico: Sonora. The species has been associated with Solanaceae Burke (1968).

Cionomimus Marshall, 1939. New World species 11, with 9 species from Mexico and Central America. Distribution: Colombia, Venezuela, Guatemala, Mexico and Panama; states of Mexico: Baja California, Coahuila, Chihuahua, Chiapas, Durango, Guerrero, Hidalgo, Jalisco, Michoacán, Querétaro, Oaxaca, Nuevo León and Veracruz. Species have been associated with Santalaceae. See Burke (1981a) and Anderson (1994) to separate species.

Cionopsis Champion, 1903. New World species 5, with 3 species from Mexico and Central America. Distribution: Venezuela, Guatemala, Mexico, Panama; states of Mexico: Chiapas, Guerrero, Jalisco, Morelos, Sinaloa and Veracruz. Species have been associated with Sapindaceae. See Burke (1981b) to separate species.

Epimechus Dietz, 1891. New World species 11, with 7 species from Mexico. Distribution: United States of America and Mexico; States of Mexico: Baja California Coahuila, Durango, Oaxaca, Michoacan, Nayarit and Nuevo Leon. Species have been associated with Asteraceae. See Clark and Burke (2001) to separate species.

Huaca Clark, 1993**.** New World species 26, with 11 species from Mexico and Central America**.** Distribution: United States of America (Florida), Belize, Costa Rica, Cuba, Dominica, Honduras, Jamaica, Mexico, Panamá, Puerto Rico, Saint Christopher, Virgin Islands, Brazil, Trinidad, Uruguay, Venezuela; states of Mexico: Chiapas, Oaxaca, Quintana Roo and Tamaulipas. Families of associated plants include: Malpighiaceae, Myrtaceae, Phytolaccaceae, Rhizophoraceae, Rubiaceae and Rutaceae. See Clark (1993a) to separate species.

Loncophorus Chevrolat, 1832. New World species 14, with 8 species from Mexico and Central America. Distribution: Argentina, Brazil, Colombia, Ecuador, French Guyana, Paraguay, Peru Surinam, Cuba, Costa Rica, Nicaragua, Mexico, Panama; states of Mexico: Oaxaca and Veracruz. Species have been associated with Bombacaceae. See Clark (1988c, 1995) to separate the species.

Lonchophorellus Clark, 1989. New World species 4, with 2 species from Mexico and Central America. Distribution: Bolivia, Brazil, Colombia, Ecuador, Peru, Vene-

zuela, Costa Rica, El Salvador, Guatemala, Honduras, Mexico and Panama; states of Mexico: Chiapas, Guerrero, Morelos, Puebla and Veracruz. Individuals have been associated with: Flacourtiaceae, Malpighiaceae, Myrtaceae and Sterculiaceae. See Clark (1989a) to separate species.

Magdalinops Dietz, 1891. New World species 4, with 1 species from Mexico. Distribution: United States of America and Mexico; states of Mexico: Baja California. Individuals have been associated with Asteraceae. See Clark and Burke (2002) to separate species.

Melexerus Burke, 1982. New World species 1, monotypic genus, *M. hispidus* Burke 1982. Distribution: Colombia, El Salvador, Guatemala, Jamaica, Mexico, Venezuela; states of Mexico: Mexico, Michoacan, Morelos, Nayarit, San Luis Potosí, Sinaloa and Tamaulipas. Species has been associated with Fagaceae (Burke 1982).

Narberdia Burke, 1976. New World species 1, monotypic genus, *N. aridulus* Burke 1976. Distribution: United States of America and Mexico; states of Mexico: Nuevo León. Species has been associated with Euphorbiaceae (Burke and Rector 1976).

Neomastix Dietz, 1891. New World species 10, with 4 species from Mexico and Central America. Distribution: Colombia, Brazil, Costa Rica, Cuba, El Salvador, United States of America, Guatemala, Honduras, Haiti, Island Virgin, México, Nicaragua, Puerto Rico; states of Mexico: Guerrero, Morelos, Oaxaca, Puebla, Quintana Roo, Sonora, Tamaulipas. Families of associated plants include: Asteraceae, Ericaceae, Fabaceae, Palmaceae, Sapindaceae and Sterculiaceae. See Clark (1993e) to separate species.

Pseudanthonomus Dietz, 1891. New World species 35, with 14 species from Mexico and Central America. Distribution: Canada, Costa Rica, El Salvador, United States of America, Guadeloupe, Guatemala, Mexico, Panama and Venezuela; states of Mexico: Baja California and Baja California Sur, Chiapas, Durango Guanajuato Jalisco, Nayarit, Nuevo León, Puebla, Quintana Roo, San Luis Potosí, Tabasco Tamaulipas and Veracruz. Families of associated plants include: Betulaceae, Boraginaceae, Caprifoliaceae, Ericaceae, Hamamelidaceae, Krameriaceae, Malpighiaceae, Malvaceae, Rosaceae Saxifragaceae and Verbenaceae. See Clark (1987b, 1990e) to separate species.

Smicraulax Pierce, 1908. New World species 6, 6 in Mexico and Central America. Distribution: United States of America, Guatemala, Honduras, Mexico and Panama: states of Mexico: Chiapas, Durango, Guerrero, Oaxaca and Nuevo León. Species have been associated with Santalaceae. See Burke (1975), Burke and Hafernik (1971) and Anderson (1994) to separate species.

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A description of preimaginal stages of *Pseudaspidapion botanicum* Alonso-Zarazaga & Wang, 2011 (Apionidae, Curculionoidea)

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Abstract

The preimaginal stages including egg, mature larva and pupa of *Pseudaspidapion botanicum* Alonso-Zarazaga & Wang, 2011 were described and figured, diagnostic characters of larva and pupa were discussed, and corresponding biological information was supplied. The nomenclature of frontal setae in the larva compared with curculionid weevils, the absence of the hypopharyngeal bracon in the larva, and the metafemoral setae in the pupa were discussed. Common and different characters among the larvae of *P. botanicum*, *Aspidapion radiolus* (Marsham, 1802) and *A. aeneum* (Fabricius, 1775) were also provided.

Keywords

Apionidae, *Pseudaspidapion botanicum*, larva, pupa, morphology, biology

Introduction

Pseudaspidapion botanicum Alonso-Zarazaga & Wang, 2011 belongs to the tribe Aspidapiini Alonso-Zarazaga, 1990. There are 6 species of the genus *Pseudaspidapion* Wanat, 1990 recorded from China, 2 of which are only known from female specimens, and almost all of which were described without biological information apart from *P. botanicum* (Alonso-Zarazaga et al., 2011). Additionally, no species of *Pseudaspidapion* have been previously studied for developmental stages.

The knowledge of weevil larvae is still very low compared with that of the adults because of a variety of reasons (Marvaldi 1999). Authors have sparsely referred to apionid larvae in detail (e.g., Gosik et al. 2010; Sanz Benito and Gurrea Sanz 1999; Bennett 1992; May 1994), and most of the corresponding literature has only simple descriptions or keys for identification of species or higher taxa of Curculionoidea (Emden 1938; Marvaldi 1997, 2005; May 1993). Furthermore, it is rare for authors to have elaborated on the developmental stages of species of Aspidapiini. Thus far, only *Aspidapion radiolus* (Marsham, 1802) and *Aspidapion aeneum* (Fabricius, 1775) have been mentioned in a species key by Emden (1938).

Therefore, in order to supplement to the available data of *Pseudaspiapion* for distinguishing this oriental genus from other lingeages in Aspidapiini (*Aspidapion* Schilsky, 1901, *Flavopodapion* Korotyaev, 1987 and *Harpapion* Voss, 1966) (Alonso-Zarazaga 2011), we collected larvae and pupae from the host plant and document here its preimaginal stages. Moreover, relevant biological records of *P. botanicum* were also provided.

Materials and methods

Specimens examined of larvae and pupae are deposited in the Institute of Zoology, Chinese Academy of Sciences, Beijing (IZCAS).

Descriptions were made and photographs were taken with a CCD Qimagine MicroPublisher 5.0 RTV mounted on a Zeiss SteREO Discovery. V12 microscope. Extended focus images were generated with Auto-Montage Pro 5.03.0061 and edited with Adobe Photoshop CS5 if required. Microscopic slides were studied under a Leica DM 2500 microscope and photos were taken with a Nikon CoolPix 5400. Drawings were made from the original photographs by using the software Adobe Illustrator CS5, or directly by using a drawing tube attached to the microscope.

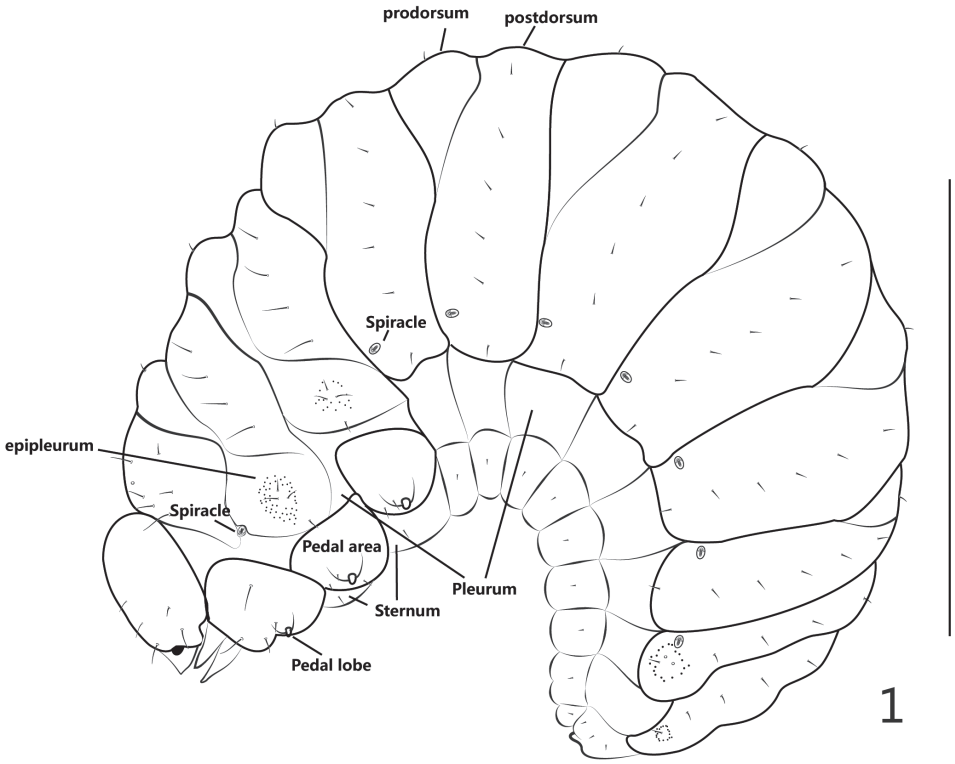
Nomenclature of the larval chaetotaxy mainly follows Marvaldi (1999) and May (1993, 1994) (some differences were pointed out in discussion below), and that of the pupa mainly follows Gosik et al. (2010). The dissecting method used follows May (1979, 1993). Indistinct structures were pigmented by "Chlorazol Black E" for further examination. After description, all structures of each individual were put into glycerin vials (1.8ml) to remain together with the adult specimens.

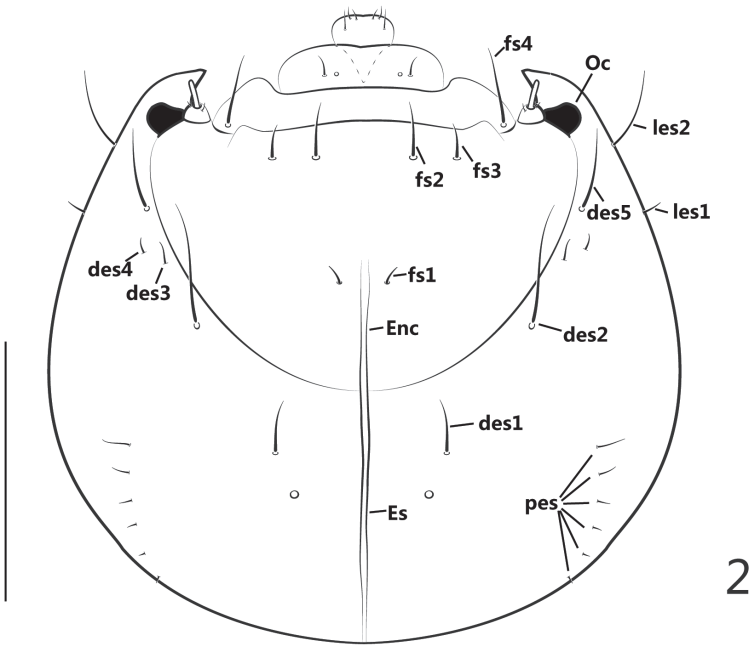
Description

Egg: round, yellowish to white, diameter ca. 0.2–0.3mm.

Mature larva: Meaurements (mm): Body length: ca. 2.0–3.0, width: ca.1.0–1.5; Capsule length (in front view): ca. 0.4–0.45, width ca. 0.4–0.44.

General appearance (Figure 1): Body plump and distinctly curved (C-shaped), with a large quantity of white fat inside, sub-cylindrical, with a comparatively small, yellowish to pale brown head; cuticle minutely spiculate, without visible



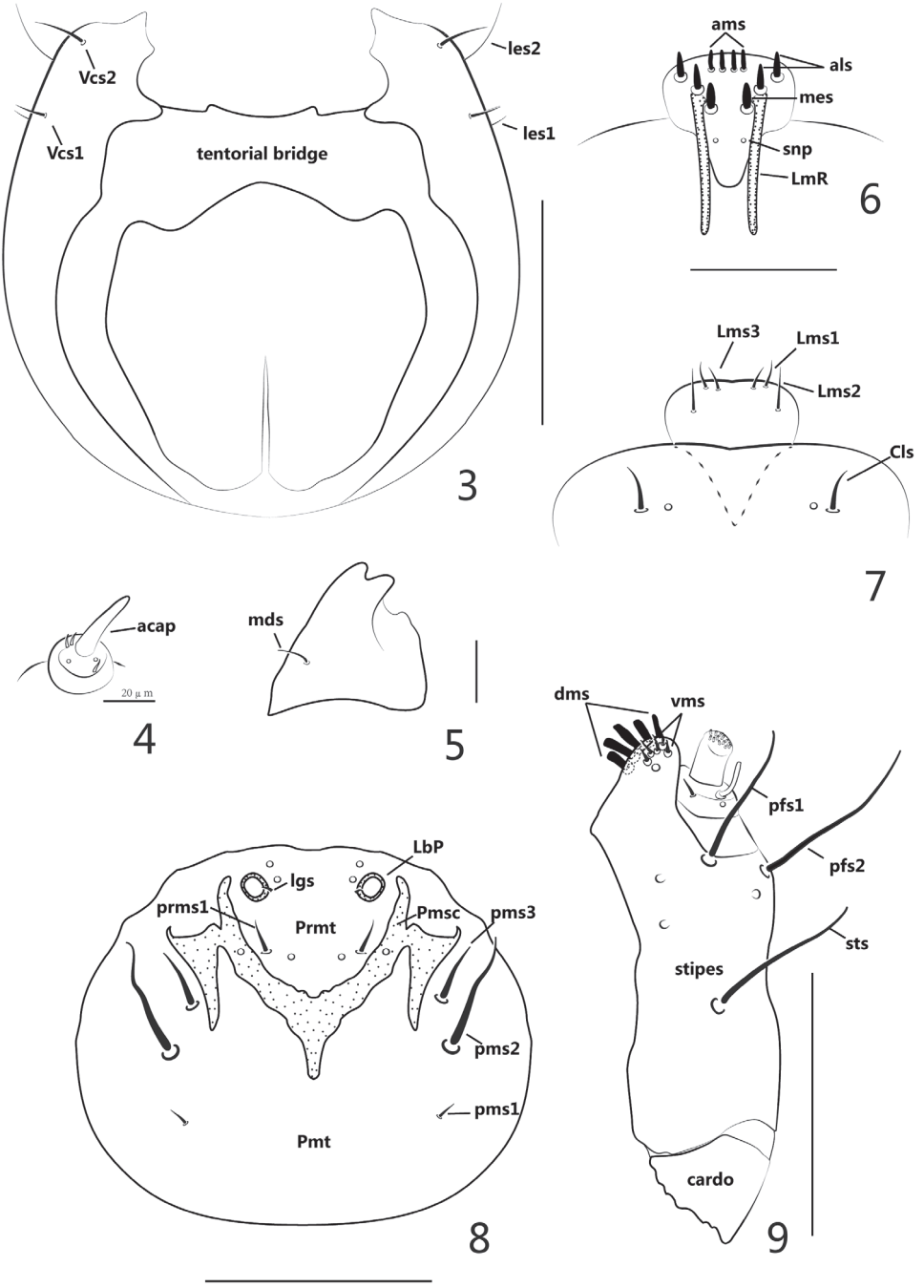


Figures 1–2. Larva. **1** mature larva, lateral view **2** head, dorsal view. Scales: **1**: 1mm. **2**: 0.2mm.

pigmented, sclerotized areas; body segments with very short setae, pedal lobes in conspicuous knobs.

Head (Figures 2–3) moderately retracted within prothorax, epicranial line distinct, undivided, wide; frontal lines distinct, narrow, completely extended to mandibular joint; endocarina short, extended to 1/2 the length of frons; epicranium with 2 pairs of lateral setae (*les*), *les1* short, *les2* long, more than 3 times longer of *les1*; dorsal epicranium with 5 pairs of setae (*des*), *des1* short, about half as long as *des2*, *des3* and *des4* much shorter, des4 a bit longer than des3, and *des5* as long as *des2*; posterior epicranium with 6 pairs of setae (*pes*), *pes1* shortest, *pes2-6* gradually longer than the former one; frons with 4 pairs of setae (*fs*), *fs1* very short, adjacent to end of epicranial line, *fs2-3* located near epistoma, nearly transversely aligned, *fs2* longer than *fs3*, *fs4* laterally positioned at epistoma close to antennae, about 1.5 × as long as *fs2*; ventral epicranium with 2 pairs of lateral setae (*Vcs*), correspondingly situated near *les*; postoccipital condyles absent, tentorial bridge wide with 2 small but moderately acute anterior projections and 2 large, obtuse-angled posterior projections; hypopharyngeal bracon absent; clypeus transverse, bearing 1 pair of setae (*cls*), inner side of *cls* bearing 1 pair of sensilla; antenna reduced to 1 article (Figure 4), with rod-like accessory sensory appendage (*acap*) more than 3x as long as wide, with 3 spinose projections and 2 sensilla; ocellus present, evidently projected, externally close to antenna.

Mouthparts (Figures 5–9): labrum (Figure 7) sub-semicircular, with 3 pairs of setae (*Lms*), *Lms1* and *Lms3* short, close to distal margin of labrum, *Lms2* distinctly longer and centrally localized; epipharynx (Figure 6) with 2 long, stout lateral rods (*LmR*) surpassing the suture between epistoma and clypeus, 2 pairs of anterolateral setae (*als*), 2 pairs of anteromedian setae (*ams*), 1 pair of median setae (*mes*), all epipharyngeal setae mentioned above stout, short and apically rounded, 1 pair of epipharyngeal sensory pores (*snp*) between pair of *LmR*; mandibles asymmetric, left mandible (when mouthparts viewed anteriorly) (Figure 5) apically bidentate, about as long as wide, cutting edge with 1 weakly prominent, rounded tooth, its laterodorsal surface with 1 mandibular seta (*mds*), without visible sensilla, right mandible with cutting edge nearly straight; labium (Figure 8) almost membranous except sclerotized area; labial palpus (*LbP*) vestigial, its apex a bit higher than surface of labium, like two big socket pores; premental sclerite (*Pmsc*) distinctly dilated, "Y" shaped, with 1 pair of sensilla, outer margins of *Pmsc* with exteneded sclerotized piece, irregularly triangular; ligulate area with 1 pair of tiny setae (*lgs*) and 2 pairs of sensilla; prementum (*Prmt*) with 1 pair of setae (*prms*) and 1 pair of sensilla, *prms*1 long and stout, *prms*2 quite short, close to inner side of labial palpi; postmentum (*Pmt*) with 3 pairs of setae (*pms*), *pms1* shortest and fine, *pms2* longest and stout, *pms3* a bit shorter than pms2; maxillary palpus (*MxP*) (Figure 9) with 2 segments, basal segment with 1 long and basally curved accessory process, 1 short inner seta, 1 sensillum close to accessory process, apical segment cylindrical and apically flattened with dense crenulate setae; mala with 5 dorsal robust setae (*dms*) and 4 shorter, more acute ventral setae (*vms*), 1 sensillum; stipes (*st*) bearing 1 stipital setae (*sts*), 2 palpiferal setae (*pfs*) and 3 sensilla, all 3 setae extremely thick



Figures 3–9. Larva. **3** head, ventral view **4** antenna **5** left mandible **6** epipharynx **7** labrum and clypeus **8** labium **9** right maxilla. Scales: **3**: 1mm. **4**: 0.02mm. **5**: 0.05mm. **6–7**: 0.05mm. **8–9**: 0.1mm.

and long, *sts* basally medioventral, *pfs1* apically medioventral, *pfs2* lateroventral; cardo completely divided from stipes.

Setae of thorax and abdomen (Figure 1) described for one side only.

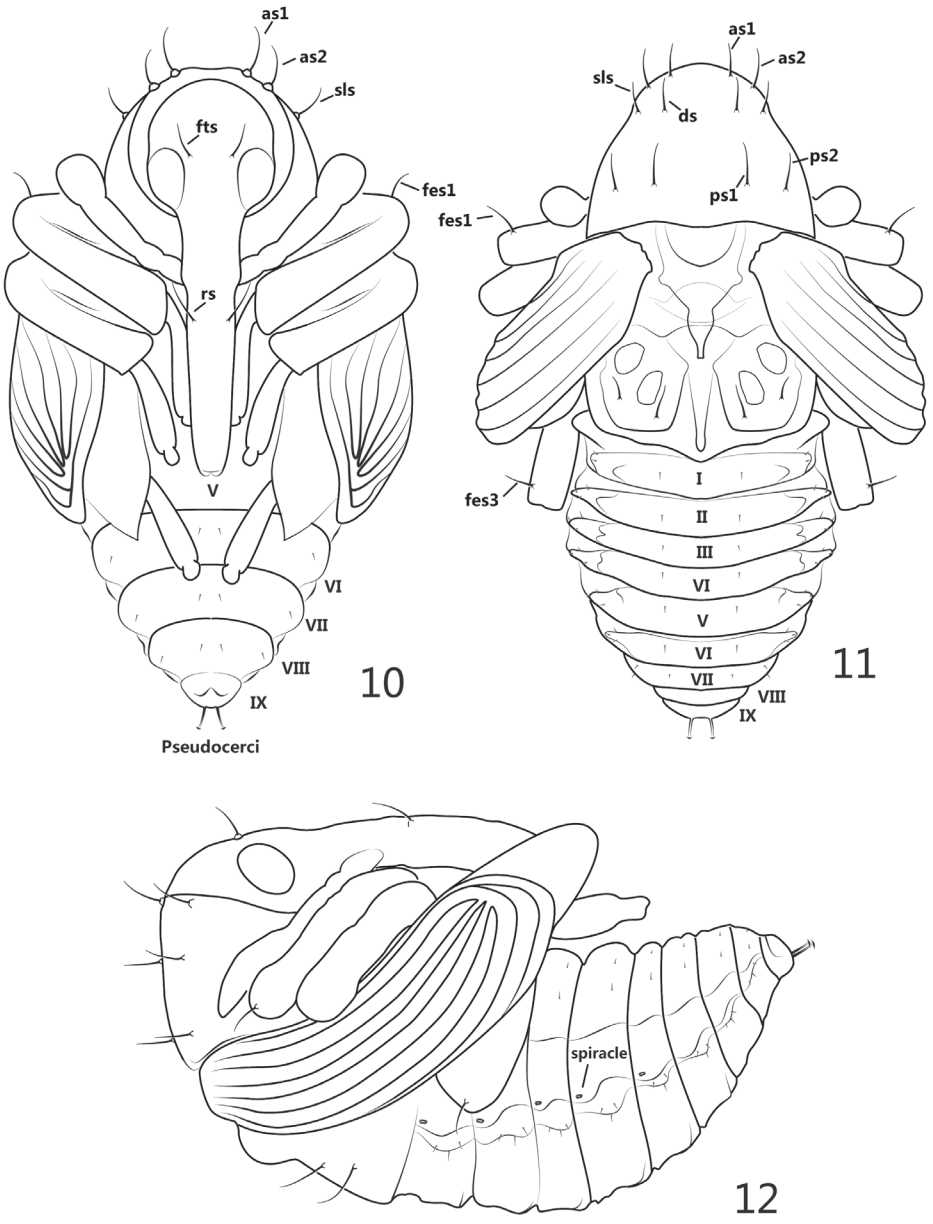
Thorax: pronotal shield simple without fold, unsclerotized; meso- and metanotum each with 2 folds, divided into prodorsum (*fold1*) and postdorsum (*fold2*); spiracle laterally intersegmental between pro- and mesothorax, bicameral; prothoracic epipleurum indistinct, meso- and metathoracic epipleura with outline distinct, centrally tuberculate around setae; pedal area well-defined, pedal lobe (papillae) present, 2-segmented; pronotum with 6 setae (*pns*): 4 longitudinally aligned and close to anterior margin, another 2 nearly at middle area; meso- and metanotum both with 9 setae: prodorsum with 1 short setae (*prs*), epipleurum with 4 setae, 3 setae surrounded by numerous small, tuberculate projections, another situated close to pleurum; postdorsum with 4 relatively longer setae (*pds*), longitudinally aligned; pedal area with 3-4 setae; sternum with 1 tiny seta.

Abdomen: tergites I-VI with 2 folds, prodorsum (*fold1*) with 1 seta on disc, postdorsum (*fold2*) with 6 setae, shorter than thoracic setae and longitudinally aligned; tergites VII-VIII undivided with 5 setae, longitudinally aligned, basal 1 seta surrounded with a circle of sparse tubercles; tergite IX undivided and greatly reduced with 3 setae; 7 spiracles present, size similar, bicameral, anterolaterally located on tergites I-VII, respectively; pleura I-VIII without setae, each sternum with 1 seta.

Pupa (Figures 10–12): Measurements (mm): length: ca. 1.9–2.0, width: ca. 1.3.

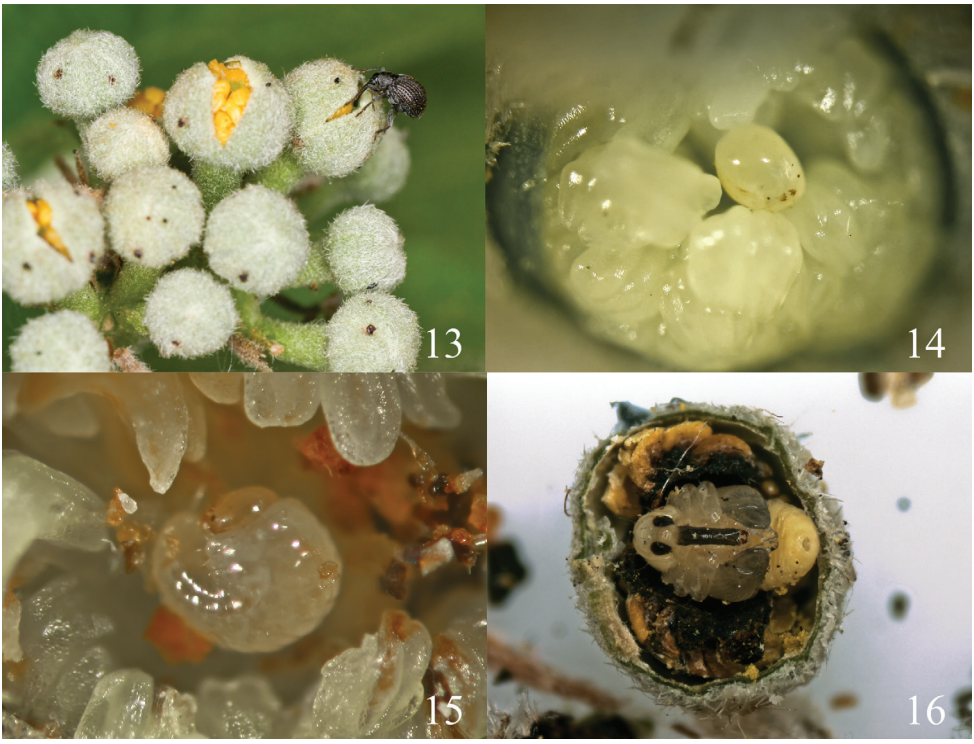
General appearance: theca transparent with semitransparent setae, setae greatly reduced in number, inner body pure white.

Rostrum: in ventral view, apex reaching ventrite V, mesorostrum visibly dilated, mandibular theca weakly projected; 1 pair of rostral setae (*rs*) positioned in front of antennal insertion. Head: frons with 1 pair of setae (*fts*), about as long as rostral setae, situated at the level of hind margin of eyes; antennae basally situated near prosternum and apically extended to propleurum, sub-parallel to protibia. Thorax: in dorsal view, pronotum with 2 pairs of apical setae (*as*), 1 pair of sublateral setae (*sls*), 1 pair of discal setae (*ds*) and 2 pairs of posterolateral setae (*pls*), these long, stout and similarly elongated setae forming 2 longitudinal rows on pronotum, 3 positioned in each row and transversely localized; in ventral view, *as1*, *as2* and *sls* completely visible, distinctly longer than *vs* and *fas*; mesonotum without setae; metanotum bearing 2 pairs of setae near lateral and hind margins of metanotum, respectively, subequal in length to pronotal setae. Legs: in ventral view, metatibiae and femora covered by pterothecae, front and middle legs and meta-tarsomere visible, in lateral view, pro- and mesofemora both covered by pterothecae; pro- and metafemora apically bearing 1 slightly outcurved seta; each seta mentioned above arising from a tuberculate base. Abdomen: in ventral view, ventrites V-IX visible, in dorsal view ventrites I-VI about equal in length and width, ventrites VII-IX clearly and gradually reduced; 5 spiracles present, positioned on pleura I-V, bicameral; peudocerci narrow, elongate and slightly outcurved in ventral and dorsal views, subterminally positioned at abdominal segment IX, a bit shorter than femoral setae, apex lenticular; in ventral view, the completely visible ventrites



Figures 10–12. pupa. **10** ventral view **11** dorsal view **12** lateral view. Scales: **10–12**: 1mm.

VI-VIII with 2 pairs of setae on each segment, 1 pair situated medially, another pair situated laterally; in dorsal view, tergites I and VII each bearing 3 pairs of setae, 1 pair situated medially, 2 pairs situated laterodorsally; tegites II-VI each bearing 4 pairs of setae, 1 pair situated medially, 3 situated laterodorsally; tergites VIII-IX without clearly visible setae; all abdominal setae short and thin.



Figures 13–16. 13 the buds of *Grewia biloba* **14** egg positioned among stamens in the bud **15** first instar larva **16** pupa.

Biological information: *P. botanicum* was collected from *Grewia biloba* G. Don var. *parviflora* (Bunge) Hand.-Mazz (Malvaceae: Grewioideae). The adults feed on leaves and buds of their host while they mate and oviposit in the bud (Alonso-Zarazaga & Wang, 2011). After dissection of some 300 buds, we have found that 1-4 oviposition holes can be found on one bud surface, but only 1–2 eggs or larvae per bud are normally found, and 3 or more eggs or larvae were quite rare (Figures 13–15). The mature larva almost completely consumes the internal organs of the bud and then constructs a chamber for pupation (Figure 16), so those buds parasitized by *P. botanicum* will never blossom. In normal conditions, *P. botanicum* can seriously reduce the fructification rate of *G. biloba*, but the damage done seems not to seriously harm the plant's reproductive rate, and the vegetative growth is not decreased by feeding on other areas. Furthermore, in late July, most of the adults disappear from their host and migrate to some other plants in sunny areas. The same case has been reported by other authors, for example, Ehret (1983) reported that apionid weevils sought shrubs and tree crowns to avoid unfavorable weather when growth of their host plants ceased temporarily or permanently, whether during the growth season or at the end of it. We have not yet had an opportunity to study the overwintering behavior of this species.

Discussion

The diagnostic characters of the preimaginal stages of *P. botanicum* can be summarized as follows. Larva: (1) antennae with *acap* more than 3× as long as wide, 3 spinose projections and 2 sensilla (2) head with 10 *des*, 8 *fs*, 4 *les*, 12 *pes* and 4 *vcs*; (3) labrum with 6 *lms*; (4) epipharynx with 4 *ams*, 4 *als*, 2 *mes* and 2 *snp*; (5) maxilla with 1 *stps*, 2 *pfs* and 3 sensilla; (6) mala with 5 *dms* and 4 *vms*; (7) each side of *Pmsc* extended outward with 1 irregularly triangular sclerotization; (8) labial palpus (*lbp*) vestigial, pore-shaped; (9) hypopharyngeal bracon absent; (10) thoracic and abdominal spiracles 1+7 in number, both bicameral. Pupa: (1) the number of setae significantly reduced on rostrum (2*rs*) and head (2*fts*); (2) pronotum with 4*as*, 2*sls*, 2*ds*, 4*ps*; (3) only metanotum with 4 setae; (4) pro- and metafemoral apical setae present, mesofemoral setae absent; (5) in lateral view, ventrites I-V each with 1 spiracle.

In terms of Anderson (1947) and Marvaldi (1999), the frontal area of Curculionidae should bear 5 setae on each side, and *fs*4 is present consistently with a consistent position and is as long as or longer than any other frontal setae. However, compared with Anderson's and Marvaldi's drawings, if *fs*2 of *P. botanicum* is here actually "*fs*4", then there will be an "*fs*6" (*fs*4 in this paper) and "*fs*4" will be much shorter than "*fs*6". Hence, this situation is confused with Marvaldi's and Anderson's nomenclature, because their research objectives did not include apionid species. Thus, we decided to sequentially denominate the frontal setae from vertex to mandible for easy comparison of the categories within Apionidae. Moreover, frontal setae of most species are reduced from modal numbers in Curculionidae on the basis of May (1993), Emden (1938), Bennett (1992), Sanz Benito and Gurrea Sanz (1999) and Gosik et al. (2010); however, *P. botanicum* is nearly undifferentiated (*fs*1-4) compared with derived curculionid species. Also, Emden (1938) thought that "frontal setae of *Apion* can be judged satisfactorily only in specimens in exactly the same position", but at least the frontal setae of *P. botanicum* are present consistently in species.

Furthermore, most authors did not mention whether mandibles are symmetric or not, and few indicated the direction of the mouthpart, which is particularly important when the mandibles are asymmetric. Inconsistent terms of morphological position resulted in those instances when "left" was identified by looking toward the body center (= proximal view) rather than away (= distal or cranial view). To avoid such ambiguities, we suggest that the left mandible should be specified and described as seen from the body center to the anterior in dorsal view.

The hypopharyngeal bracon is a bar connecting the left and right sides of the hypopharyngeal margins and supporting the hypopharynx. The presence of the bracon is one of the characters separating curculionoid larvae from those of Bruchidae and Chrysomelidae (Lawrence 1991); however, we have been unable to find this structure in *P. botanicum*, and surprisingly, no author hitherto has described any species of Apionidae or even Curculionoidea as lacking it. Most authors did not refer to ventral characters of the epicranium at all when describing apionid larvae (Emden 1938; Sanz

Benito and Gurrea Sanz 1999; Bennett 1992; Gosik et al. 2010), but the hypopharyngeal bracon is at least distinctly present in *Neocyba* sp. (May 1993). Obviously, more materials urgently need checking for this problem to be resolved.

It is also worthy to stress that the absence of mesofemoral setae in the pupae of Apionidae has not been recorded before, while some or all femoral setae of some groups of Anthribidae, Brentinae and Curculionidae could be absent (May 1994). It should be a useful character to distinguish *P. botanicum* from other recorded pupae (*Exapion* spp., *Apion soleatum* (Wagner), *Diplapion confluens* (Kirby, 1808)).

Additionally, Emden (1938) keyed out 24 species of apionid larvae, including 2 species of *Aspidapion* (*A. radiolus* and *A. aeneum*), but all of the species were then under the genus *Apion* and not generically well-arranged in the key. The common features and several differences among *P. botanicum*, *A. radiolus* and *A. aeneum* can still be extracted as in Table 1 below; however, the generic characters to verify the phylogenetic relationship between *Aspidapion* and *Pseudaspidapion* require more studies of preimaginal stages of these two genera in the future.

Table 1. Character comparison among *A. aeneum*, *A. radiolus* and *P. botanicum*.

Species	***A. aeneum***[1)]	***A. radiolus***[1)]	***P. botanicum***
head	as long as wide	wider than long	as long as wide
antennal accessory sensory appendage (*acap*)	slender, more than 2 × as long as wide	slender, more than 2 × as long as wide	rod-like, more than 3 × as long as wide
endocarina	long	long	short
left mandibular cutting edge	with a rather distinct tooth	with a strong, rounded dilatation	with a weakly prominent, rounded tooth
setae of labrum (*lms*)	4 pairs	4 pairs	3 pairs
anterolateral setae of epipharynx (*als*)	3 pairs	3 pairs	2 pairs
prms (=ventral bristles of prementum)	as close together as inner basal end of palpi	as far apart as inner basal end of palpi	as far apart as inner basal end of palpi

[1)] Emeden's key (1938)

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RESEARCH ARTICLE

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New western Palaearctic *Dinotrema* species with mesoscutal pit and only medially sculptured propodeum (Hymenoptera, Braconidae, Alysiinae)

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Abstract

Descriptions of four new species of the genus *Dinotrema* Foerster with a mesoscutal pit and only medially sculptured propodeum are given. *Dinotrema alysiae* **sp. n.** (Denmark, England, Netherlands, Spain), *D. paramicum* **sp. n.** (Denmark, Finland), *D. tirolense* **sp. n.** (Italy) and *D. valvulatum* **sp. n.** (Denmark, Italy).

Keywords

Braconidae, Alysiinae, *Dinotrema*, new species, western Palaearctic

Introduction

The genus *Dinotrema* Foerster, 1862 is the largest genus of the subfamily Alysiinae with approximately 320 species described worldwide (Yu et al. 2005). About 250 species of this genus were recorded in the European fauna (Fischer 1972, 1973a, 1993, 1996; van Achterberg 1988; Tobias 2003, 2004a, 2004b, 2006, etc). In spite of this number, numerous Palaearctic *Dinotrema* species remain undescribed up to now.

The current status of the genus *Dinotrema* was established by van Achterberg (1988), and this genus differs from the closely related *Aspilota* Foerster, 1862 in the size of paraclypeal areas which are not connected to the inner eye margin. *Dinotrema* species are parasitoids of Diptera mainly belonging to the family Phoridae (van Achterberg 1988) as well as Anthomyiidae and Platypezidae (Fischer et al. 2008).

We have revised the available type material of this genus of the European fauna to estimate the real composition of *Dinotrema* species and prepare a new determination key for these species. In this paper, four new species with a mesoscutal pit and only medially sculptured propodeum are described and illustrated, viz. *Dinotrema alysiae* sp. n., *D. paramicum* sp. n., *D. tirolense* sp. n., and *D. valvulatum* sp. n.

For the terminology of the morphological features and sculpture, measurements and wing venation nomenclature, see Fischer (1973b). The following abbreviations, generally accepted in the taxonomy of Hymenoptera, are used in the paper: POL – postocellar line; OOL – ocular-ocellar line; OD – maximum diameter of lateral ocellus. The types of species described are deposited in the following museums: Entomological Collection of the University of Valencia (Valencia, Spain; further – ENV), Natural History Museum (London, England; – BMNH), Naturhistorisk Museum (Århus, Denmark; further – NMA), Naturalis Biodiversity Center (Leiden, Netherlands; further – RMNH) and Zoologische Staatssammlung München (Germany; further – ZSSM).

Taxonomical part

***Dinotrema alysiae* Munk & Peris-Felipo, sp. n.**
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http://species-id.net/wiki/Dinotrema_alysiae
Figs 1–13

Type material. Holotype, female (NMA), "Denmark, E-Jutland, Mols Strandkær, 56°14'N 10°25'E, 02.09.1991, Munk". Paratypes: 2 females (NMA), "same label as holotype but, 30.07.1991, Munk"; 2 females (NMA), "Denmark, E-Jylland, Yoling Skov sw. of Skanderborg, 06.09.1986, Munk"; 1 female (RMNH), Netherlands, Waarder (Z.H.), Oosteinde, 30–31.08.1974, C. v. Achterberg"; 2 females (BMNH), "England, Bramham Park Nat., Hants., ex. *Callomyia amoena*, 1985, R.E. Evans".

Other material: 1 female (ENV), "Denmark, E-Jutland, Højkol Skov, 56°05'N 9°38'E, 11.09.2000, Munk"; 1 female (ENV), "Spain, Navarra, Artikutza, Mixto M-1, 16.10.1995, L. Murguia"; 1 female (ENV), "Spain, Navarra, Artikutza, Mixto M-2, 24.07.1995, L. Murguia".

Diagnosis. This new species resembles *D. erythropum* Foerster and *D. valvulatum* sp. n. *Dinotrema alysiae* sp. n. differs from *D. erythopum* in having the first flagellar segments 3.50 times as long as wide (2.50 times in *D. erythopum*), middle flagellar segments 1.90–2.00 times as long as wide (1.40 times in *D. erythropum*), first metasomal

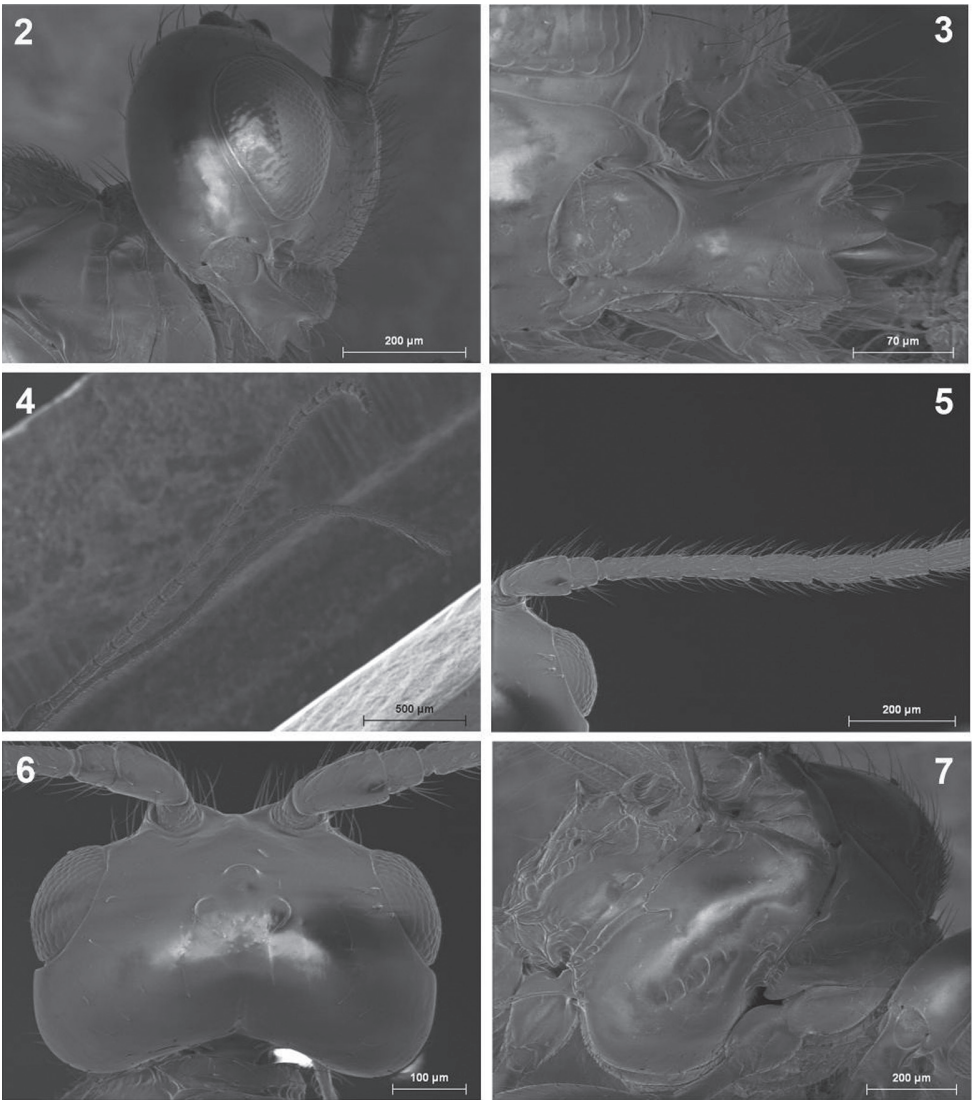
Figure 1. *Dinotrema alysiae* sp. n. (female). Habitus, lateral view.

tergite 1.45 times as long as apical width (1.70 times in *D. erythropum*), mesoscutal pit oval (slender and very long in *D. erythropum*), and lower tooth shorter than upper tooth (longer in *D. erythropum*). The new species differs from *D. valvulatum* in having the first metasomal tergite almost entirely smooth (sculptured with two dorsal carinae in *D. valvulatum*) and ovipositor distinctly shorter than metasoma (ovipositor as long as metasoma in *D. valvulatum*).

Description. Holotype, female, length of body 2.30–2.40 mm, of fore wing 3.30–3.35 mm.

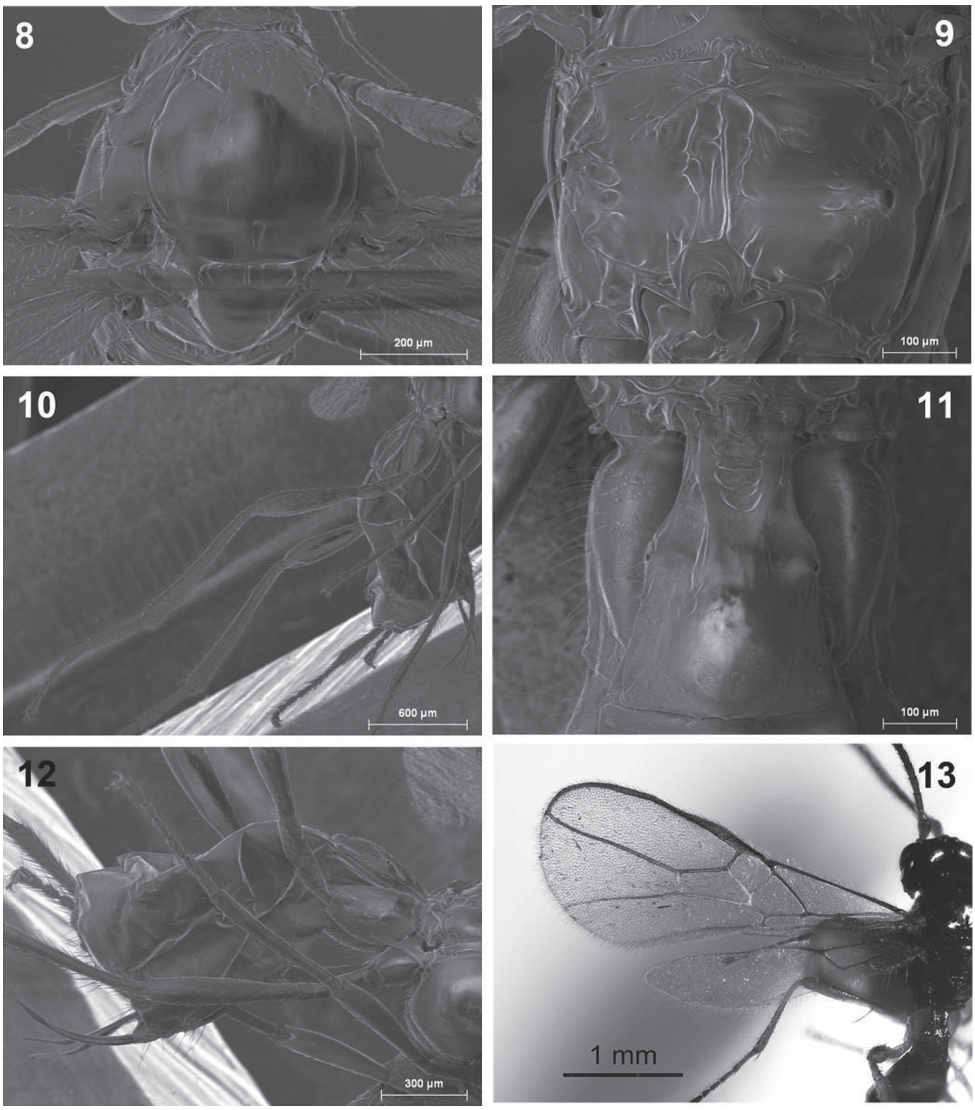
Head. In dorsal view, 1.85–1.90 times as wide as its median length, 1.40 times as wide as mesoscutum, smooth, with rounded temples behind eye. Eye in lateral view 1.60–1.65 times as high as wide and 1.05–1.10 times as wide as temple. POL 3.15–3.20 times OD; OOL 3.25–3.30 times OD. Face 1.80–2.00 times as wide as high; inner margins of eyes subparallel. Clypeus 1.90–1.95 times as wide as high, slightly curved ventrally. Diameter of paraclypeal fovea half distance between clypeus and eye. Mandible widened towards apex, 1.50 times as long as its maximum width. Upper tooth weakly shorter and as wide as base of middle tooth. Middle tooth the longest, wide basally and pointed apically. Lower tooth rather long, but weakly shorter and wider than upper tooth, rounded apically. Antenna thick, 24–25-segmented. Scape 2.40–2.45 times as long as pedicel. First flagellar segment 3.50 times as long as its apical width, 1.10–1.15 times as long as second segment; second segment 2.60–2.65 times as long as its maximum width. Third to twenty-second flagellar segments 1.90–2.00 times as long as their width; twenty-third segment 2.40 times as long as wide.

Mesosoma. In lateral view, 1.30 times as long as high. Mesoscutum 1.05–1.10 times as long as maximum width, with two rows of two setae. Notauli mainly ab-



Figures 2–7. *Dinotrema alysiae* sp. n. (female). **2** Head, lateral view **3** Mandible **4** Antenna **5** Basal segments of antenna **6** Head, dorsal view **7** Mesosoma.

sent. Mesoscutal pit present, oval. Prescutellar depression smooth, with lateral carinae. Sternaulus (= precoxal suture) present, not reaching anterior and posterior parts of mesopleuron. Posterior mesopleural furrow smooth below. Propodeum with median longitudinal carina running from anterior to posterior margin, in anterior third with transverse angulated carina, with additional long subparallel carinae laterally to median one; from lateral carinae emerging short carinae not reaching with the propodeal edges. Propodeal spiracles relatively small.



Figures 8–13. *Dinotrema alysiae* sp. n. (female). **8** Mesonotum **9** Propodeum **10** Hind leg **11** First metasomal tergite **12** Metasoma and ovipositor **13** Fore and hind wings.

Legs. Hind femur 4.10 times as long as wide. Hind tibia weakly widened to apex, 9.10 times as long as its maximum subapical width, 1.10 times as long as hind tarsus. First segment of hind tarsus 2.65 times as long as second segment.

Wings. Length of fore wing 2.35–2.40 times its maximum width. Vein r1 present. Radial cell reaching to apex of wing, 3.40–3.45 times as long as its maximum width. Nervulus distinctly postfurcal. Brachial cell closed, 3.25 times as long as its maximum width. Hind wing 5.00 times as long as its maximum width.

Metasoma. Distinctly compressed. First tergite weakly widened towards apex, 1.45 times as long as its apical width, almost entirely smooth. Ovipositor as long as first tergite, shorter than metasoma, 0.40–0.45 times as long as hind femur.

Colour. Body, mandible and first metasomal tergite dark brown. Legs brown. Wings hyaline. Pterostigma brown.

Male unknown.

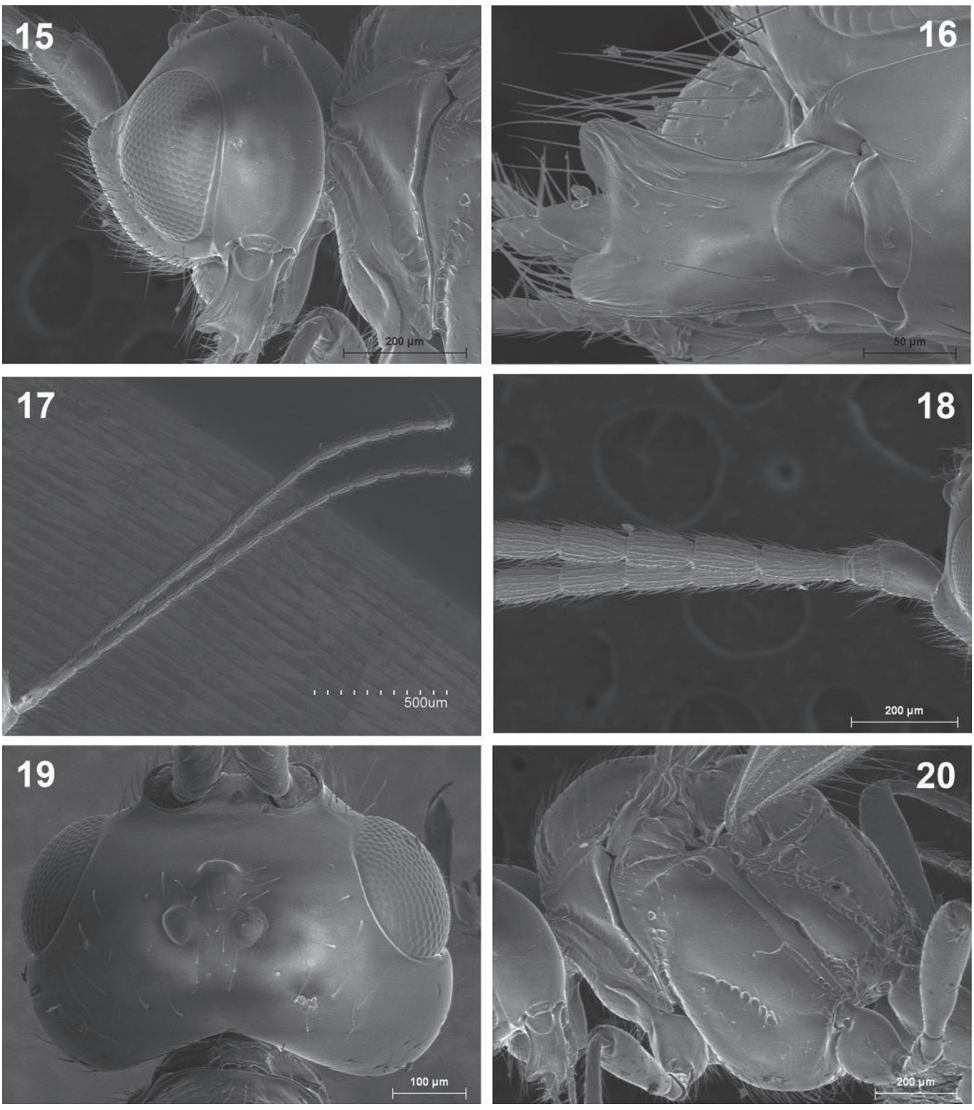
Etymology. The name is referring to the general size and shape of the body which is very similar as species of *Alysia* genus.

***Dinotrema paramicum* Munk & Peris-Felipo, sp. n.**
urn:lsid:zoobank.org:act:CF5FE99B-66C1-43FF-8E16-1AE7409577E5
http://species-id.net/wiki/Dinotrema_paramicum
Figs 14–26

Type material. Holotype: 1 female (NMA), "Denmark, E-Jutland, Mols, Strandkær 56°14'N 10°25'E, 30.09.1982, Munk". Paratypes: 2 females (NMA), same label as holotype; 1 female (ENV), same label as holotype; 1 female (NMA), "Finland, E.S. Ristlina, 6826:501, 06.08.1978, M. Koponen"; 1 female (ENV), "Finland, U. Nurmijärvi, 6715:376, 05.08.1976, M. Koponen".

Diagnosis. This new species resembles *D. kempei* (Hedqvist) but differs in having first metasomal tergite 2.30–2.35 times as long as its apical width (3.50-4.00 times in *D. kempei*), mesoscutal pit rounded (elongated in *D. kempei*), prescutellar depression rec-

Figure 14. *Dinotrema paramicum* sp. n. (female). **14** Habitus, lateral view

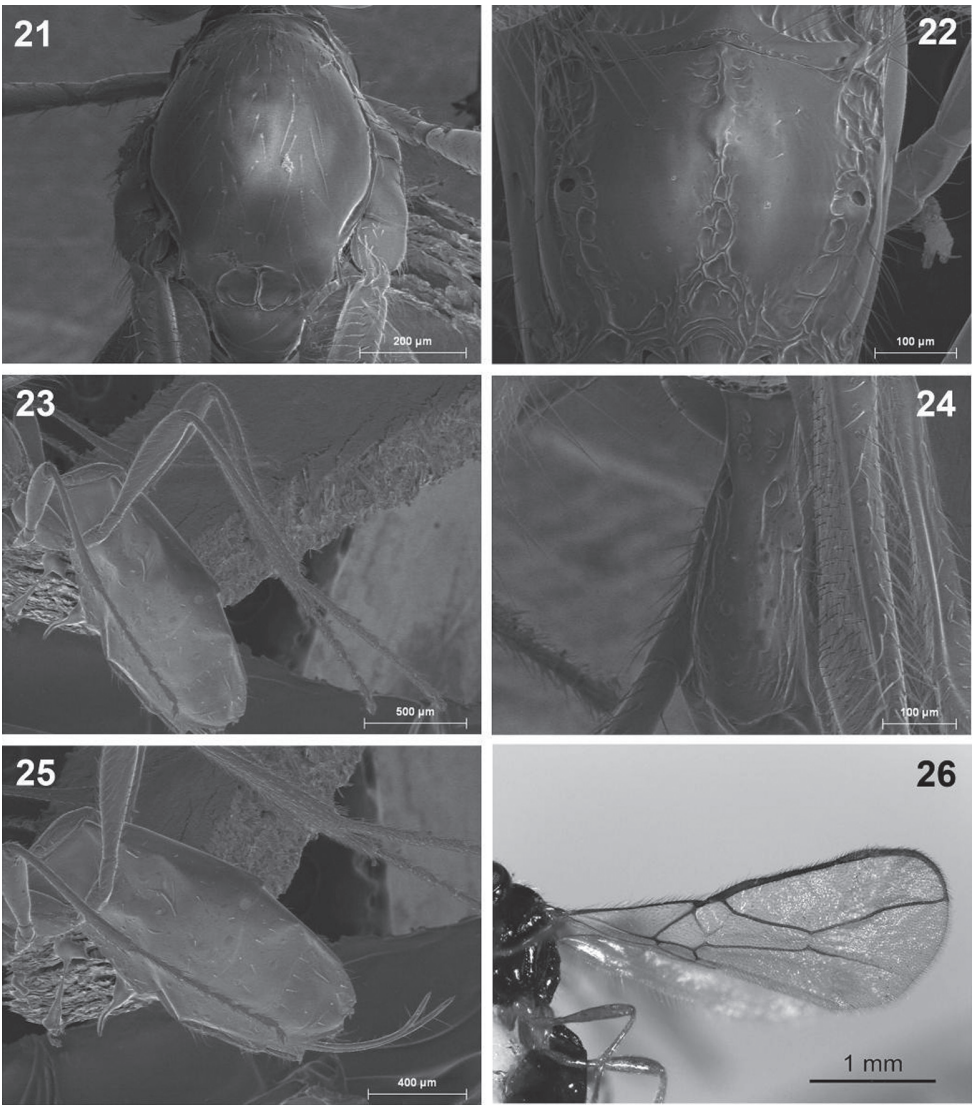


Figures 15–20. *Dinotrema paramicum* sp. n. (female). **15** Head, lateral view **16** Mandible **17** Antenna **18** Basal segments of antenna **19** Head, dorsal view **20** Mesosoma.

tangular and without lateral carinae (square and with lateral carinae in *D. kempei*) and mesoscutum with two rows of double setae (with two rows of single setae in *D. kempei*).

Description. Holotype, female, length of body 2.70–2.80 mm, of fore wing 3.25–3.30 mm.

Head. In dorsal view, 1.60–1.65 times as wide as its median length, 1.45–1.50 times as wide as mesoscutum, smooth, with rounded temples behind eye. Eye in lateral view 1.75 times as high as wide and 0.90–0.95 times as wide as temple. POL 2.60–2.65 times OD; OOL 2.60–2.65 times OD. Face 1.60 times as wide as high;



Figures 21–26. *Dinotrema paramicum* sp. n. (female). **21** Mesonotum **22** Propodeum **23** Hind leg **24** First metasomal tergite **25** Metasoma and ovipositor **26** Fore and hind wings.

inner margins of eyes subparallel. Clypeus 2.65 times as wide as high, slightly curved ventrally. Diameter of paraclypeal fovea less than half of distance between clypeus and eye. Mandible widened towards apex, 1.20 times as long as its maximum width. Upper tooth distinctly shorter and wider than middle tooth and wider than lower tooth. Middle tooth the longest, wide basally and pointed apically. Lower tooth rounded apically and longer than upper tooth. Antenna thick, 23-segmented, as long as body. Scape 1.55–1.60 times as long as pedicel. First flagellar segment 3.00 times as long as its apical width, 1.05–1.10 times as long as second segment; second segment 2.35 times as

long as its maximum width. Third to twentieth flagellar segments 1.70–1.80 times as long as their width; twenty-first segment 2.20 times as long as wide.

Mesosoma. In lateral view, 1.10–1.15 times as long as high. Mesoscutum 1.10 times as long as maximum width with two rows of double setae. Notauli mainly absent. Mesoscutal pit present, rounded. Prescutellar depression smooth, without lateral carinae. Sternaulus (= precoxal suture) present, not reaching anterior and posterior parts of mesopleuron. Posterior mesopleural furrow smooth. Propodeum with median longitudinal carina running from anterior to posterior margin. Propodeal spiracles small.

Legs. Hind femur 4.15–4.20 times as long as wide. Hind tibia weakly widened to apex, 9.75 times as long as its maximum subapical width, 1.05–1.10 times as long as hind tarsus. First segment of hind tarsus 1.85 times as long as second segment.

Wings. Length of fore wing 2.60–2.70 times its maximum width. Vein r1 present. Radial cell reaching to apex of wing, 3.95–3.40 times as long as its maximum width. Nervulus distinctly postfurcal. Brachial cell closed, widened apically, 3.40 times as long as its maximum width. Hind wing 4.50–4.60 times as long as its maximum width.

Metasoma. Distinctly compressed. First tergite weakly widened towards apex, 2.80 times as long as its apical width, almost entirely smooth. Ovipositor 1.90–1.95 times as long as first tergite, shorter than metasoma, 1.55–1.60 times as long as hind femur.

Colour. Body and legs brown to dark brown. Wings hyaline. Pterostigma brown.

Male unknown.

Etymology. The name is from Greek "para" meaning "elongate" and "micus" from Latin meaning "character" and referring to the general shape of the body.

***Dinotrema tirolense* Munk & Peris-Felipo, sp. n.**

urn:lsid:zoobank.org:act:13DD07E4-4DDA-469E-9FE9-428DA8CD0504

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

Figs 27–39

Type material. Holotype: 1 female (ZSSM), "Italy, St. Peter/Ahrntal, Südtirol, 1950 m., Ja/26.08.1967, Haeselbarth". Paratype: 1 female (ENV), same label as holotype but, "1800 m., Jh/26.08.1969, Haeselbarth".

Diagnosis. This new species resembles *D. sylvestre* Tobias but differs in having the mesoscutal pit present (absent in *D. sylvestre*), mandible 1.55–1.60 times as long as wide (as long as wide in *D. sylvestre*), first flagellar segment 4.25 times as long as wide (3.50 times in *D. sylvestre*), middle flagellar segments 3 times as long as their width (2.00 times in *D. sylvestre*) and hind femur 5.00 times as long as its maximum width (4.00 times in *D. sylvestre*).

Description. Holotype, female, length of body 1.90–1.95 mm, of fore wing 3.00 mm.

Head. In dorsal view, 1.80 times as wide as its median length, 1.30–1.35 times as wide as mesoscutum, smooth, with rounded temples behind eye. Eye in lateral view

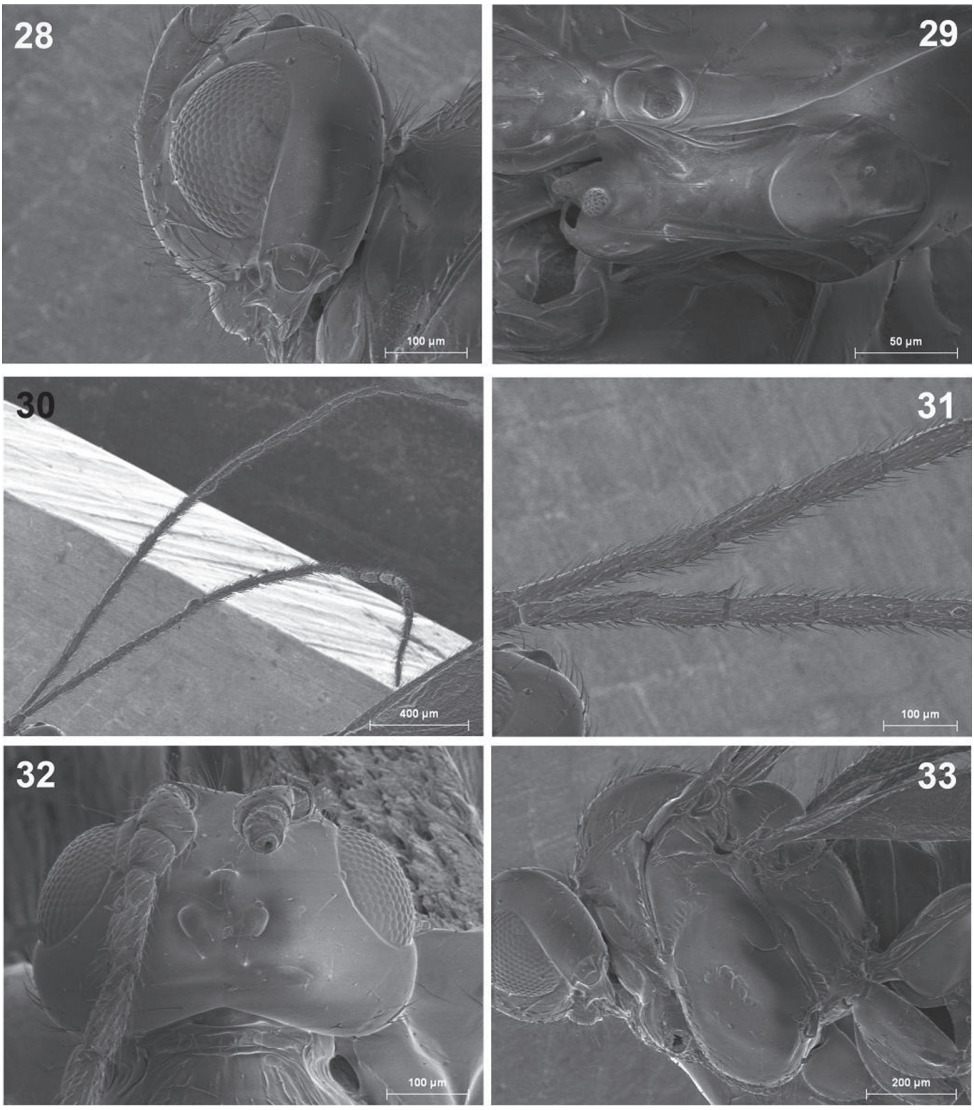
Figure 27. *Dinotrema tirolense* sp. n. (female). **27** Habitus, lateral view.

1.60–1.65 times as high as wide and 1.05–1.10 times as wide as temple. POL 2.85-2.90 times OD; OOL 2.75-2.80 times OD. Face 1.50-1.55 times as wide as high; inner margins of eyes subparallel. Clypeus 1.65 times as wide as high, slightly curved ventrally. Diameter of paraclypeal fovea less than half of distance between clypeus and eye. Mandible weakly widened towards apex, 1.55-1.60 times as long as its maximum width. Upper tooth distinctly shorter than middle tooth. Middle tooth the longest, widened basally and pointed apically, wider than upper and lower tooth. Lower tooth rounded apically and longer than upper tooth. Antenna thick, 23-segmented, as long as body. Scape 1.65-1.70 times as long as pedicel. First flagellar segment 4.25 times as long as its apical width, 1.25–1.30 times as long as second segment; second segment 3.00 times as long as its maximum width. Third to twentieth flagellar segments 3.00 times as long as their width; twenty-first segment 2.50 times as long as wide.

Mesosoma. In lateral view, 0.95 times as long as high. Mesoscutum as long as maximum width with three rows of two setae, two around notauli and one in middle part. Notauli mainly absent. Mesoscutal pit present, rounded. Prescutellar depression smooth, with small lateral carinae. Sternaulus (= precoxal suture) present, not reaching anterior and posterior parts of mesopleuron. Posterior mesopleural furrow smooth. Propodeum smooth, with incomplete median longitudinal carinae not crossing line of spiracles. Propodeal spiracles small.

Legs. Hind femur 5.00 times as long as wide. Hind tibia weakly widened to apex, 11.40 times as long as its maximum subapical width, 1.15–1.20 times as long as hind tarsus. First segment of hind tarsus 1.50 times as long as second segment.

Wings. Length of fore wing 2.30 times its maximum width. Vein r1 present. Radial cell reaching to apex of wing, 4.75 times as long as its maximum width. Nervulus



Figures 28–33. *Dinotrema tirolense* sp. n. (female). **28** Head, lateral view **29** Mandible **30** Antenna **31** Basal segments of antenna **32** Head, dorsal view **33** Mesosoma.

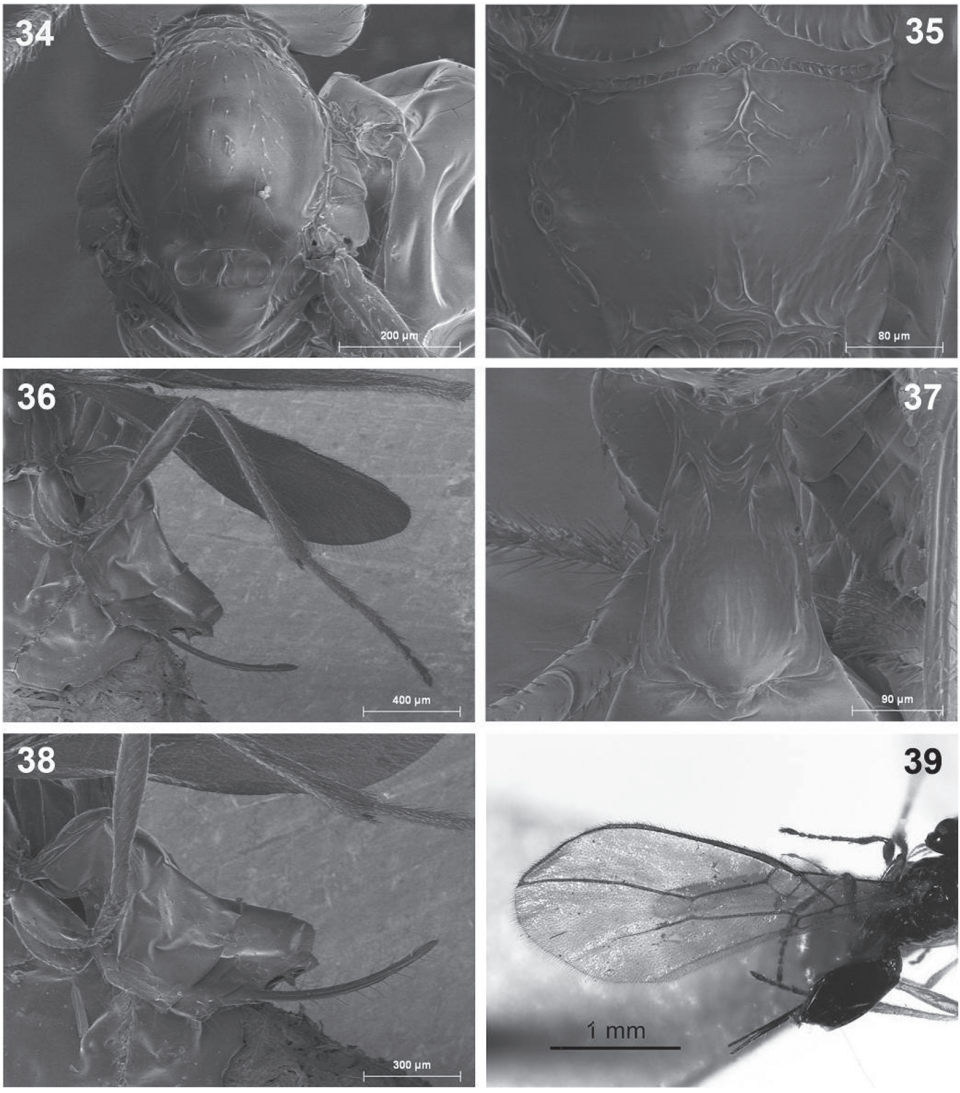
distinctly postfurcal. Brachial cell closed, widened apically, 3.50 times as long as its maximum width. Hind wing 4.80–4.90 times as long as its maximum width.

Metasoma. Distinctly compressed. First tergite weakly widened towards apex, 1.60 times as long as its apical width, almost entirely smooth. Ovipositor 1.85-1.90 times as long as first tergite, shorter than metasoma, 1.15–1.20 times as long as hind femur.

Colour. Body and legs brown to dark brown. Wings hyaline. Pterostigma brown.

Male unknown.

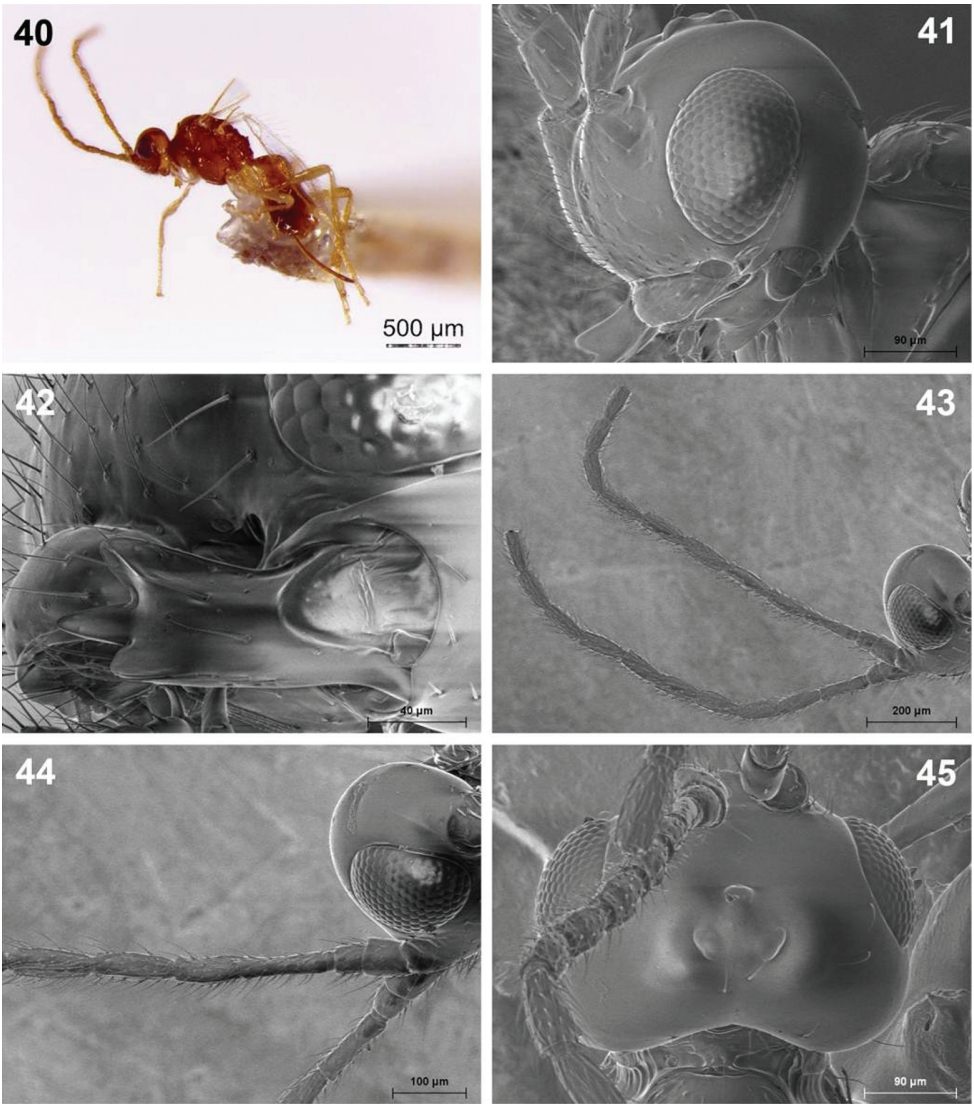
Etymology. The name is from geographical area "Tirol", the type locality of species.



Figures 34–39. *Dinotrema tirolense* sp. n. (female). **34** Mesonotum **35** Propodeum **36** Hind leg **37** First metasomal tergite **38** Metasoma and ovipositor **39** Fore wing.

***Dinotrema valvulatum* Munk & Peris-Felipo, sp. n.**
urn:lsid:zoobank.org:act:D3CEA3C7-32FB-411D-A479-AA9AEC125236
http://species-id.net/wiki/Dinotrema_valvulatum
Figs 40–51

Type material. Holotype: 1 female (NMA), "Denmark, E-Jutland, Højen Bæk, 5 km S of Vejle, 07.07.1984, Munk". Paratype: 1 female (NMA), same label as holotype, both specimens were collected in a deciduous wood with *Alnus*, *Fraxinus* and *Fagus* on



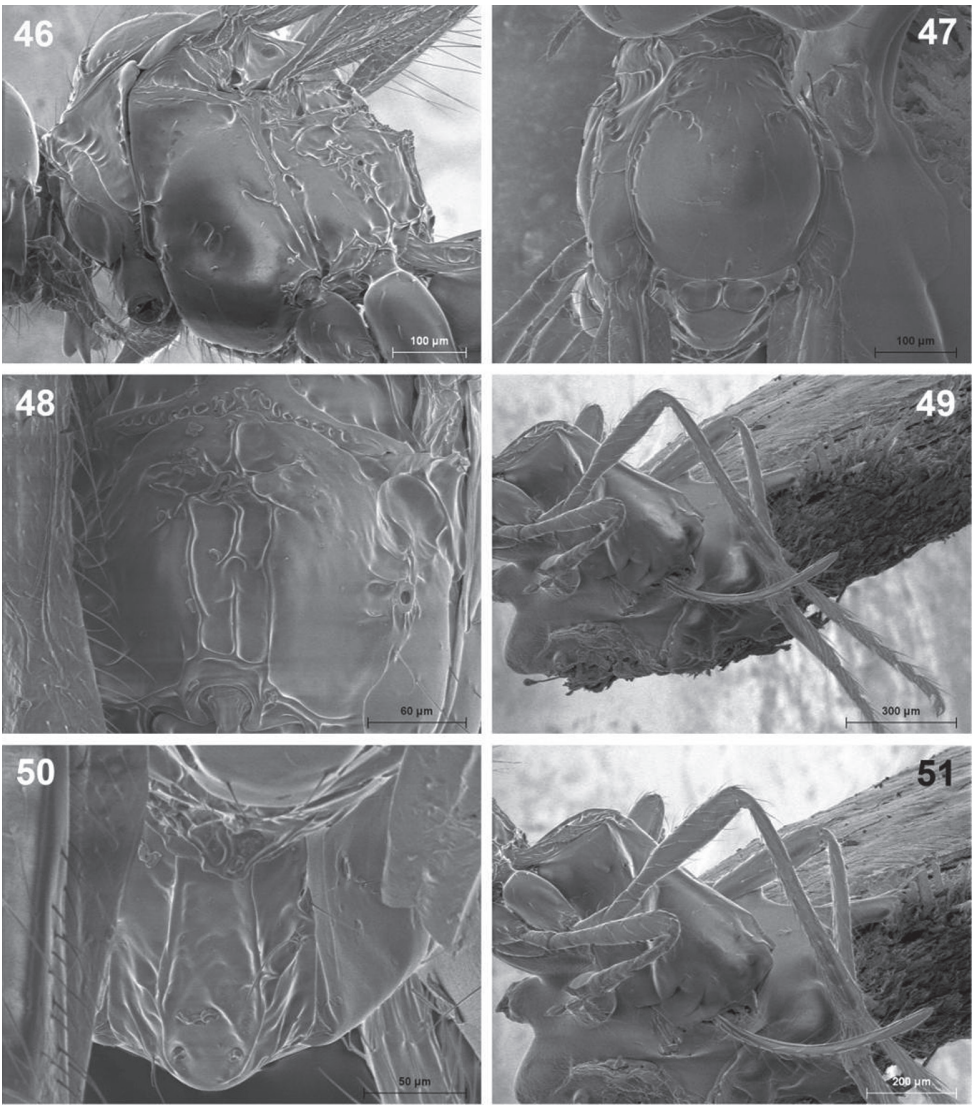
Figures 40–45. *Dinotrema valvulatum* sp. n. (female). **40** Habitus, lateral view **41** Head, lateral view **42** Mandible **43** Antenna **44** Basal segments of antenna **45** Head, dorsal view.

wet ground, 07.07.1984; 1 female (ZSSM), "Italy, St. Peter/Ahrntal, Südtirol, 1600 m., Ja/26.08.1967, Haeselbarth".

Diagnosis. This new species resembles *D. alysiae* sp. n.; their differences are given after the description of *D. alysiae*.

Description. Holotype, female, Length of body 1.40–1.60 mm, of fore wing 2.20 mm.

Head. In dorsal view, 1.60 times as wide as its median length, 1.50 times as wide as mesoscutum, smooth, with rounded temples behind eye. Eye in lateral view 1.55 times



Figures 46–51. *Dinotrema valvulatum* sp. n. (female). **46** Mesosoma **47** Mesonotum **48** Propodeum **49** Hind leg **50** First metasomal tergite **51** Metasoma and ovipositor.

as high as wide and 0.90–0.95 times as wide as temple. POL 2.75–2.80 times OD; OOL 3.40–3.45 times OD. Face 1.35 times as wide as high; inner margins of eyes subparallel. Clypeus 3.10 times as wide as high, slightly curved ventrally. Paraclypeal fovea large, its diameter more than half the distance between clypeus and eye. Mandible widened towards apex, 1.60 times as long as its maximum width. Upper tooth weakly shorter than middle tooth and wider than middle and lower tooth. Middle

tooth the longest, widened basally and pointed apically. Lower tooth rounded apically and shorter than upper tooth. Antenna thick, 21-segmented, longer than body. Scape 2.00 times as long as pedicel. First flagellar segment 3.65–3.70 times as long as its apical width, 1.15 times as long as second segment; second segment 2.50 times as long as its maximum width. Third to eighteenth flagellar segments 2.20–2.30 times as long as their width; nineteenth segment 2.00 times as long as its maximum width.

Mesosoma. In lateral view, 1.10–1.15 times as long as high. Mesoscutum 1.10–1.15 times as long as maximum width with two rows of single setae. Notauli mainly absent. Mesoscutal pit present and elongated. Prescutellar depression smooth, without lateral carinae. Sternaulus (= precoxal suture) present, not reaching anterior and posterior parts of mesopleuron. Posterior mesopleural furrow smooth. Propodeum with median longitudinal carina running from anterior to posterior its margins, in anterior third with transverse angulated carina, with additional long subparallel carinae laterally to median one; from lateral carinae emerging short carinae not reaching propodeal edges. Propodeal spiracles relatively small.

Legs. Hind femur 4.50 times as long as wide. Hind tibia weakly widened to apex, 9.10–9.15 times as long as its maximum subapical width, as long as hind tarsus. First segment of hind tarsus 1.95–2.00 times as long as second segment.

Wings. Length of fore wing 2.50–2.60 times its maximum width. Vein r1 present. Radial cell reaching to apex of wing, 4.50 times as long as its maximum width. Nervulus distinctly postfurcal. Brachial cell closed, 3.00 times as long as its maximum width. Hind wing 8.0 times as long as its maximum width.

Metasoma. Distinctly compressed. First tergite weakly widened towards apex, 1.90 times as long as its apical width, almost sculptured with fine striae. Ovipositor 2.10 times as long as first tergite, as long as metasoma, 1.60–1.65 times as long as hind femur.

Colour. dark brown with a red tone, except propleuron, scapus, pedicellus and anterior half of metasoma infuscate reddish; clypeus and legs yellow (fifth tarsal segment infuscate).

Male unknown.

Etymology. The name is due to the large size of the ovipositor valves.

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First of all, we wish to thank Dr. Maximilian Fischer for his great help and his kindness during all our studies and Dominique Zimmermann, curator of the Naturhistorisches Museum Wien, for her hospitability and patience during our stays in the museum. Also, we wish to thank Dr. Kees van Achterberg from Naturalis Biodiversity Center, Leiden and Dr. E. Haeselbarth from Zoologische Staatssammlung München, for his help during our studies in Alysiinae World. Finally, we wish to thank all of those who have offered their support, time and advice.

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RESEARCH ARTICLE

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Two new species of *Membranacea* Qin & Zhang from China (Hemiptera, Cicadellidae, Typhlocybinae, Empoascini)

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Abstract

Two new species of the empoascine leafhopper genus *Membranacea* Qin & Zhang are reported from China: *M. hubeiensis* Yu & Yang, **sp. n.** and *M. stenoprocessa* Yu & Yang, **sp. n.**. A key to distinguish all species of the genus is provided.

Keywords

Auchenorrhyncha, leafhopper, taxonomy, morphology, description

Introduction

The Typhlocybinae genus *Membranacea* was established by Qin & Zhang in 2011 for three new species from China with *M. spinata* as its type species. Here we described two new species from China and provide a key for the separation of all species. The examined specimens in this study are deposited in the Institute of Entomology, Guizhou University, Guiyang, Guizhou, China (GUGC).

Materials and methods

The methods and terminology follow Zhang (1990) except for the nomenclature of wing, for which we follow Dworakowska (1993). Male specimens were dissected with the MOTIC B1 SMS-168 SERIES. Figures were made using OLYMPUS CX41 and enhanced using Adobe Illustrator CS4. Pictures were taken with VHX-1000C and dealt with Adobe Illustrator CS4. The body length is measured from the apex of the head to the apex of the forewing.

Results

Genus *Membranacea* Qin & Zhang
http://species-id.net/wiki/Membranacea

Membranacea Qin & Zhang, 2011, Zootaxa, 2923: 48–58.

Type species. *Membranacea spinata* Qin & Zhang, 2011

Description. Body robust. Crown rounded at anterior margin, with a median black apical spot; coronal suture distinct, reaching anterior margin of vertex (Figs 1, 19). Ocellus present. Face elongated and convex in profile, lateral frontal suture present (Figs 2, 20). Pronotum wider and longer than crown (Figs 1, 19). Scutellum yellow with basolateral triangles and apex black; scutoscutellar sulcus distinct, not reaching lateral margin of scutellum (Figs 1, 19). Forewing rounded apically, apical cells less than one-third total length, RP and MP' separated at base, both originated from r cell, MP''+CuA' from m cell, width of c cell equal with r cell (Figs 4, 22). Hindwing with CuA bifurcated, the branching point at or distad of coalescence of CuA with MP'' (Figs 5, 23).

Male ventral abdominal apodemes well developed, rounded apically, reaching segment IV or V (Figs 7, 25). Male pygofer long, dorsal margin strongly concave, lightly sclerotized and less pigmented in basal 2/3 but more sclerotized apically, apex with few rigid microsetae; pygofer appendage absent (Figs 9, 27); dorsal bridge short (Figs 8, 26). Subgenital plate longer than pygofer (Figs 6, 24), basal broad, with an oblique line of macrosetae; outer margin slightly expanded at midlength and bearing few moderately long and stout setae forming the basal group (Figs 10, 28). Paramere shorter than pygofer, curved, narrowed from near midlength to apex, laterally with few setae, apex with teeth and sensory pits (Figs 14, 31). Aedeagal shaft elongated, curved posteriorly, with symmetrical flanges, gonopore apical on ventral surface; basal apodeme absent; preatrium developed (Figs 11, 12, 13, 17, 18, 29, 30, 34, 35). Connective with base broad, apex narrow (Figs 16, 33). Anal tube as in Figs 15, 32.

Distribution. China (Guizhou, Hubei, Hunan, Shaanxi, Sichuan)

Remarks. This genus is similar to *Alebroides* Matsumura, *Apheliona* Kirkaldy, *Nikkotettix* Matsumura, *Ghauriana* Thapa, *Matsumurama* Thapa, *Bhatasca* Dwora-

kowska and *Luodianasca* Qin & Zhang in having veins MP' and RP in the forewing arising from cell r and CuA in the hindwing branched apically. The genus differs from these genera in the pygofer having the dorsal margin strongly concave with a weekly sclerotized area, and from *Alebroides*, *Apheliona*, *Ghauriana*, *Matsumurama*, *Nikkotettix* in lacking the ventral pygofer appendage. The genus differs from *Bhatasca* in having the basal group setae of the subgenital plate located near the midlength of the dorsal margin and from *Luodianasca* in the absence of ventrally projecting anal tube processes, the abdominal apodemes well developed and the subgenital plate having setae in the basal group. It also differs from *Bhatasca* and *Luodianasca* in having the lateral macrosetae of the subgenital plate arranged in two rows submedially.

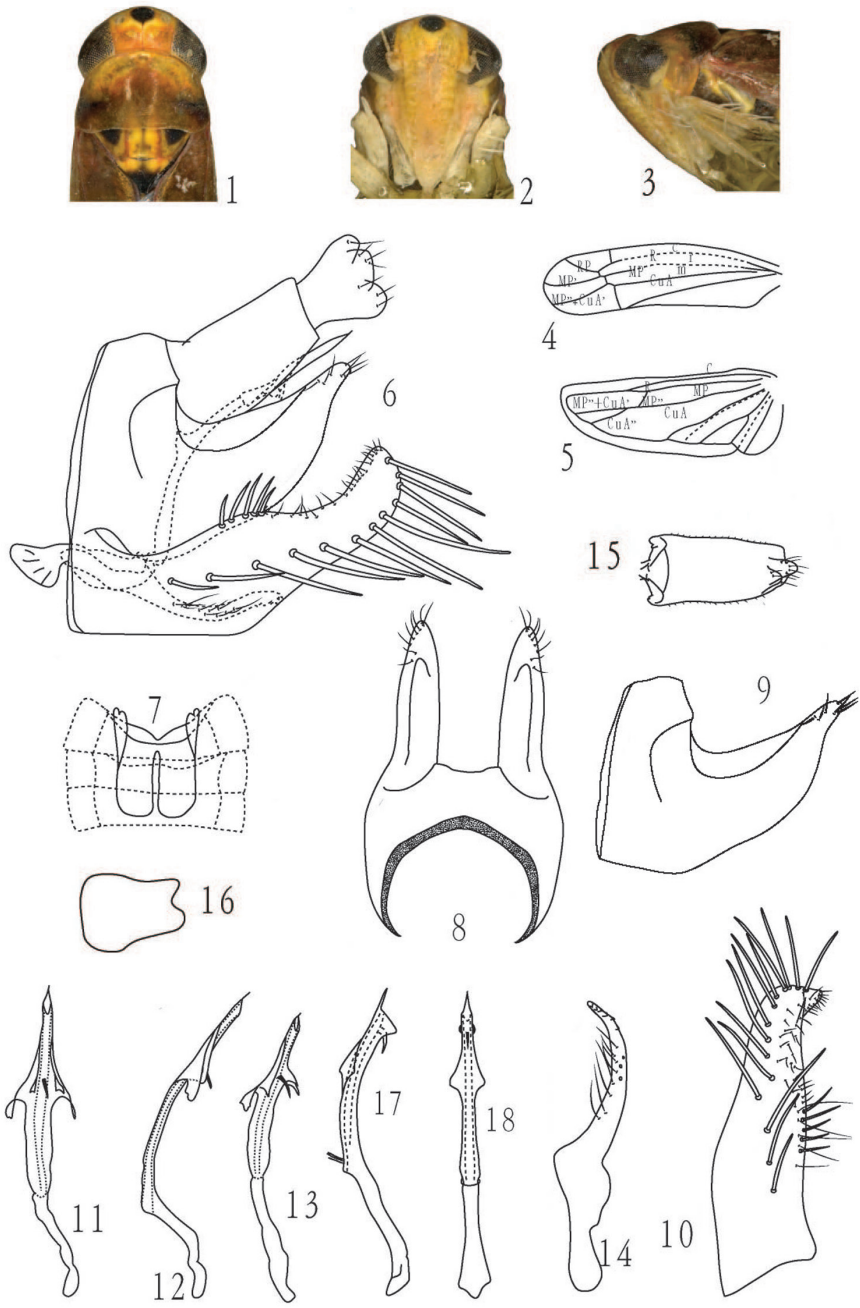
Key to species (male)

1 Aedeagal shaft with two pairs of flanges (Figs 11, 18, 29, 34).....**2**
– Aedeagal shaft with a pair of flanges..... ***M. unijugata* Qin & Zhang**
2 Aedeagal shaft with a ventral central spine (Figs 6, 11, 12, 13, 17, 18).....**3**
– Aedeagal shaft without ventral central flange (Figs 29, 30, 34, 35)..... **4**
3 Aedeagus with ventral central spine near apex (Figs 17, 18) .....
.....***M. spinata* Qin & Zhang**
– Aedeagus with ventral central spine at or slightly beyond midlength of shaft (Figs 11, 13) .....***M. hubeiensis* Yu & Yang, sp. n.**
4 Aedeagus with subapical flanges slightly broader than flanges at midlength of shaft (Figs 29, 30) ..... ***M. stenoprocessa* Yu & Yang, sp. n.**
– Aedeagus with subapical flanges distinctly narrower than flanges at midlength of shaft (Figs 34, 35).....***M. plana* Qin & Zhang**

***Membranacea hubeiensis* Yu & Yang, sp. n.**
urn:lsid:zoobank.org:act:798AFF17-4227-4ADE-9DB5-7DA56F59BA11
http://species-id.net/wiki/Membranacea_hubeiensis
Figs 1–16

Description. Length, male 4.1–4.3mm.

General color reddish to yellowish orange. Eyes dark. Ocellus on anterior margin of crown, light brownish. Coronal suture brown margined with cream and with a yellowish brown spot on each side (Fig. 1). Face orange, paler on gena; some specimens with brownish stripe on anteclypeus (Figs 2, 3). Pronotum reddish orange centrally and posteriorly, with a median yellowish patch at anterior margin (Fig. 1). Scutellum yellow with basolateral triangles black margined with reddish orange; apex and sometimes a stripe medially, black (Fig.1). Forewing reddish orange, semi-transparent in basal 2/3 and yellowish, hyaline in apical 1/3. Abdomen brownish. Legs yellow except midlength of hind tibia, brownish.



Figures 1–18. 1–16 *Membranacea hubeiensis* Yu & Yang, sp. n., **1** head and thorax, dorsal view **2** face **3** head and thorax, lateral view **4** forewing **5** hindwing **6** male terminalia, lateral view **7** male abdominal apodemes **8** male pygofer, dorsal view **9** male pygofer, lateral view **10** subgenital plate, ventral view **11** aedeagus, ventral view **12** aedeagus, lateral view **13** aedeagus, lateroventral view **14** paramere, dorsal view **15** male anal tube, ventral view **16** connective **17–18** *Membranacea spinata* Qin & Zhang **17** aedeagus, lateral view **18** aedeagus, ventral view. Figs **17** and **18** from Qin, Liu & Zhang, 2011

Ventral male abdominal apodemes broad, reaching segment IV or V, margins parallel or slightly divergent (Fig. 7). Pygofer with dorsal margin strongly concave, apex finger-like with few microsetae; dorsal bridge less than one-third of total length of pygofer (Figs 8, 9). Subgenital plate broad, with an oblique line of ca. 14 macrosetae and ca. 40 microsetae in 4 irregular rows; outer margin slightly expanded at midlength and bearing five moderately long and stout setae forming the basal group (Fig. 10). Paramere narrowed from near midlength to apex, curved laterally with ca. 9 fine setae, apex with teeth and sensory pits (Fig. 14). Aedeagal shaft elongated, curved posteriorly, subapically with a flange on each side and a narrower flange each side of a single central spine on ventral surface (Figs 11, 12, 13); preatrium nearly half length of shaft (Figs 11, 13). Connective with base broad, apex narrow, apical margin deeply emarginate (Fig. 16).

Type material. Holotype, male, Houhe Natural Reserve, Wufeng City, Hubei Province, 27 July 2010, coll. Xiaofei Yu. Paratypes: 22 males, same data as holotype.

Etymology. The new species is named after its type locality: Hubei.

Remarks. The new species is similar to *M. spinata* Qin & Zhang, 2011, but can be distinguished from the latter by the different configuration of the aedeagal processes (compare Figs 11–13 with 17, 18) and by the more pointed apex of the male pygofer (Fig. 9).

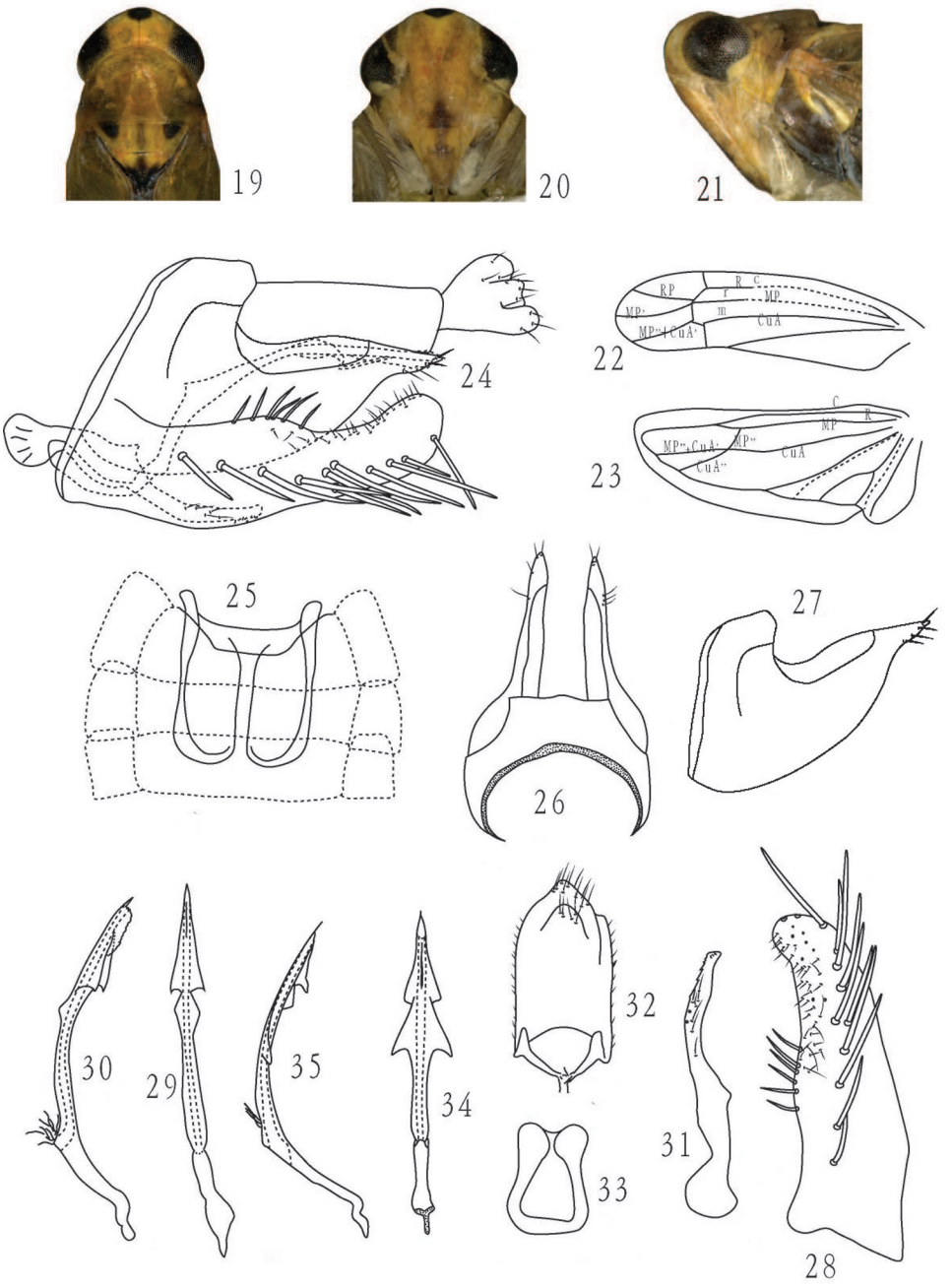
***Membranacea stenoprocessa* Yu & Yang, sp. n.**
urn:lsid:zoobank.org:act:56407D4D-CB37-4E0B-9089-AB10A6AD19DF
http://species-id.net/wiki/Membranacea_stenoprocessa
Figs 19–33

Description. Length male 4.0–4.2mm.

Colour as for previous species but face dorsally and postclypeus yellowish orange, paler on anteclypeus, lorum, maxillary plate and gena, some specimens with a brownish stripe on anteclypeus and ventrally on postclypeus (Figs 19, 20, 21).

Ventral male abdominal apodemes broad, reaching the end of segment IV or V (Fig. 25). Pygofer with dorsal margin strongly concave, apex finger-like with few microsetae (Figs 26, 27). Subgenital plate broad, with ca. 12 macrosetae and ca. 42 irregular microsetae in 3 rows; outer margin slightly expanded at midlength and bearing 6 moderately long and stout setae (Fig. 28). Paramere narrowed from near midlength to apex, curved, laterally with ca. 7 fine setae, apex with teeth and sensory pits (Fig. 31). Aedeagal shaft elongated, curved posteriorly, with a flange on each side at midlength, a broader subapical flange on each side and a central flange on ventral surface extending to near apex, flange margins smooth to slightly dentate; preatrium less half length of shaft (Figs 29, 30). Connective with base broad, apex narrow, apical margin deeply emarginate (Fig. 33)

Type material. Holotype: male, Houhe Natural Reserve, Wufeng City, Hubei Province, 27 July 2010, coll. Xiaofei Yu. Paratypes: 5 males, Xingdou mountain, Hubei Province, 4 August 2010, coll. Xiaofei Yu light; 1 male, Zhujia mountain, Guizhou



Figures 19–35. 19–33 *Membranacea stenoprocessa* Yu & Yang, sp. n., **19** head and thorax, dorsal view **20** face **21** head and thorax, lateral view **22** forewing **23** hindwing **24** male terminalia, lateral view **25** male abdominal apodemes **26** male pygofer, dorsal view **27** male pygofer, lateral view **28** subgenital plate, ventral view **29** aedeagus, ventral view **30** aedeagus, lateral view **31** paramere, dorsal view **32** male anal tube, ventral view **33** connective **34–35** *Membranacea plana* Qin & Zhang **34** aedeagus, ventral view **35** aedeagus, lateral view. Figs **34** and **35** from Qin, Liu & Zhang, 2011.

Province, 25 July 2005, coll. Zaihua Yang; 1 male, Fanjing mountain, Guizhou Province, 21 September 2011, coll. Jiankun Long; 2 males, Longchang town, Xiuwen County, Guizhou Province, 8 July 2010, coll. Yinlin Mu.

Etymology. The new species name alludes to the single narrower ventral flange on the aedeagal shaft.

Remarks. The new species is similar to *M. plana* Qin & Zhang, 2011, but differs from the latter in the more pointed apex of the pygofer and the slightly different shape of the aedeagal flanges with the lower dorsal pair slightly higher on the shaft (compare Figs 29, 30 with 34, 35). In one species of the genus (*M. unijugata*) there is variability in the aedeagus suggesting that the new species could represent a variation of *M. plana*. However, the differences seen between the two species are consistent in all the materials examined.

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