

ORIGINAL ARTICLE

Six newly recorded species of whitefly (Hemiptera: Aleyrodidae) from China

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Abstract Six species of whitefly (Hemiptera: Aleyrodidae), namely *Aleuromarginatus corbettiaformis* Martin, *Aleurotrachelus machili* Takahashi, *Asialeurodes indica* Sundararaj & David, *Asterobemisia takahashii* Danzig, *Pealius akebiae* (Kuwana) and *Tetraleurodes neemani* Bink-Moenen, are reported as new records to Chinese fauna and redescribed with their morphology, illustrations and photographs of scanning electron microscope (SEM). The specimens are deposited in the Insect Collection of Yangzhou University.

Key words Hemiptera, Aleyrodidae, taxonomy, new record, China.

1 Introduction

The family Aleyrodidae (Hemiptera: Sternorrhyncha) was proposed by Westwood in 1840. It distributed worldwide, with many important pests in agriculture and forestry. Mound & Halsey (1978) provided a comprehensive catalogue of the worldwide whitefly, with 1156 species under 126 genera. Martin & Mound (2007) published a checklist of the whiteflies of the world that includes 1556 species and 161 genera belonging to three extant (living) subfamilies (Aleurodicinae, Aleyrodinae, Udamosellinae), and one fossil (non-living) subfamily (Bernaeinae) (Evans, 2008). Aleyrodidae comprises of 248 species in 49 genera, 2 subfamilies (Aleurodicinae, Aleyrodinae) from China (Chou, 1949; Tang, 1960; Ko *et al.*, 1992, 1993a, b, 1995; Dubey & Ko, 2006, 2008a, b, 2009, 2010, 2012; Martin & Lau, 2011; Wang *et al.* 2013, 2014a, b; Wang & Du, 2015). In this paper, six newly recorded species from China are redescribed with morphological illustrations and photographs from a scanning electron microscope (SEM).

2 Materials and methods

The specimens were mounted following the method given by Martin (1987). The terminology for morphological structures follows Bink-Moenen (1983), Martin (1985) and Gill (1990).

The measurements and camera lucida drawings were made using a OLYMPUS microscope BX63 located in the Institute of Applied Entomology, Yangzhou University, China. A sample of the specimen was prepared for SEM studies by cutting the leaf along with a puparium, then mounted it on a stub on black carbon conductive adhesive. The SEM images were taken by Philips XL30-Environmental Scanning Electron Microscope at 20 kV/EHT and 80 Pa between 160 × to 1600 × magnification.

The specimens are deposited in the Insect Collection of Yangzhou University (YZU).

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3 Taxonomy

Aleuromarginatus corbettiaformis Martin, 1985 (Figs 1–7)

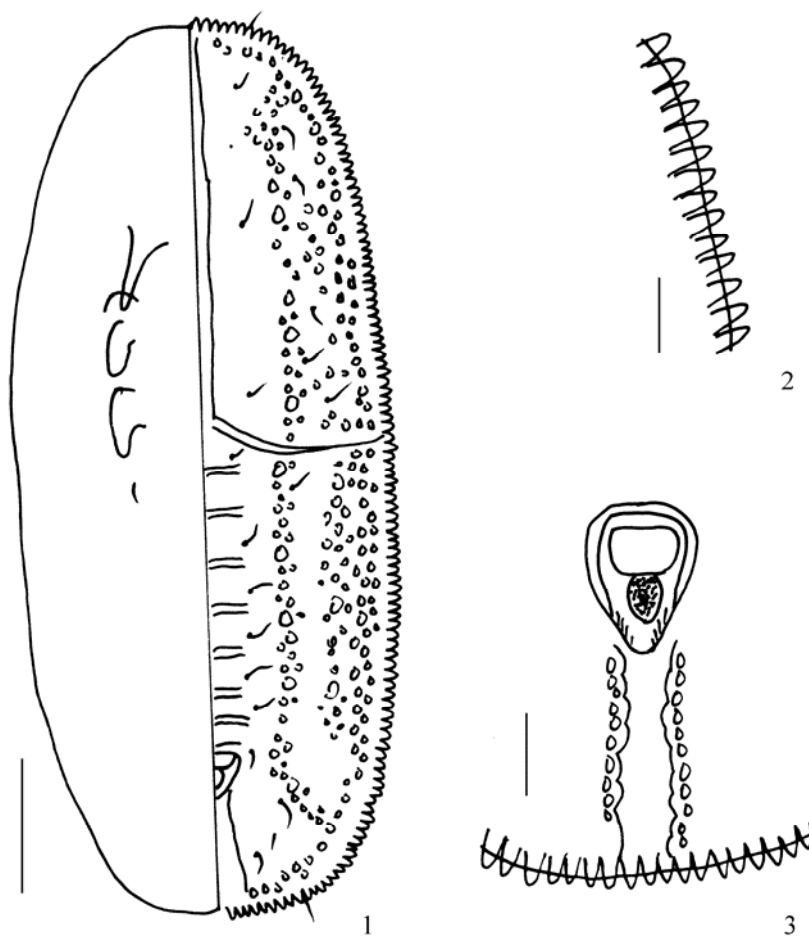
Aleuromarginatus corbettiaformis Martin, 1985. *Bull. Br. Mus. Nat. Hist. (Ent.)*, 50(3): 318.

Diagnosis. Puparia. White, but with a brown median stripe, 1.3 mm in length and 0.45 mm in width; outline asymmetrically elongate-oval, broadest across the abdominal segment III–IV region. Crenulate, margin with regular double row of teeth; primary teeth triangular, about 7–9 crenulations in 0.1 mm, each tooth with a long hair wax filament beyond the margin, 189.4–257.3 μm long; secondary row in form of shallow crenulations. Paired anterior and posterior marginal setae 11 μm and 30.1 μm long, respectively. Dorsum densely patterned, with many subcircular papillae, which in submargin area were larger than in median area, the diameter about 15–20 μm and 10–14 μm , respectively. A row of wax secretions present along each side of submedian area from cephalothorax to vasiform orifice. Dorsum bearing 21 pairs of short setae, 27.6–30.0 μm long, usually much curved. Longitudinal and transverse molting suture both reaching the margin, and the end of transverse molting suture consist with some small papillae. Abdominal segment sutures well defined, abdominal segment I–II about 62.9 μm long, abdominal segment III–VI about 85.7 μm long, abdominal segment VII only about half of abdominal segment VI, about 43 μm long, abdominal VIII about 74.2 μm long. Vasiform orifice subcordate, longer than wide, 74.2 μm long, 57.1 μm wide. operculum inverted trapezoid, covering about half of the orifice. Lingula exposed, knobbed, covering the other half of the orifice. Caudal furrow distinct, about 125.7 μm long.

Material examined. 10 puparia on 8 slides, China, Hainan, Wuzhi Mt., 18.V.2012, coll. Jirui Wang & Haiyan Wu, from *Fagaceae* spp., deposited in YZU.

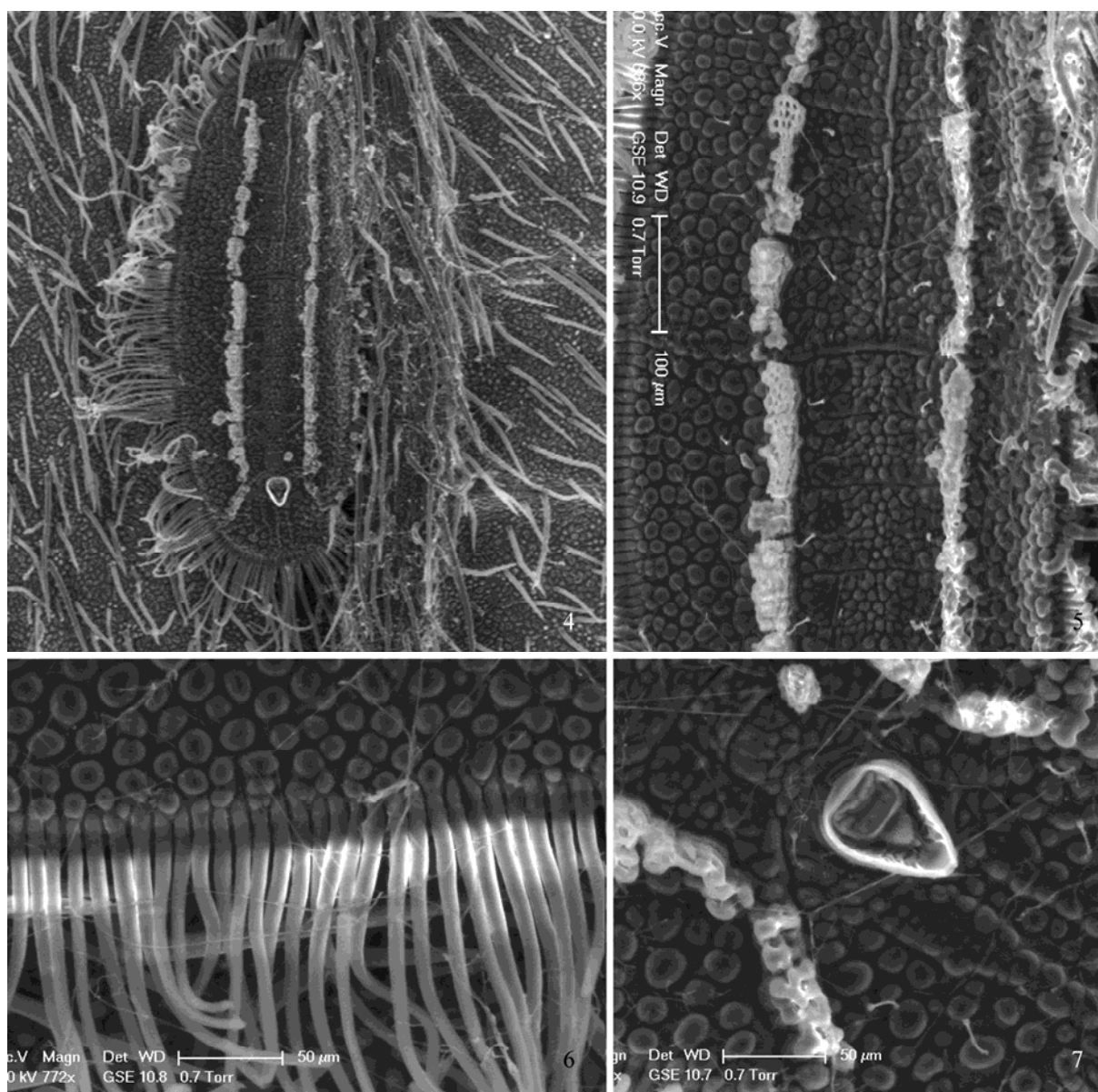
Distribution. China (Hainan); Papua New Guinea (Martin, 1985).

Host plants. *Fagaceae* spp., *Desmodium unbellatum*.



Figures 1–3. *Aleuromarginatus corbettiaformis* Martin. 1. Puparium. 2. Margin. 3. Vasiform orifice and caudal furrow. Scale bars: 1 = 0.2 mm; 2–3 = 0.04 mm.

Remarks. This species differs from the other species of *Aleuromarginatus* by the density and form of cuticular patterning (Martin, 1985).

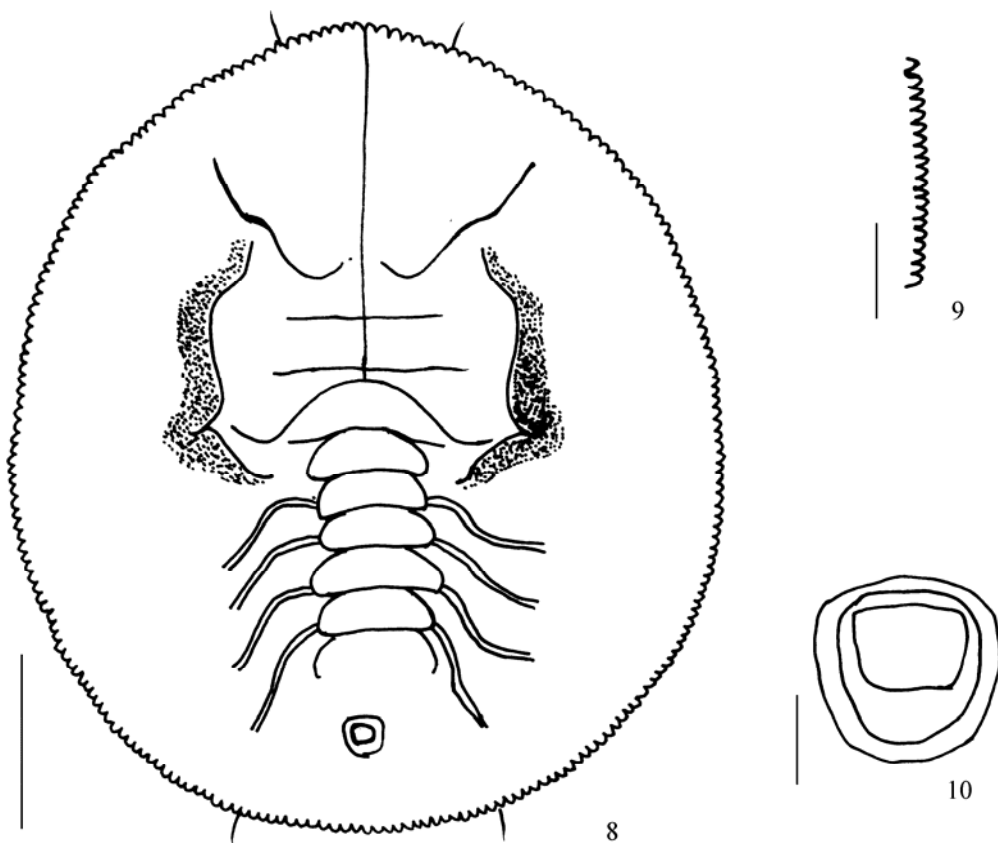


Figures 4–7. SEM of *Aleuromarginatus corbettiaformis* Martin. 4. Puparium. 5. Wax secretion. 6. Margin. 7. Vasiform orifice.

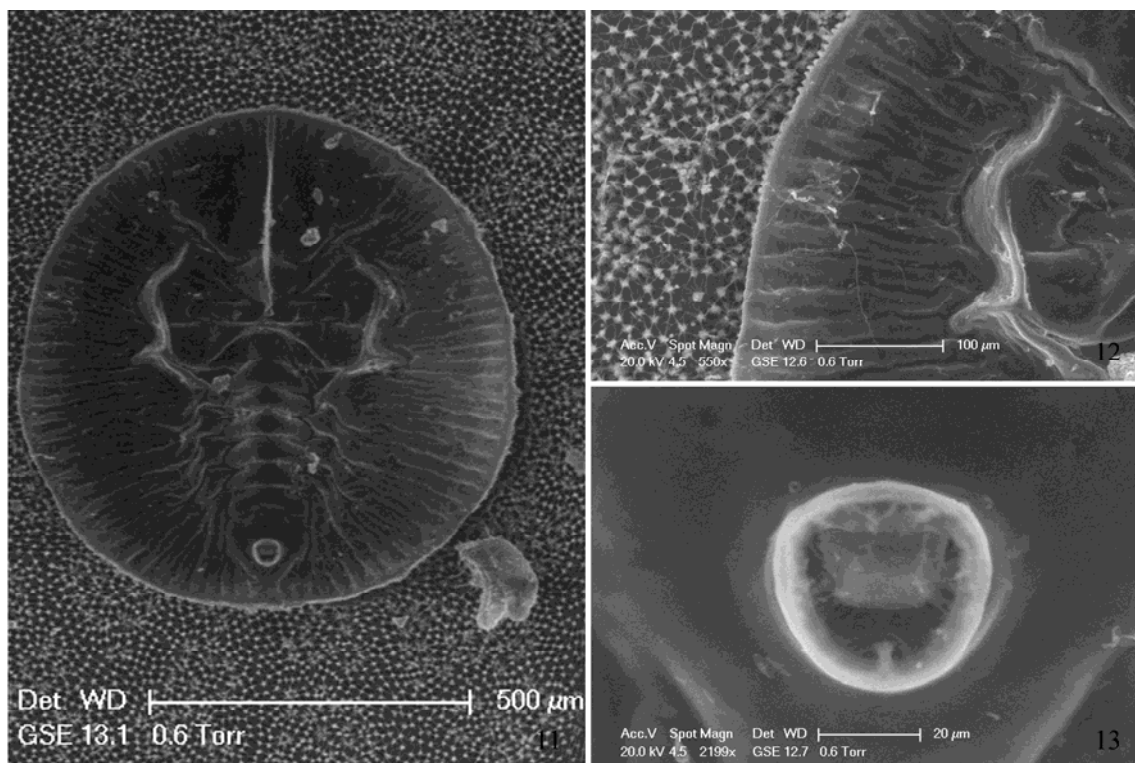
***Aleurotrachelus machili* Takahashi, 1942 (Figs 8–13)**

Aleurotrachelus machili Takahashi, 1942. *Trans. Nat. Hist. Soc. Formosa*, 32: 168.

Diagnosis. Puparia. Yellowish brown, shining, subcircular, broadest across the abdominal, slightly narrower anteriorly, 0.873 mm in length and 0.783 mm in width. Dorsum flattened, with no distinct median ridge but with some wax secretion. Some small circular pores present on disk, each with a minute central spot. Marginal teeth in two rows, outer teeth large, stout, a little longer than wide, 13 crenulations in 0.1 mm; inner teeth small, indistinct. Paired anterior and posterior marginal setae present. Cephalothorax with a central ridge extending to the margin, at both sides with a bent pleat extending outward from the pro-thorax to meso-thorax, bending to abdominal segment II. Submarginal area not separated from dorsum clearly, with many ridge-like fold running mesad from margin. Thoracic tracheal folds and pores not discernible. Longitudinal molting suture reaching the margin while transverse molting suture not reaching the submargin. Abdominal segment sutures well defined, subequal in length, about 39.6 µm, and at the both side of abdominal segment III–VII with the ridge. Vasiform orifice subcircular, nearly as long as wide, about 40.1 µm, without teeth; operculum square, covering about half of the orifice.



Figures 8–10. *Aleurotrachelus machili* Takahashi. 8. Puparium. 9. Margin. 10. Vasiform orifice. Scale bars: 8=0.2mm; 9=0.05mm; 10=0.02mm.



Figures 11–13. SEM of *Aleurotrachelus machili* Takahashi. 11. Puparium. 12. Margin. 13. Vasiform orifice.

Lingula and caudal furrow absent.

Material examined. 3 puparia on 3 slides, China, Guangxi, Guangxi University, 21.VIII.2011, coll. Jirui Wang, from *Dimocarpus longan*, deposited in YZU.

Distribution. China (Guangxi); Thailand (Takahashi, 1942).

Host plants. *Dimocarpus longan*, *Desmodium unbellatum*.

Remarks. This species is extremely similar to the *Crenidorsum caerulescens* (Singh), but can be easily distinguished from the presence of a tubercle on vasiform orifice.

***Asialeyrodes indica* Sundararaj & David, 1992 (Figs 14–21)**

Asialeyrodes indica Sundararaj & David, 1992. *J. Bombay Nat. Hist. Soc.*, 88: 415; David & Jesudasan, 2002. *Entomon*, 27: 325.

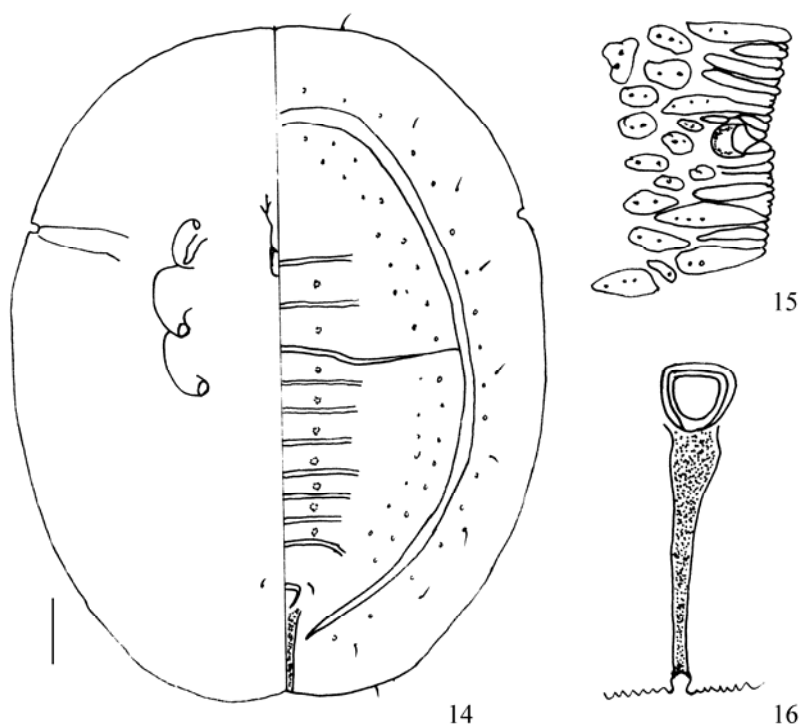
Asialeurodes saklespurensis Regu & David, 1993. *Entomon*, 18: 91–93.

Diagnosis. Puparia. Light brown, elliptical, flattened, slightly constricted across the thoracic tracheal pores, broadest at the first abdominal segment region; about 0.972 mm in length and 0.768 mm in width. Margin smooth, teeth small, 30 crenulations in 0.1 mm. Paired anterior and posterior marginal setae 16.9 μ m and 21.2 μ m long, respectively. Thoracic and caudal tracheal pores distinct with chitinised rim. Submarginal area separated from dorsum clearly by a distinct furrow, submargin broad, about 83.6 μ m wide. Eight pairs of short setae distributed on the submarginal area- three pairs on cephalothorax and five pairs on abdomen, about 6.3 μ m long. Longitudinal and transverse molting suture both reaching the submargin. Dorsum with many irregular or small polygonal markings. Pores sparsely distributed throughout dorsum. Abdominal segment sutures well defined. Vasiform orifice cordate, wider than long, 31.2 μ m long and 36.4 μ m wide; operculum also cordate, almost covering all the orifice, obscuring the lingula. Caudal furrow distinct, 137.6 μ m long and 26.3 μ m wide, expanded at the base, and slightly depressed at the end; with some polygonal markings. Cephalic setae 9.3 μ m long, first abdominal setae 13.2 μ m long, eighth abdominal setae 6.5 μ m long.

Material examined. 5 puparia on 5 slides, China, Guangxi, Shiwandashan, 17.VIII.2011, coll. Jirui Wang, from *Psychotria* sp., deposited in YZU.

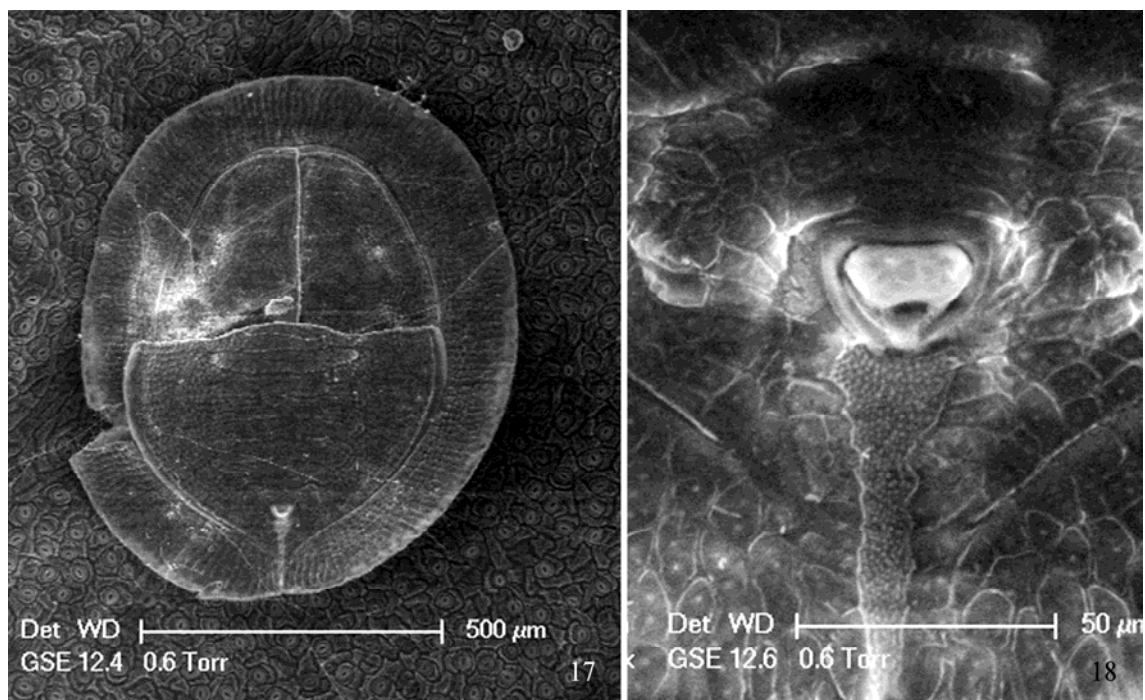
Distribution. China (Guangxi); India (Sundararaj & David, 1992).

Host plants. *Psychotria* sp., *Ervatonia coronaria*, *Tabernmontana heyneana*, *Scheffera rostrate*, *Capparis rheedii*, *Antidesma* sp., *Lagerstromia microcarpa*, *Syzygium* sp., *Streblus asper*, *Olea dioica*, *Xeromphis spinose*, *Smilax zeylanica*, *Symplocaceae* sp. (Evans, 2008)

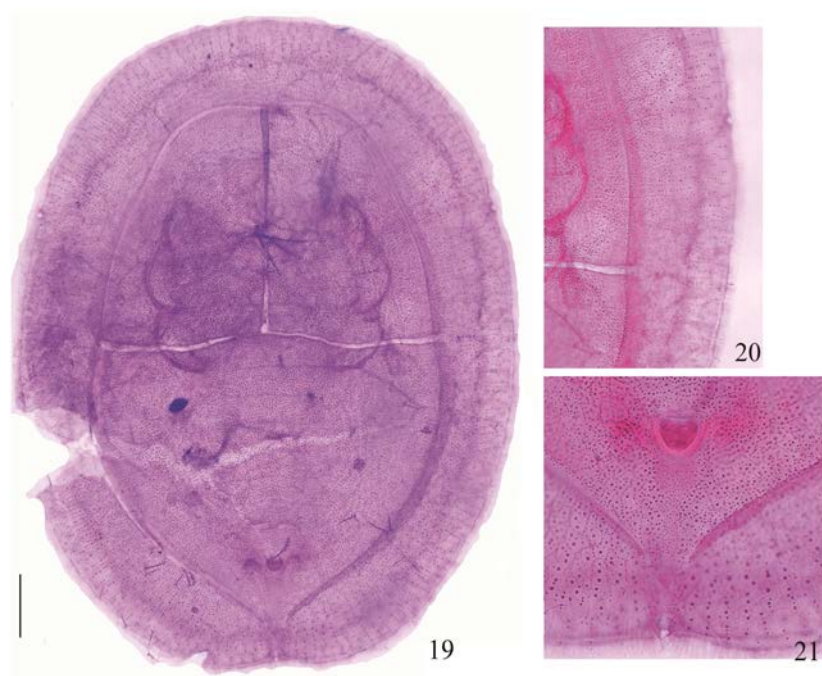


Figures 14–16. *Asialeyrodes indica* Sundararaj & David (after Meganathan & David, 1994). 14. Puparium. 15. Margin. 16. Vasiform orifice and caudal furrow. Scale bars = 0.1 mm.

Remarks. This species is similar to *A. selangorensis* Corbett, but can be distinguished by the colour, presence of submarginal setae and markings on dorsum.



Figures 17–18. SEM of *Asialeyrodes indica* Sundararaj & David. 17. Puparium. 18. Vasiform orifice and caudal furrow.

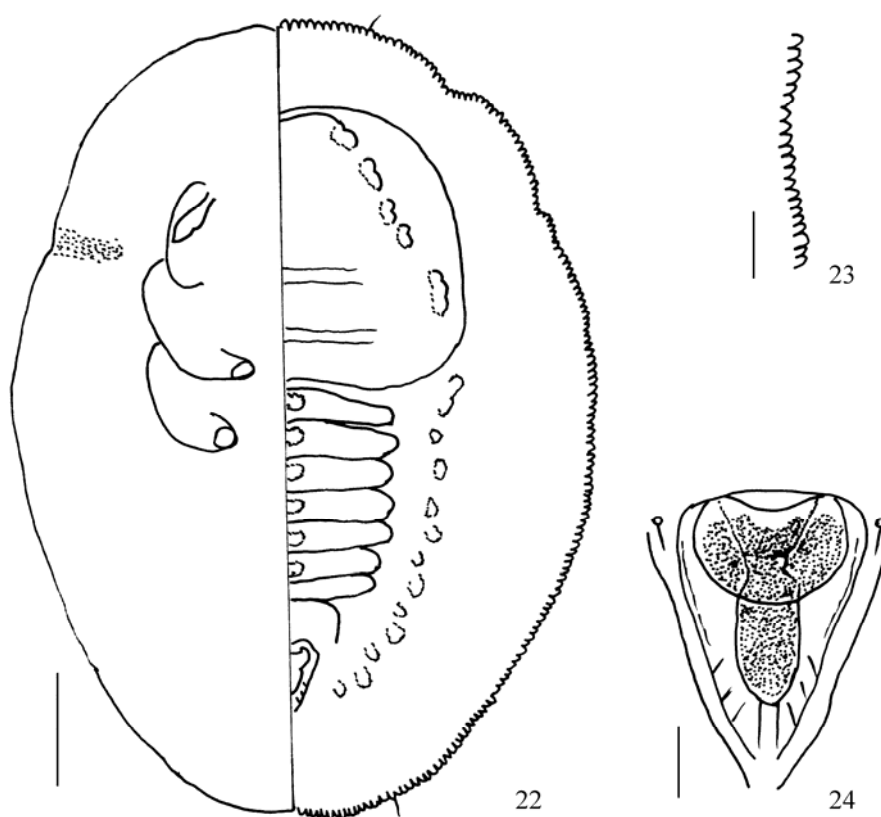


Figures 19–21. *Asialeyrodes indica* Sundararaj & David, slide mounted specimen. 19. Puparium. 20. Margin. 21. Vasiform orifice and caudal furrow. Scale bar: 19=100 μm.

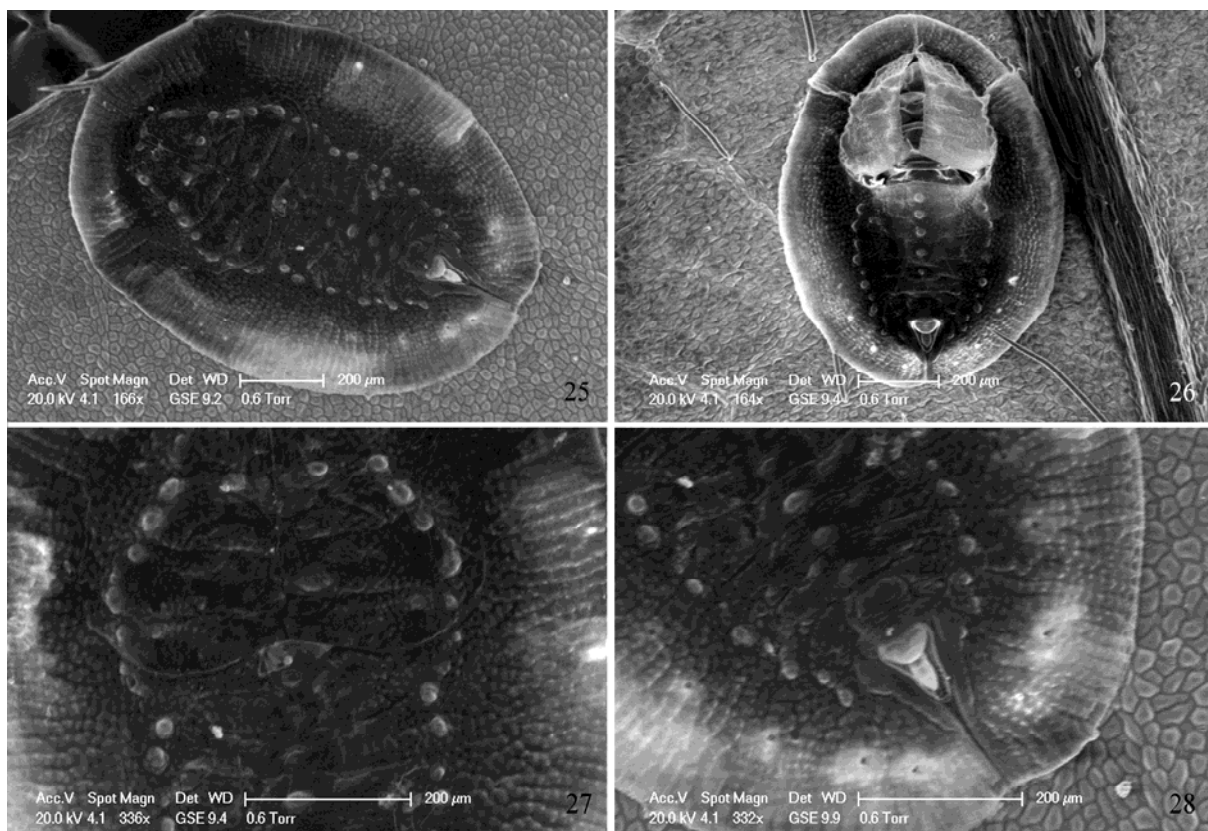
***Asterobemisia takahashii* Danzig, 1966 (Figs 22–28)**

Asterobemisia takahashii Danzig, 1966. *Entom. Oboz.*, 45: 376.

Diagnosis. Puparia. Yellowish, broadly oval, 1.35 mm in length and 0.95 mm in width, with transparent wax bands on



Figures 22–24. *Asterobemisia takahashii* Danzig. 22. Puparium. 23. Margin. 24. Vasiform orifice. Scale bars: 22 = 0.2 mm; 23 = 0.05 mm; 24 = 0.03 mm.



Figures 25–28. SEM of *Asterobemisia takahashii* Danzig. 25. Puparium. 26. Empty pupal case. 27. Tubercle. 28. Vasiform orifice and caudal furrow.

dorsal disk. Margin dentate, 11 denticles in 0.1 mm. Paired anterior and posterior marginal setae about 18 μm long. Submarginal area not separated from dorsum clearly, with many ridge-like fold running mesad from margin. Thoracic tracheal folds distinct, with many granulated structure. Thoracic comb discernible, consist of 15–20 denticles which are smaller than the other marginal denticles. Longitudinal and transverse molting suture not reaching the margin. Abdominal segment sutures well defined, abdominal segment I–II about 53.3 μm long, abdominal segment III about 66.7 μm long, abdominal segment IV–VI about 35.6 μm long, abdominal VII about 16.3 μm long. One tubercle presents on the median line of each abdominal segments. Margin of thoracic and abdominal segments area with a row of distinct rounded tubercles. Vasiform orifice triangular, 120.7 μm long, 82.7 μm wide, with several transverse folds; operculum semicircular, 37.9 μm long, 76.8 μm wide, covering about half of the orifice. Lingula exposed, elongate, about 41.6 μm long, apex bearing a pair of apical setae. Caudal furrow indistinct.

Material examined. 4 puparia on 4 slides, China, Zhejiang, Tianmu Mt., 28.VII.2011, coll. Jirui Wang, from *Sophora japonica*, deposited in YZU.

Distribution. China (Zhejiang); Korea (Suh *et al.*, 2008), Russia (Danzig, 1966).

Host plants. *Sophora japonica*, *Quercus mongolica*, *Pueraria thunbergiana* (Evans, 2008).

Remarks. This species is similar to *A. lata* Danzig, but is different by the presence of sclerotized denticles along the margin, and the absence of the transverse constriction in the region of the thoracic tracheal combs (Danzig, 1966).

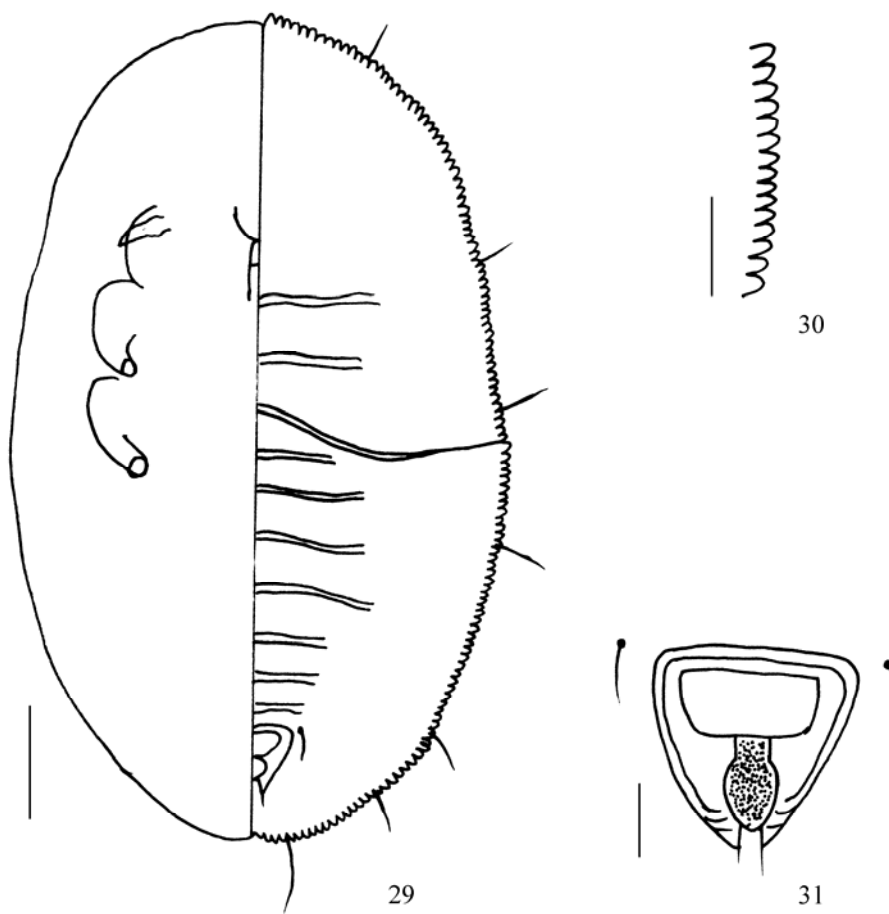
***Pealius akebiae* (Kuwana, 1911) (Figs 29–39)**

Aleyrodes akebiae Kuwana, 1911. *Pomona Coll. J. Entomol. Zool.*, 3: 622.

Odontaleyrodes akebiae: Takahashi, 1954. *Insec. Matsum.*, 18: 49.

Pealius akebiae: Martin, 1999. *CSIRO Entomology Technical Paper*, 38: 91.

Diagnosis. Puparia. White, elliptical, 0.699 mm in length and 0.468 mm in width; oval, broadest across the first



Figures 29–31. *Pealius akebiae* (Kuwana). 29. Puparium. 30. Margin. 31. Vasiform orifice. Scale bars: 29 = 0.1 mm; 30–31 = 0.02 mm.

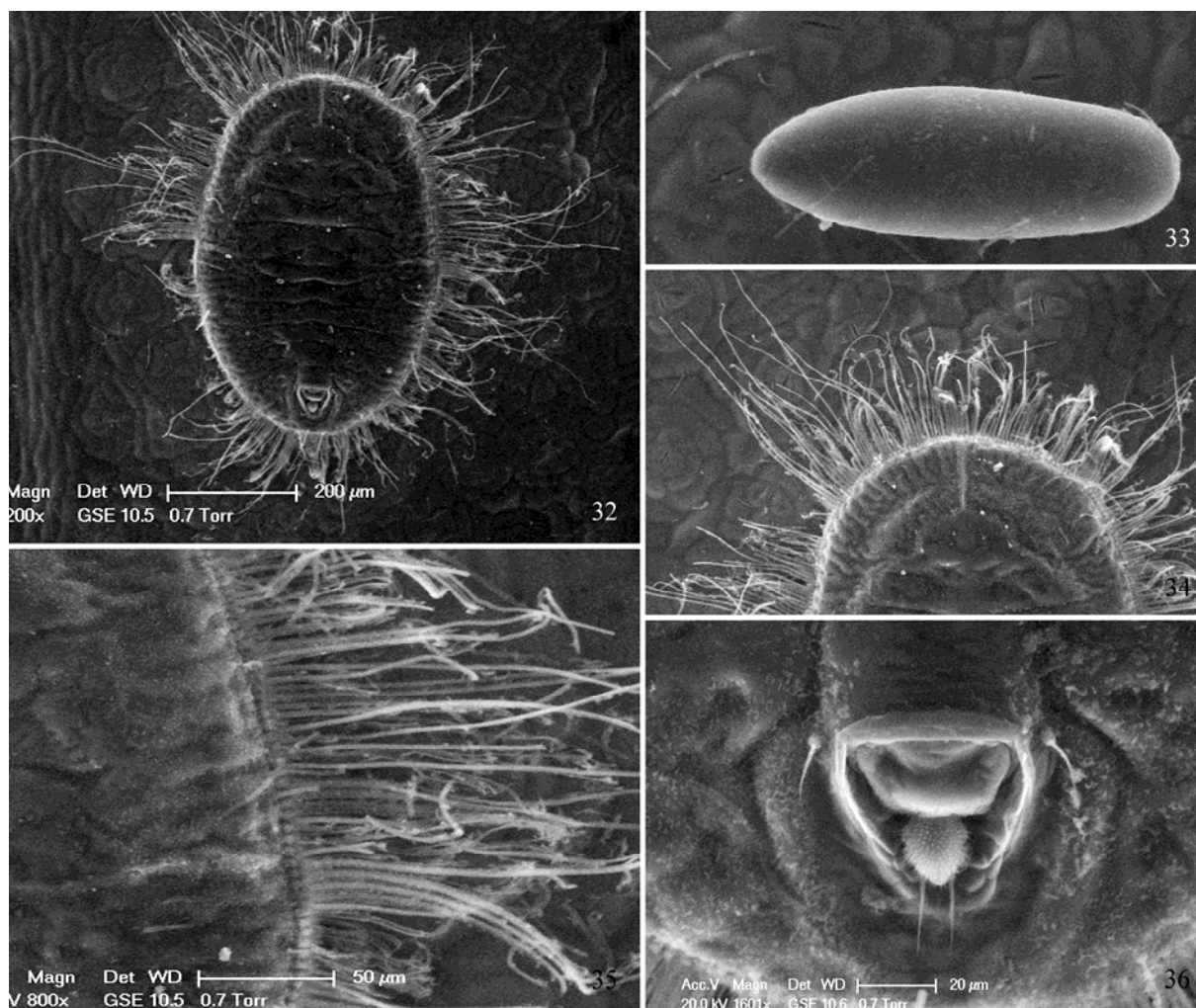
abdominal segment region, with a little wax secretion. Margin with many long wax fringe, usually curved, about 0.346 mm long. The margin rim is narrow and minutely crenulated, about 30–35 crenulations in 0.1 mm; 6 pairs of short setae along the margin, subequal in length, about 17.1 μm . Submarginal area separated from dorsum clearly, 42.9 μm in width. Thoracic tracheal folds and pores not discernible. Longitudinal and transverse molting suture not reaching the margin. Abdominal segment sutures well defined, abdominal segment I–II about 28.6 μm long, abdominal segment III–VI about 40 μm long, abdominal segment V–VI about 29.1 μm long, abdominal VII about 15.6 μm long. Vasiform orifice subcordate, anterior margin straight, longer than wide, 55.2 μm long, 47.1 μm wide; operculum trapezoid, covering about half of the orifice. Lingula exposed, distal part enlarged and apex bearing a pair of apical setae, 20.1 μm long. Caudal furrow indistinct, caudal setae about 38.7 μm long.

Material examined. 20 puparia on 20 slides, China, Guangzhou, 8.VIII.2014, coll. Shunxiang Ren, from an unidentified plant, deposited in YZU.

Distribution. China (Guangdong); Japan.

Host plants. an unidentified plant, *Akebia labata*

Remarks. This species resembles to *P. maskelli* (Bemis), but can be distinguished by the presence of a series of setae along the margin, tracheal combs not differentiated.



Figures 32–36. SEM of *Pealius akebiae* (Kuwana). 32. Puparium. 33. Egg. 34. Cephalothorax. 35. Margin and wax secretion. 36. Vasiform orifice.

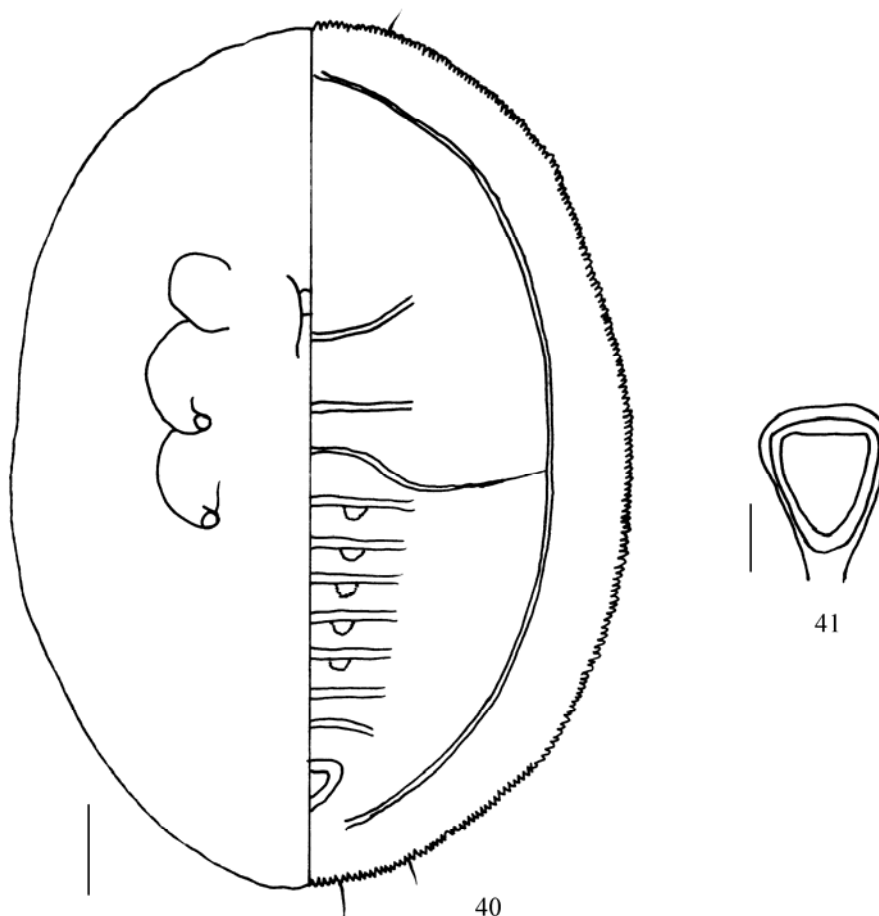
***Tetraleurodes neemani* Bink-Moenen, 1992 (Figs 40–42)**

Tetraleurodes neemani: Bink-Moenen & Gerling, 1992. *Boll. Lab. Entomol. Agrar.*, 47: 34.

Diagnosis. Puparia. Yellowish, elliptical, 1.06 mm in length and 0.668 mm in width, slightly narrower anteriorly,



Figures 37–39. *Pealius akebiae* (Kuwana), slide mounted specimen. 37. Puparium. 38. Margin. 39. Vasiform orifice. Scale bar: 37 = 100 μ m.



Figures 40–41. *Tetraleurodes neemani* Bink-Moenen. 40. Puparium. 41. Vasiform orifice. Scale bars: 40 = 0.1 mm; 41 = 0.04 mm.

margin with wax fringe, usually curved, about $65.4\text{ }\mu\text{m}$ long. Margin crenulated, 14–19 crenulations in 0.1 mm . Paired anterior and posterior marginal setae about $22.8\text{ }\mu\text{m}$ long. Submarginal area separated from dorsum clearly by a distinct furrow, submargin broad, about $98.6\text{ }\mu\text{m}$ wide. Some small pores present in the submarginal area and dorsal disc. Longitudinal molting suture reaching the margin while transverse molting suture not reaching the margin. Thoracic and abdominal segment sutures well defined, abdominal segment I–VI about $53.3\text{ }\mu\text{m}$ long, abdominal segment VII about $28.1\text{ }\mu\text{m}$ long. Vasiform orifice cordate, without teeth, longer than wide, $62.3\text{ }\mu\text{m}$ long and $41.6\text{ }\mu\text{m}$ wide. Eighth abdominal setae $20.1\text{ }\mu\text{m}$ long. Operculum cordate, almost covering all the orifice. Lingula not discernible. Caudal furrow distinct, about $92.1\text{ }\mu\text{m}$ long and $30.2\text{ }\mu\text{m}$ wide. Caudal setae about $41.6\text{ }\mu\text{m}$ long.

Material examined. 2 puparia on 2 slides, China, Guangdong, South China Agricultural University, 26.V.2011, Col. Jirui Wang, from *Carmona microphylla*, deposited in YZU.

Distribution. China (Guangdong); Iran, Israel (Evans, 2008).

Host plants. *Carmona microphylla*, *Laurus nobilis*.

Remarks. This species resembles to *T. hederæ* Goux, but can be distinguished by the smaller puparium.

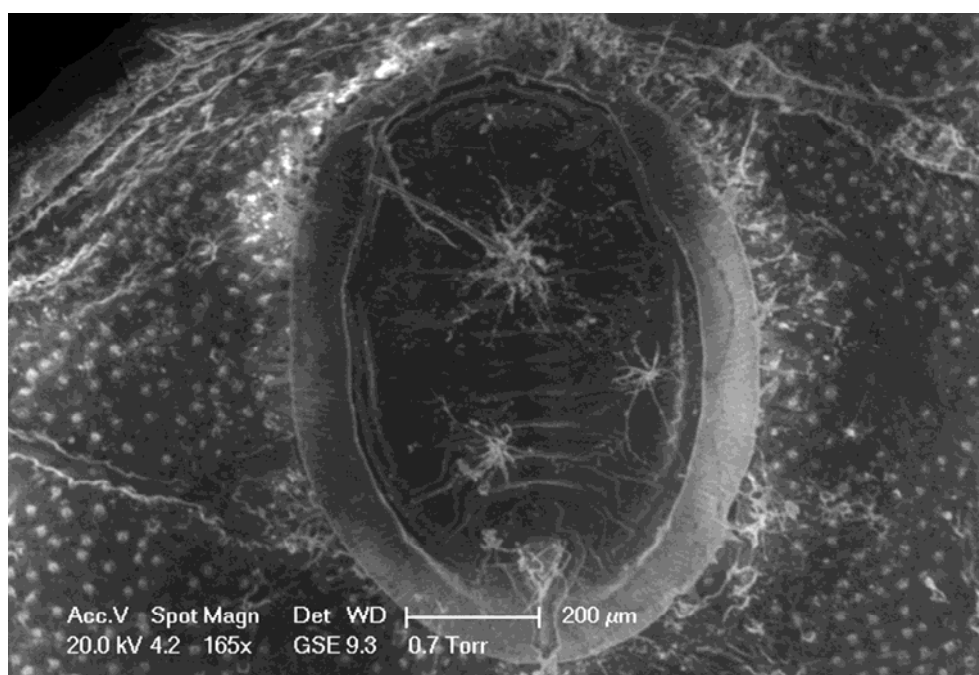


Figure 42. SEM of *Tetraleurodes neemani* Bink-Moenen.

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