Zootaxa 1331: 31–54 (2006)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

1331

Lipaleyrodes emiliae, a new species of whitefly (Hemiptera: Aleyrodidae) from Taiwan and Hong Kong

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Abstract

The adult male, female, immature stages, and egg of a new species of whitefly, *Lipaleyrodes emiliae*, are described from Taiwan and Hong Kong. The species has been found commonly on *Emilia sonchifolia* (Asteraceae). Scanning electron micrographs, photographs and drawings are included with descriptions of immature stages and adults. The immatures and adults of *L. emiliae* are compared with those of *Bemisia tabaci*.

Key words. Hemiptera, Aleyrodidae, *Lipaleyrodes*, Taxonomy, new species, Taiwan

Introduction

This paper describes all life stages of a new species of Aleyrodidae that is widely distributed in Taiwan and has also been found in Hong Kong. The species appears to have restricted host associations, having been found feeding only on Asteraceae, especially *Emilia sonchifolia*. A detailed study of the structural features of the immature stages and adults indicated that this species is a member of the genus *Lipaleyrodes* Takahashi, and it is therefore described as *Lipaleyrodes emiliae*. Details of the egg, immatures and adult are presented in this paper, with scanning electron micrographs and figures. A comparison is made of the pupal cases and adults of this new species with others in the genus. *Lipaleyrodes* currently includes 8 described species: *L. breyniae* (Singh), *L. crossandrae* David & Subramaniam, *L. euphoribiae* David & Subramaniam, *L. vernoniae* David & Thenmozhi, *L. hargreavesi* (Corbett), *L. phyllanthi* Takahashi, *L. atriplex* (Froggatt), and *L. leguminicola* (Takahashi) (Mound & Halsey 1978; David & Thenmozhi 1995; Martin 1999).

Accepted by L. Mound: 25 Aug. 2006; published: 9 Oct. 2006

Material and methods

Leaf undersurfaces containing eggs and late instar nymphs of the new species were collected in the field, and a colony was established in the laboratory. Emergent parasitoids were removed. Specimens for scanning electron microscopy were removed from host plants and washed in 95% ethanol with an ultrasonic mini-cleaner at 50–60 Hz for 2 min, then were dehydrated in 95% ethanol and finished in 100% ethanol. Specimens were next critical-point-dried using CO_2 as a transfer fluid, mounted on stubs, sputter-coated with a gold-palladium alloy, and examined with a scanning electron microscope (JEOL JSM-5600) in the Department of Entomology, National Taiwan University. Descriptions and terminology of the external and interior morphological structures are based on Bink-Moenen (1983), Martin (1985), Gill (1999) and Guimares (1996). Measurements were made of 5 specimens of each stadium.

Specimen depositories:

ANIC	Australian National Insect Collection, CSIRO Entomology, Canberra, ACT, Australia
BMNH	Natural History Museum, London, UK
CDFA	California Department of Food and Agriculture, Sacramento, CA, USA
NMNS	National Museum of Natural Science, Taichung, Taiwan
NTU	National Taiwan University, Taipei, Taiwan
TARI	Taiwan Agricultural Research Institute, Taichung, Taiwan
USNM	United States Department of Agriculture, Beltsville, MD, USA (Sternorrhyncha collections of the United States National Museum of Natural History, Washington DC)

Lipaleyrodes emiliae sp. nov.

(Figs 1–53)

PUPARIUM (Figs 1A, 10). Pale to yellowish, average size 0.66 mm long and 0.47 mm wide, 1.4 times as long as wide. Elongate to ovoid, broadest at metathorax. Found in groups on the undersurface of leaves. Margin crenulate (Fig. 11). Pairs of anterior and posterior marginal setae evident, anterior 10 µm long; posterior 25 µm long. Thoracic and caudal tracheal area not evident. Lingula appearing reddish-brown pigmented (Fig. 48). Most pupae with a marginal ring of uneven, fine, white wax (Fig. 51). This waxy secretion associated with a kind of minute pore (Figs 13–14). At a distance, groups of immatures appear to have been dusted with a white powder, although closer examination indicates the presence of white, fluffy and contorted wax filaments (Fig. 52). Some specimens show accumulation of this waxy secretion on the thoracic area. ***Dorsum***. Dorsum with 2 pairs of dorsal setae; cephalic setal length ranging widely from 21 to 82 µm, 102 µm apart; abdominal VIII setae much longer than vasiform orifice, 102 µm long, 82 µm apart. Longitudinal molting suture reaching margin, but transverse one failing to. Abdominal

sutures ending on subdorsum. Caudal setae submarginal, 101 µm long, 52 µm apart; submarginal tiny setae 7 pairs, 2 pairs on cephalic area, 5 pairs posterioral to transverse moulting suture; porettes ill-defined; abdominal segment I 33 µm long; segments II–V slightly subequal, 28, 30, 30 and 29 µm long, respectively, segment VI 38 µm long; segment VIII longest at 42 µm; segment VII much reduced, medially shortened, 9 µm long. Vasiform orifice triangular to trapezoidal, posterior margin poorly defined, with lateral teeth on both sides; a little longer than wide at 70 x 63 µm (Fig. 16). Operculum semicircular, 1.41 times as wide as long at 36 x 51 µm; truncate at hind margin, occupying about half of vasiform orifice. Lingula exposed, 74 µm long, almost included within vasiform orifice except for the slightly tapering, spinulose apex that is exposed; a pair of subapical setae present, 29 µm long. Caudal furrow and ridges barely indented (Figs 1C, 15). Dorsal disc separated from submargin by a distinct fold. Submargin broad with 11 pairs of wax plate clusters, wax plates oval (Figs 1B, 12), clusters I and II with fewest (< 5) wax plates; clusters IV–VI and XI with most wax plates, each with 1015; each of clusters III and VII–IX with 79. ***Venter*** (Fig. 17). A pair of ventral abdominal setae present, 4.6 µm long, 75 µm apart. Antenna not extending beyond base of prothoracic leg (Fig. 18). Outline of legs curved. Setae tiny at base of legs and rostrum.

THIRD INSTAR (Figs 2A, 19). Pale to yellowish, with an average size 1.43 times as long as wide at 0.46 x 0.32 mm. Elongate to ovoid, broadest at metathorax. Margin crenulate. Pairs of anterior and posterior marginal setae evident: anterior 5.6 µm long, posterior 20 µm long. Thoracic and caudal tracheal areas not evident. Lingula appears reddish-brown. ***Dorsum***. Dorsum with 2 pairs of dorsal setae; cephalic setae varied in length at 8–28 µm, 79 µm apart; abdominal VIII setae 54 µm long, 66 µm apart. Abdominal sutures ending on subdorsum. Caudal setae submarginal, 84 µm long, 37 µm apart. Abdominal segment I 26 µm long; segments II–VI subequal, 22, 20, 20, 18, and 22 µm long, respectively; segment VIII longest at 34 µm; segment VII much reduced, medially shortened, 7.5 µm long. Vasiform orifice triangular to trapezoidal; wider than long, at 49 µm long x 52 µm wide. Operculum semicircular, 1.61 times as wide as long at 26 x 42 µm; truncate at hind margin, occupying about half of vasiform orifice. Lingula exposed, 59 µm long, almost enclosed in vasiform orifice, except a small part of posterior end exposed outside, awl-shaped, slightly tapering, spinulose; a pair of subapical setae present, 18 µm long. Caudal furrow and ridges barely indented (Figs 2B, 20). Dorsal disc separated from submargin by a distinct line. ***Venter*** (Fig. 21). Antenna thin and not extending beyond base of prothoracic leg. Legs appearing circular-conical. Setae tiny on base of legs and rostrum.

SECOND INSTAR (Figs 3A, 22). Pale to yellowish, with an average size 1.6 times as long as wide at 0.37 x 0.23 mm. Elongate to ovoid, broadest at metathorax. Margin crenulate. Pairs of anterior and posterior marginal setae evident, anterior 5.9 µm long; posterior 17 µm long. Thoracic and caudal tracheal area not evident. Lingula appears reddish-brown. ***Dorsum***. Dorsum with 2 pairs of dorsal setae; cephalic setae 13 µm long,

53 µm apart; abdominal VIII setae much shorter than vasiform orifice, 19 µm long, 49 µm apart. Abdominal sutures ending on subdorsum. Caudal setae marginal, 59 µm long, 26 µm apart; abdominal segment I 18 µm long; segments II–V subequal, 13, 15, 14, and 12 µm long, respectively; segment VI 17 µm long; segment VIII longest at 27 µm; segment VII much reduced, medially shortened, 4.3 µm long. Vasiform orifice triangular to trapezoidal, posterior margin truncated, with lateral teeth on both sides; as long as wide at 38 x 39 µm. Operculum semicircular, 1.60 times as wide as long at 20 x 32 µm; truncate at hind margin, occupying about half of vasiform orifice. Lingula exposed, 42 µm long, almost enclosed within vasiform orifice; exposed posterior end awl-shaped, slightly tapering, spinulose; a pair of subapical setae present, 13 µm long. Caudal furrow and ridges barely indented (Fig. 23). ***Venter*** (Fig. 24). Antenna not extending beyond base of prothoracic leg. Legs circular-conical. Setae tiny on base of legs and rostrum.

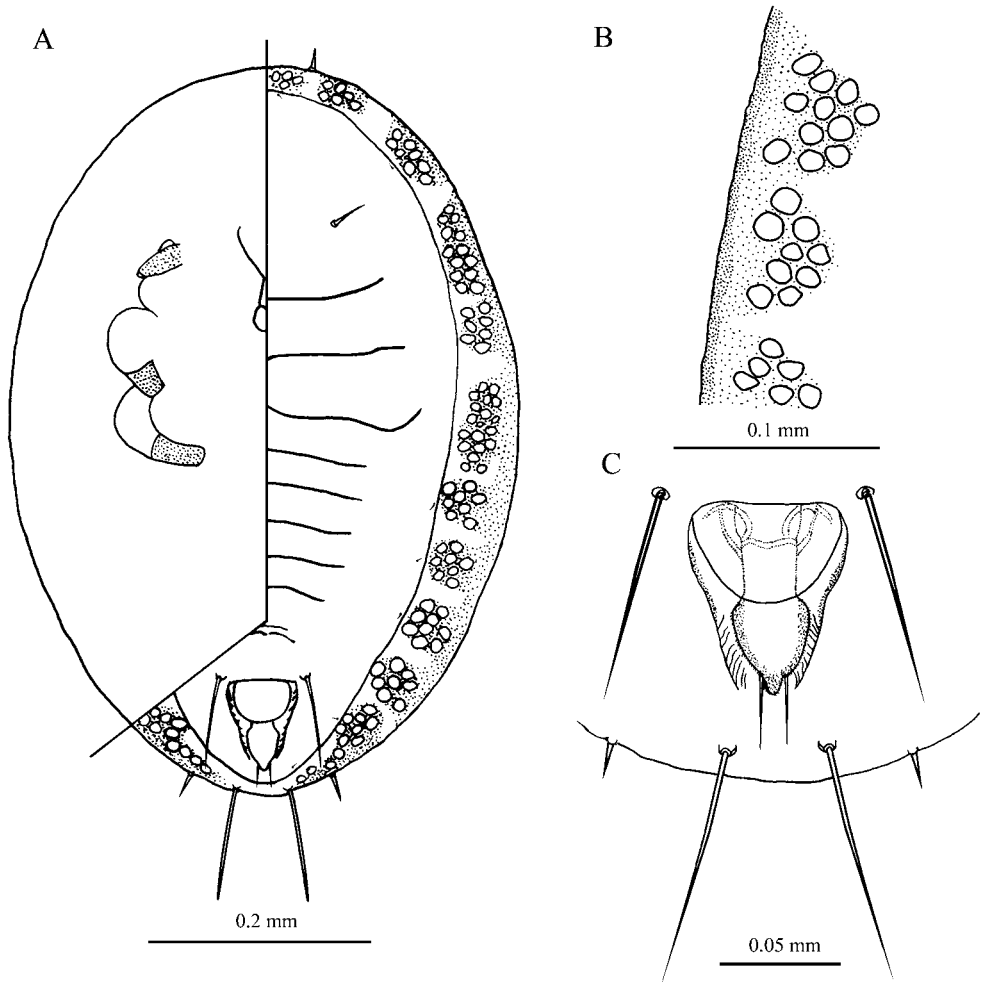


FIGURE 1A–C. *Lipaleyrodes emiliae*, 4th instar. A, dorsal and ventral view; B, clusters of wax plates; C, posterior area.

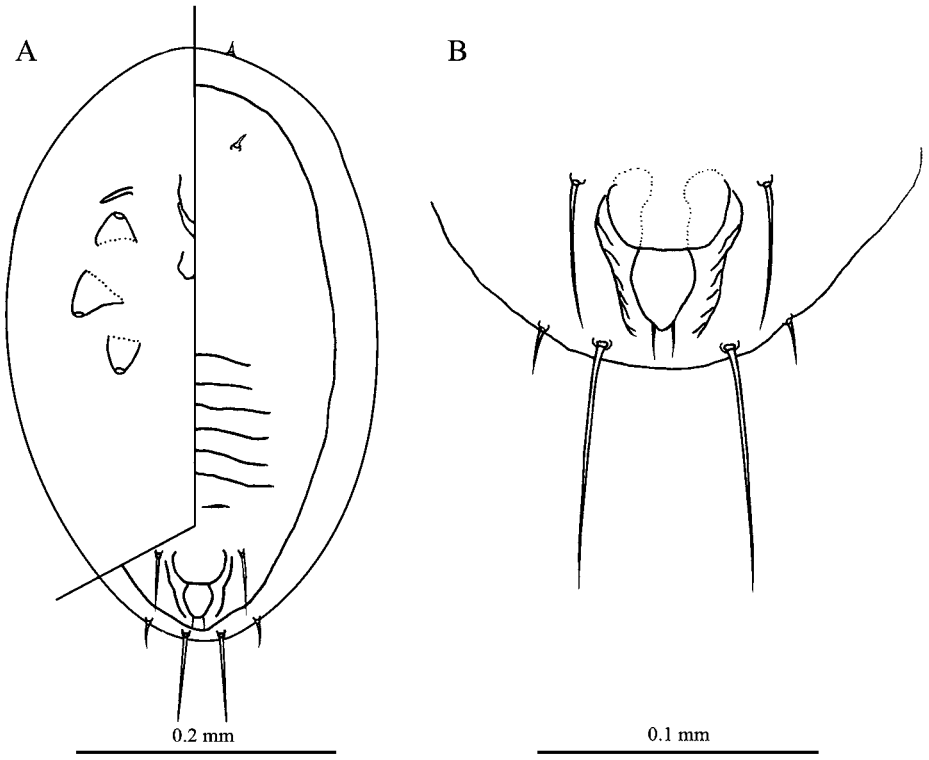


FIGURE 2A–B. *Lipaleyrodes emiliae*, 3rd instar: A, dorsal and ventral view; B, posterior area.

FIRST INSTAR (Figs 3B, 25). Pale to yellowish, with an average size 1.69 times as long as wide at 0.23 x 0.14 mm. Elongate to ovoid, broadest at mesothorax. Margin crenulate, surrounded by 15 pairs of variably sized setae (including posterior and caudal setae). Posterior marginal setae 17 µm long. Thoracic and caudal tracheal area not evident. ***Dorsum***. Abdominal segment VIII setae much shorter than vasiform orifice, 2.3 µm long, 32 µm apart. Abdominal sutures ending on subdorsum, suture between segments II and III much thicker than others. Caudal setae marginal, 57 µm long, 20 µm apart; abdominal segments I and II usually not visible, segment III 8 µm long; segments IV–VI subequal, 11, 11, and 10 µm long, respectively; segment VIII longest at 21 µm; segment VII much reduced, medially shortened, 2.6 µm long. Vasiform orifice triangular to trapezoidal, about as long as wide at 27 x 26 µm; posterior margin truncated, with lateral teeth on both sides. Operculum dumbbell-shaped, 2.15 times as wide as long at 11 x 23 µm; truncate at hind margin, occupying less than half of vasiform orifice. Lingula exposed, 23 µm long, extending slightly beyond vasiform orifice, the posterior end semicircular, spinulose; a pair of subapical setae present, 6.9 µm long. Caudal furrow and ridges barely indented (Fig. 26). ***Venter*** (Fig. 27). A pair of ventral abdominal setae present, 4.3 µm long, 25 µm apart. Antenna 62 µm long, 3-segmented, with apical seta. Legs segmented. Setae present at base of mid and hind legs.

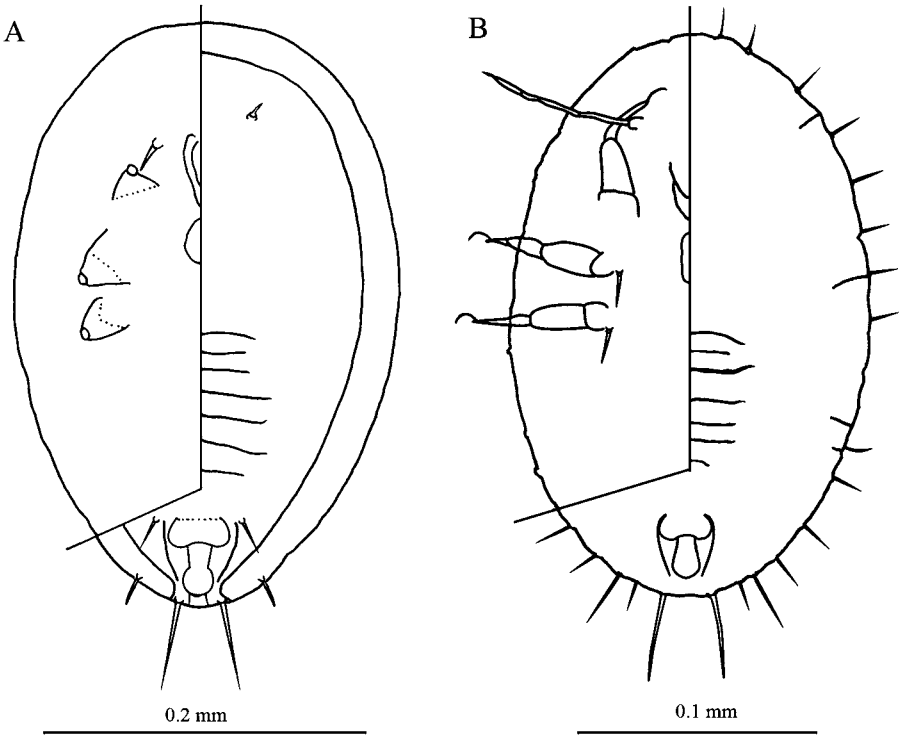


FIGURE 3A–B. *Lipaleyrodes emiliae*, 2nd instar: A, dorsal and ventral view; B, 1st instar, dorsal and ventral view.

EGG (Figs 9D, 28). Elongate to oval, surface smooth with brown metallic luster, 132 µm long, often found on undersurface of leaf and covered with waxy secretion. Base with a short pedicel, 26 µm long.

ADULT MALE. Length from vertex to claspers, 0.79 mm. One ocellus present laterally on each side, located close to upper compound eyes. Upper and lower compound eyes joined by a single ommatidium as in *B. tabaci* (Figs 5, 31). Tip of labium with sensorial hairs (Figs 29, 30). *Antenna* (Fig. 4A). As in other *Lipaleyrodes* species, near compound eyes, 7-segmented; segment I of short cylindrical form, 14 µm long; segment II 39 µm long; segment III longest, sub-cylindrical, 87 µm long, armed with 2 primary sensoria and 1 sensorial cone, sensoria located apically and sub-apically on segment III, tip of cone extending to base of sub-apical primary sensoria (Fig. 32); segment IV sub-cylindrical, 17 µm long, segment V sub-cylindrical, 25 µm long, with a primary sensoria apically (Fig. 33); segment VI sub-cylindrical, 19 µm long, with a sensorial cone sub-apically, distal end extending to junction of segments VI and VII; segment VII sub-fusiform, 30 µm long, with a primary sensorium and sensorial cone in the distal half and a seta on the tip; cone long at over one-third of segment VII (Fig. 34). *Wings*. Forewing 604 µm long, 215 µm wide. Hindwing 527 µm long, 185 µm wide. Wings not mottled, limpid, covered with white waxy secretions. Wing venation reduced to costal-subcostal veins and

radial vein. *Legs*. Mesotibia 184 µm long with ordinary rows of spines, brushes with 2 and 3 setae; proximal tarsus 59 µm long; distal tarsus 55 µm long (Figs 6A, 35). Hindtibia 249 µm long; proximal tarsus 74 µm long; distal tarsus 64 µm long (Fig. 7A); ending with 2 claws and paronychium, a little shorter than claw and covered with fine microtrichia at base (Fig. 37). Metatibial comb ordinarily with rows of 15 spines (Fig. 36) (in most individuals), numbers of spines not the same on all observed specimens (range, 1417). *Genitalia*. Aedeagus not bifurcate, 77 µm long, 11 µm wide, shorter than clasper. Clasper 23 µm at base, 88 µm long; 7 setae in mid-region (Figs 9B, 38 39).

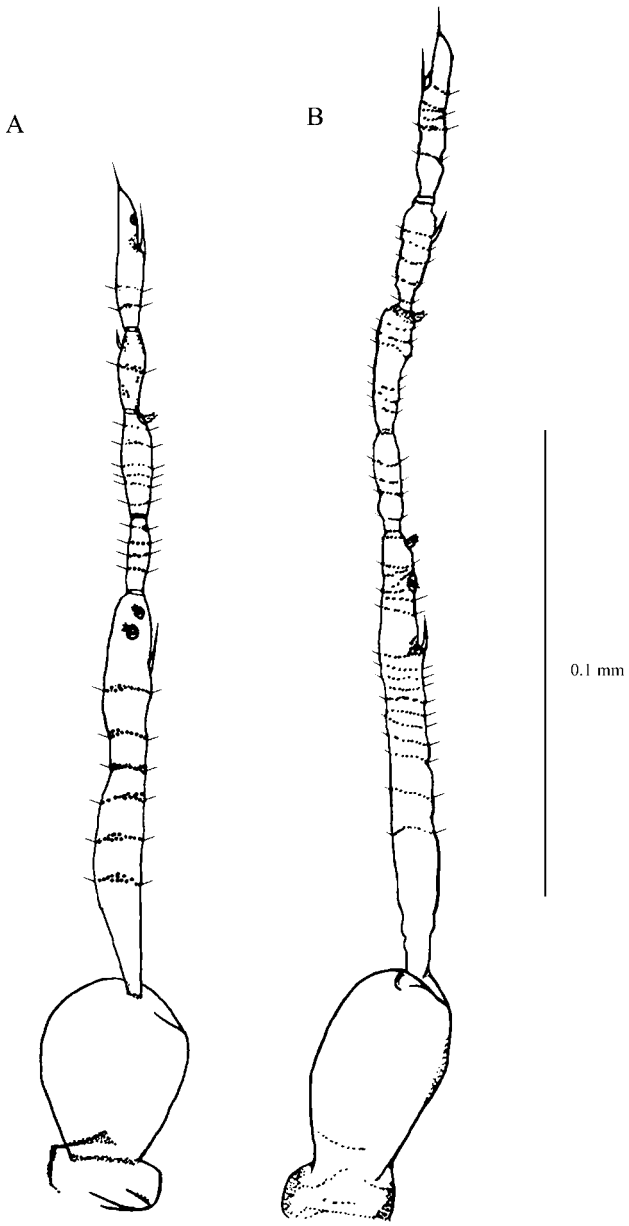


FIGURE 4A–B. *Lipaleyrodes emiliae*, adult antenna: A, male; B, female.

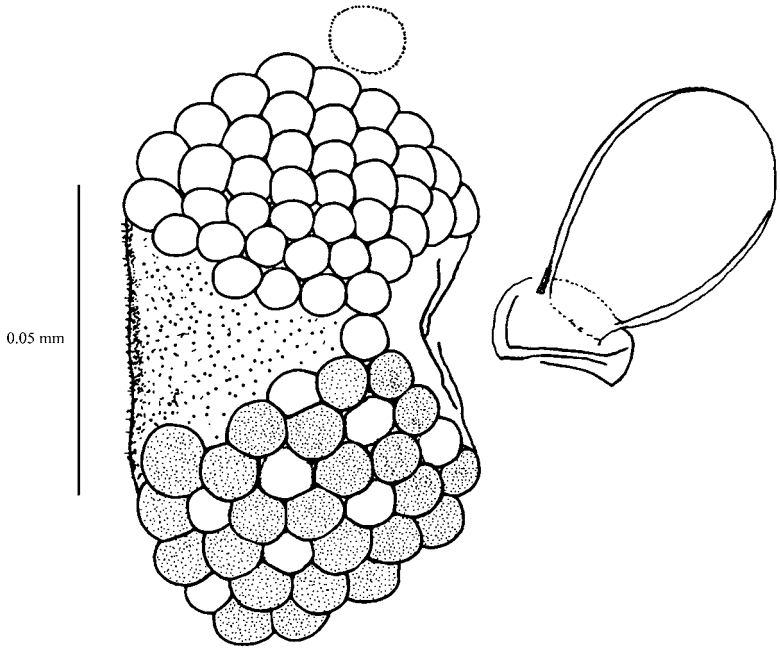
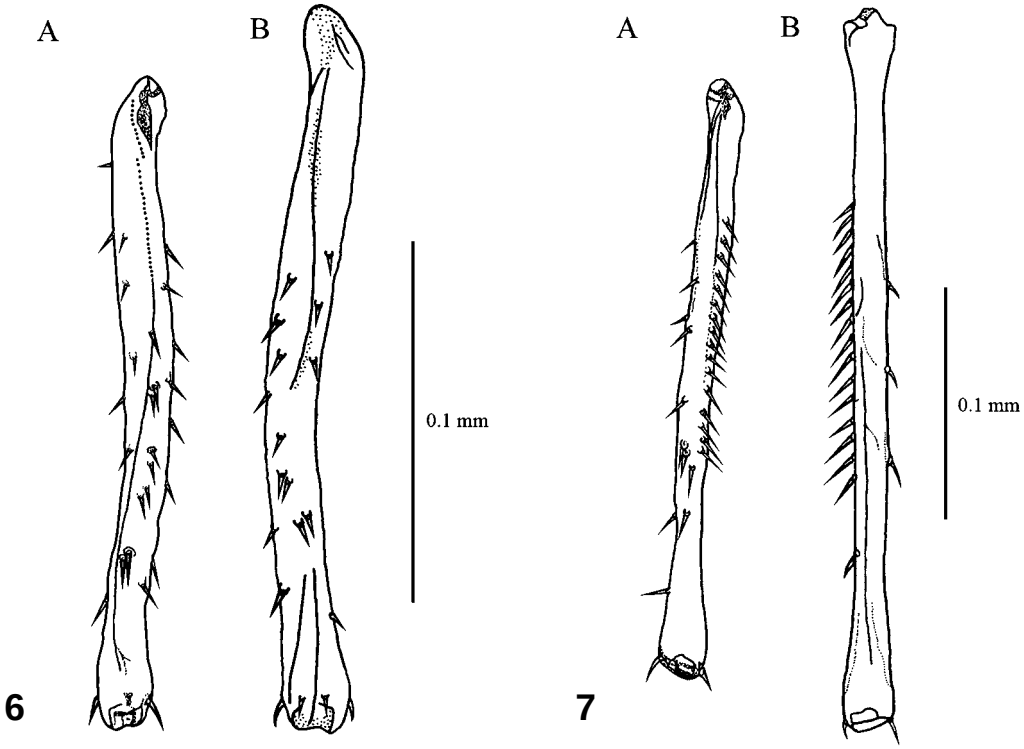


FIGURE 5. *Lipaleyrodes emiliae*: adult female, compound eye.



FIGURES 6–7. *Lipaleyrodes emiliae*, adult: 6A, male midtibia; 6B, female midtibia; 7A, male hindtibia; 7B, female hindtibia.

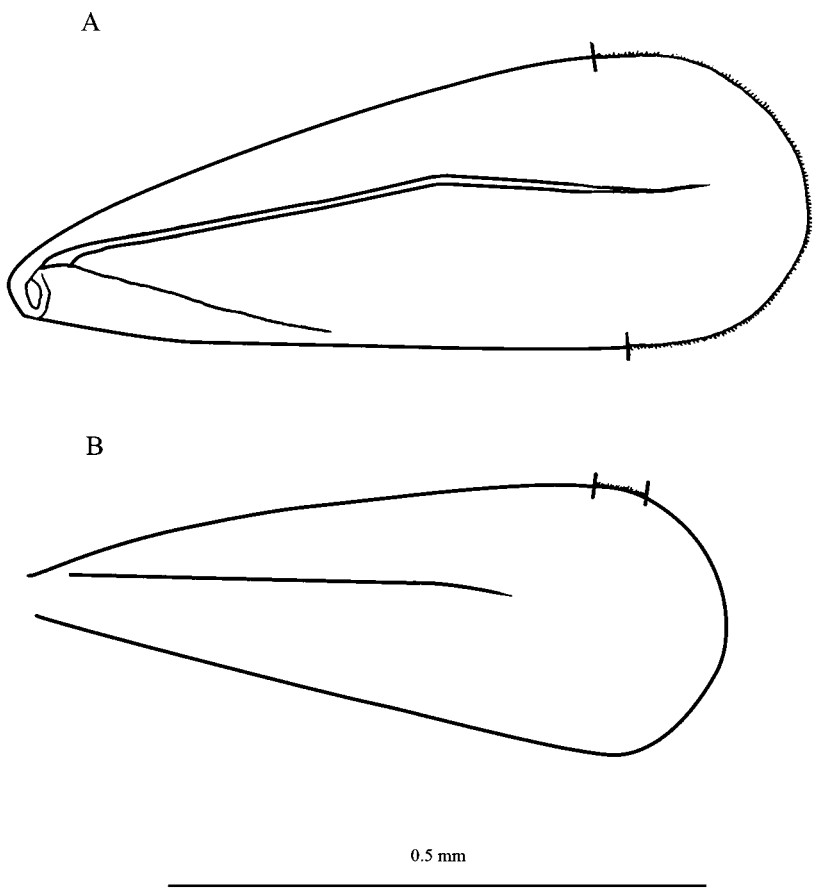


FIGURE 8A–B. *Lipaleyrodes emiliae* adult female, wing: A, forewing; B, hindwing.

ADULT FEMALE. Most of the characters are similar to those of males. Vertex to tip of ovipositor 0.89 mm in length. *Antenna* (Fig. 4B). Segments I–VII 15, 45, 99, 20, 28, 22, and 32 µm long, respectively. *Wings*. Forewing 748 µm long, 285 µm wide (Fig. 8A). Hindwing 649 µm long, 241 µm wide (Fig. 8B). *Legs*. Mesotibia 204 µm long, proximal tarsus 70 µm long, distal tarsus 67 µm (Fig. 6B). Hindtibia 291 µm long, proximal tarsus 88 µm long, distal tarsus 74 µm (Fig. 7B). *Genitalia*. Nine pairs of setae on gonapophysis, 2 pairs centrally, and 7 pairs laterally (Figs 40 41). Bulb-like orifice of cement gland trapezoidal, extremely curved, not mottled, full length 36 µm (Fig. 9A).

COMMENTS. In Taiwan, two different species are now included in the genus *Lipaleyrodes*: *L. breyniae* and *L. emiliae*. The puparia of both species have 11 pairs of wax plate clusters on the submarginal band, and all plates are oval in the two species. Each cluster consists of 4 or 5 wax plates in *L. breyniae*, but of 5 to 15 in *L. emiliae*. *Lipaleyrodes breyniae* occurs on euphorbiaceous and papilionaceous plants, whereas *L. emiliae* is restricted to Asteraceae, mostly *Emilia sonchifolia*. This new species may be distinguished from *L. breyniae* by the shorter the puparium and longer abdominal VIII

setae, which are much longer than the vasiform orifice. In contrast, *L. breyniae* has a longer puparium and the abdominal VIII setae are shorter than the vasiform orifice. Moreover, the lingula apex of *L. emiliae* is particularly distinctive.

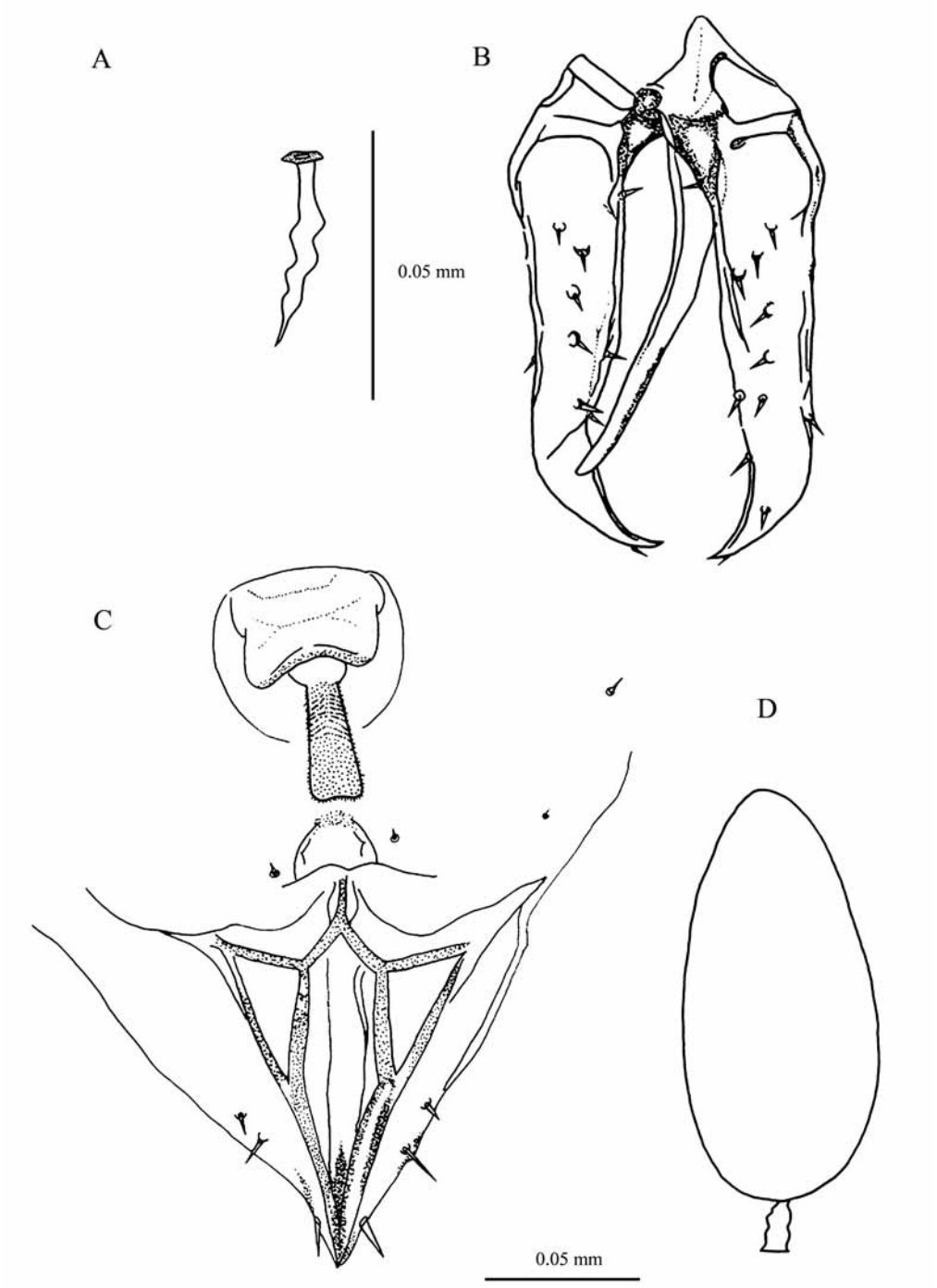
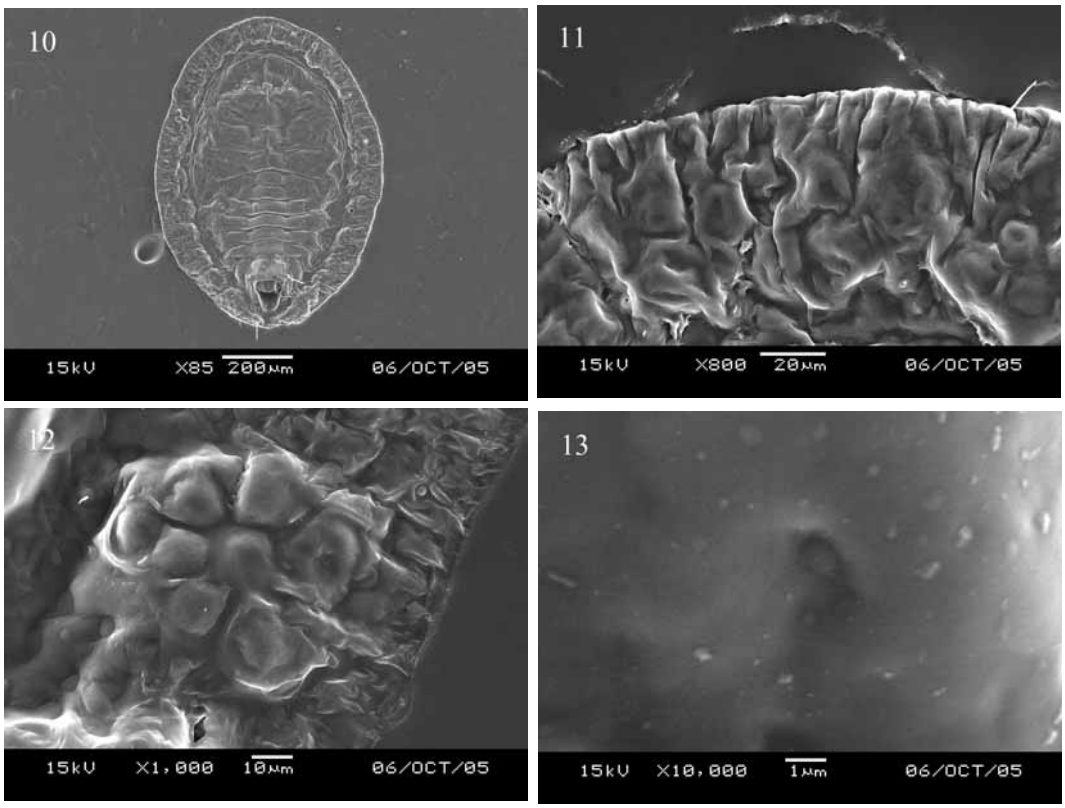


FIGURE 9A–D. *Lipaleyrodes emiliae*, adult: A, cement gland; B, terminalia of male; C, terminalia of male; D, egg.

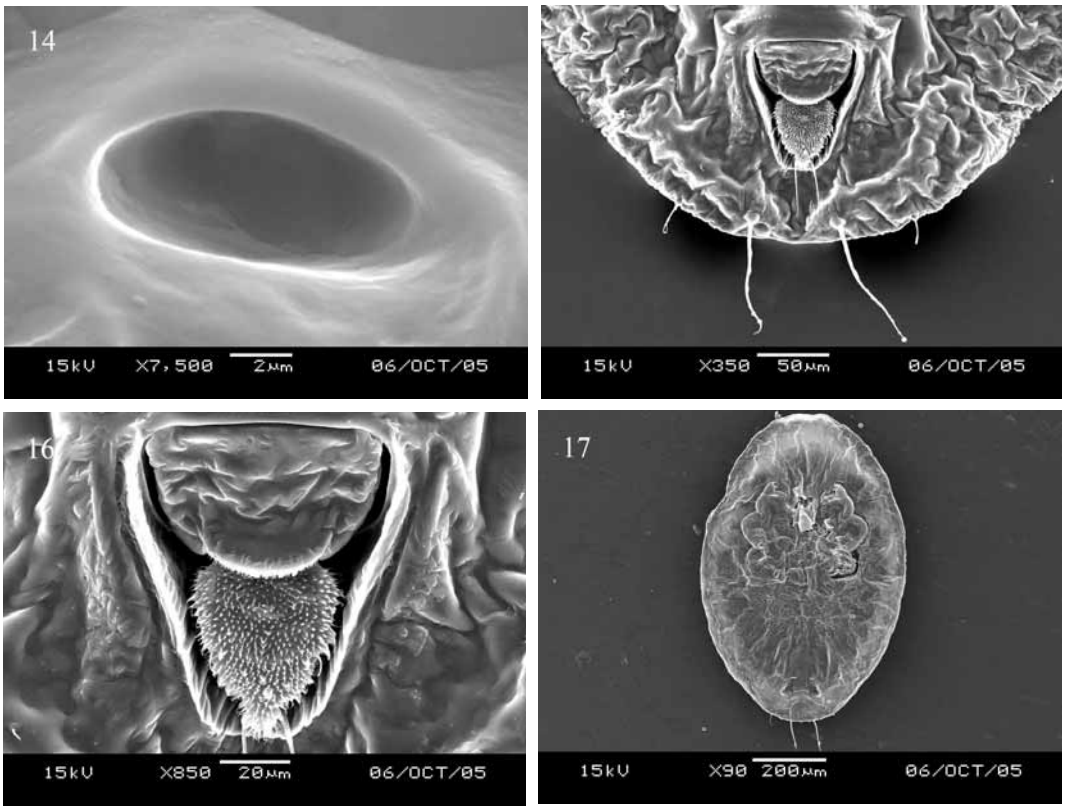


FIGURES 10–13. *Lipaleyrodes emiliae*, 4th instar: 10, dorsal view; 11, marginal area; 12, cluster of wax plates; 13, wax plate.

In Taiwan, we often found *L. emiliae* together with *Bemisia tabaci* (Gennadius) on the lower surface of the leaves of *Emilia sonchifolia*. These two species can be distinguished because the waxy secretion of *L. emiliae* is always dense, white, and fluffy, composed of filaments full of twists and turns (Fig. 52), whereas *B. tabaci* puparia secrete no noticeable white wax. Moreover, the lingula of live *L. emiliae* is dark brownish-black in all stages, particularly at the edges, whereas the lingula of *B. tabaci* is pale yellowish (Fig. 48). It should be noted that females are larger and longer than males in both species.

No adult character states have been recognized that can be used to define membership of the genus *Lipaleyrodes*, including *L. euphorbiae*, *L. crossandrae*, *L. emiliae*, and *L. vernoniae*. For example, the upper and lower compound eyes are joined by just one ommatidium; the numbers and position of the primary sensoria and sensorial cones on the antenna are the same in both male and female of these species; the wing venation is reduced to costal-subcostal veins and the radial vein. We also found it difficult initially to differentiate adults of *L. emiliae* and *B. tabaci*. because the color and appearance of *L. emiliae* are similar to those of *B. tabaci*, although *L. emiliae* specimens look a little larger than *B. tabaci*. The adult lingula of *L. emiliae* is club-shaped (Fig. 42), being inflated at the

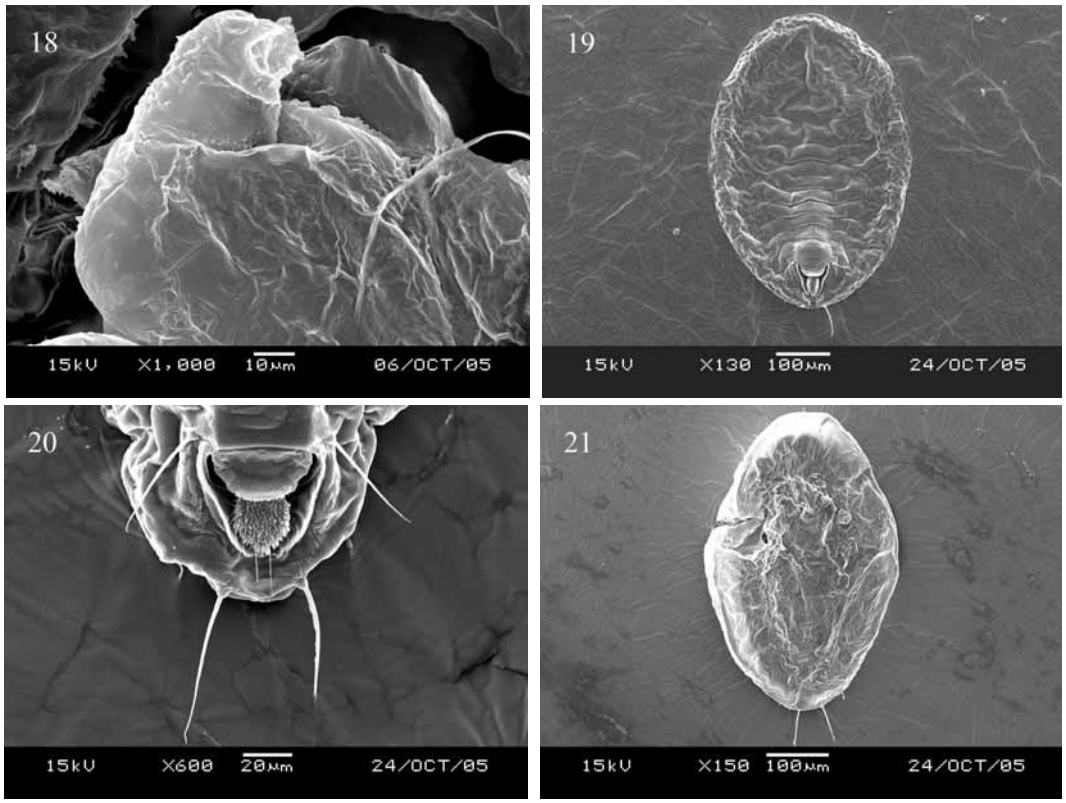
distal end. In *B. tabaci*, it looks like a cylinder with a uniform diameter throughout (Fig. 47). The other obvious difference between them concerns the wax plates in both male and female adults. In *B. tabaci*, the wax plates are separated into two parts by a little distance, which is about one-fifth of the width of the sternum in both the male and female. Wax plates in *L. emiliae* are much closer than those of *B. tabaci* (Figs 43–46). In live adults, there is a heart-shaped spot on the thoracic pleuron and a mouth-shaped spot on the prothoracic tergum of *L. emiliae* (Figs 49–50), but in *B. tabaci*, the thoracic pleuron and prothoracic tergum are evenly yellowish and not mottled.



FIGURES 14–17. *Lipaleyrodes emiliae*, 4th instar: 14, pore of wax plate; 15, posterior area; 16, vasiform orifice; 17, ventral view.

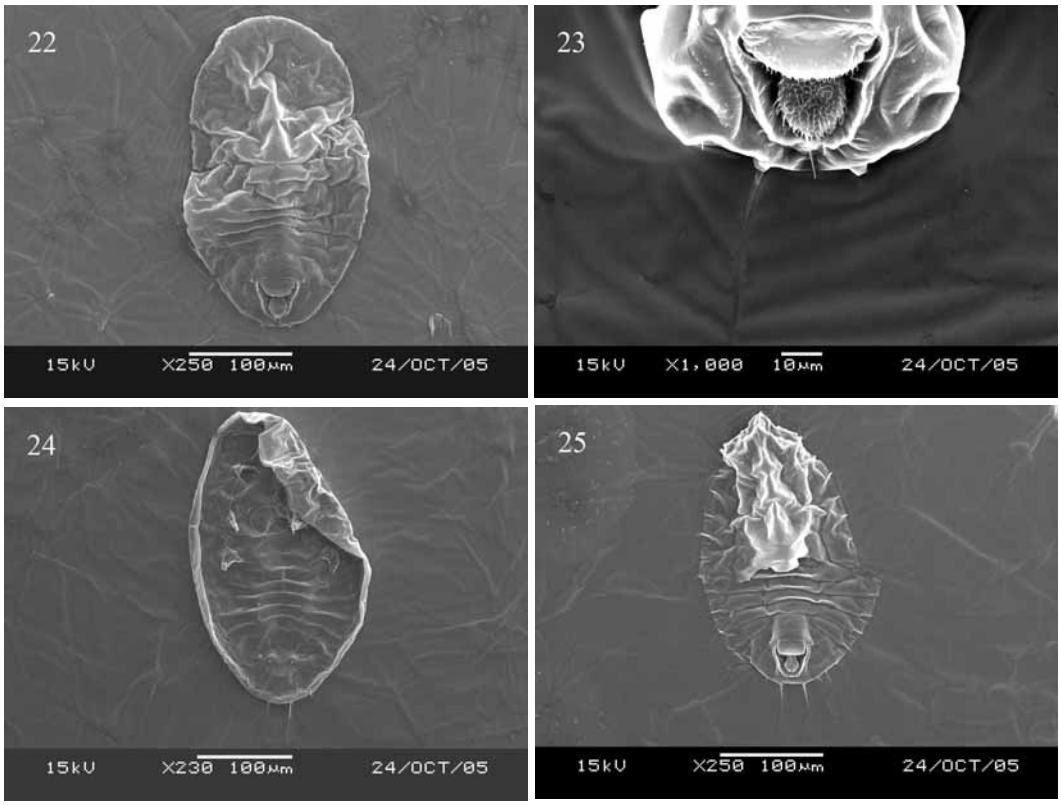
Material examined. **Holotype puparium**, **TAIWAN**, Renwu, on *Emilia sonchifolia* (Asteraceae), 6-VII-2003, C. H. Hsieh (TW1931) (NTU).

Paratypes: TAIWAN: All collected from *Emilia sonchifolia* except TW2173, and deposited at NTU except where otherwise noted. 2 pupal cases, 4 adult females, same data as for holotype; Taipei Co.: Shuanghsi, 5 pupal cases (on 1 microscope slide), 28-II-2004, Y. C. Hung (TW2172); Yungho, 137 pupal cases, 73 adult females, 10 adult males (on 36 microscope slides), 21-VII-2003, C. C. Ko (TW1957) (ANIC; BNHM; CDFA; NMNS; TARI; USNM); Yungho, 133 pupal cases, 32 third instars, 13 second instars, 5 first instars



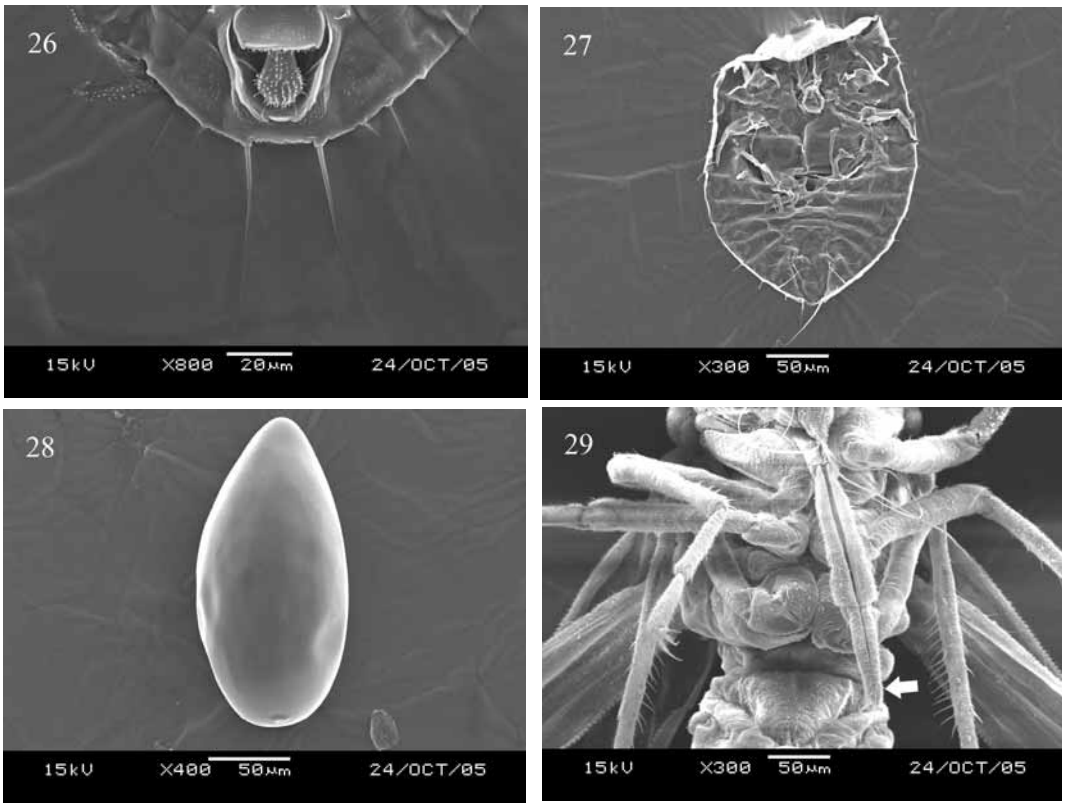
FIGURES 18–21. *Lipaleyrodes emiliae*: 18, 4th instar, antenna and fore leg; 19, 3rd instar, dorsal view; 20, 3rd instar, posterior area; 21, 3rd instar, ventral view.

(on 36 microscope slides), 15-I-2004, C. C. Ko (TW2137); Sanhsia, 14 pupal cases (on 3 microscope slides), 1-I-2004, H. T. Yeh (TW2136); Sanhsia, 10 pupal cases (on 1 microscope slide), 23-X-2004, C. C. Ko (TW2388); Taipei City: Neihu, 2 pupal cases (on 1 microscope slide), 10-X-2004, C. C. Ko (TW2354); Sungshan, 8 pupal cases (on 1 microscope slide), 27-VII-2002, C. C. Ko (TW1747); Kungkuan, 43 adult females, 2 adult males (on 4 microscope slides), 14-VIII-2002, Y. C. Hung (TW1777); Taoyuan Co.: Sanguang, 10 pupal cases (on 1 microscope slide), 30-VII-2003, C. C. Ko (TW1989); Chutung, 4 pupal cases (on 2 microscope slides), 11-I-2004, H. T. Yeh (TW2146); Miaoli Co.: Nanchuang, 3 pupal cases (on 1 microscope slide), 1-VII-2003, C. H. Hsieh (TW1917); Sanwan, 7 pupal cases, 4 adult females (on 2 microscope slides), 1-VII-2003, C. H. Hsieh (TW1918); Nantou Co.: Nantou City, 7 pupal cases (on 1 microscope slide), 26-X-2003, H. T. Yeh (TW2105); Jihyuetan (Sun Moon Lake), 32 pupal cases, 1 female adult (on 6 microscope slides), 13-VIII-2004, H. T. Yeh (TW2308); Chiayi Co.: Chuchi, 3 pupal cases (on 1 microscope slide), 6-VII-2002, C. C. Ko (TW1701); Fenglu, 8 pupal cases (on 1 microscope slide), 10-IV-2004, C. C. Ko (TW2210); Chungpu, 4 pupal cases (on 1 microscope slide), 8-IX-2003, C. C. Ko (TW2026); Yichu, 14 pupal cases (on 1



FIGURES 22–25. *Lipaleyrodes emiliae*: 22, 2nd instar, dorsal view; 23, 2nd instar, posterior area; 24, 2nd instar, ventral view; 25, 1st instar, dorsal view.

microscope slide), 14-VII-2002, C. C. Ko (TW1720); Yichu, 1 pupal case, 8 adult females (on 3 microscope slides), 3-II-2003, C. C. Ko (TW1809); Tapu, 1 pupal case (on 1 microscope slide), 20-VII-2002, C. H. Hsieh (TW1732); Chiayi City, 1 pupal case (on 1 microscope slide), 7-VII-2002, C. C. Ko (TW1708); Tainan Co.: Paiho, 13 pupal cases (on 1 microscope slide), 28-IX-2003, C. C. Ko (TW2073); Paiho, 4 pupal cases (on 1 microscope slide), 28-VIII-2004, C. C. Ko (TW2314); Hsuehchia, 1 adult female (on 1 microscope slide), 5-VII-2003, C. H. Hsieh (TW1928); Liuchia, 7 pupal cases (on 1 microscope slide), 23-X-2004, C. H. Hsieh (TW2365); Hsinhua, 3 pupal cases (on 1 microscope slide), 23-X-2004, C. H. Hsieh (TW2360); Tainan City: Kuantzuling, 12 pupal cases (on 1 microscope slide), 21-VII-2002, C. C. Ko (TW1738); Kaohsiung Co.: Tashe, 3 pupal cases (on 2 microscope slides), 14-IX-2003, C. H. Hsieh (TW2053); Kaohsiung City: Shoushan, 6 pupal cases (on 1 microscope slide), 23-X-2004, H. T. Yeh (TW2385); Kaohsiung City, 5 pupal cases (on 1 microscope slide), 6-III-2004, Y. C. Hung (TW2181); Pingtung Co.: Neipu, 7 pupal cases (on 1 microscope slide), 3-VIII-2002, C. C. Ko (TW1752); Chaochou, 4 pupal cases (on 1 microscope slide), 3-VIII-2002, C. C. Ko (TW1749); Hsinpei, 2 pupal cases (on 1 microscope slide), 9-X-2004, C. H. Hsieh

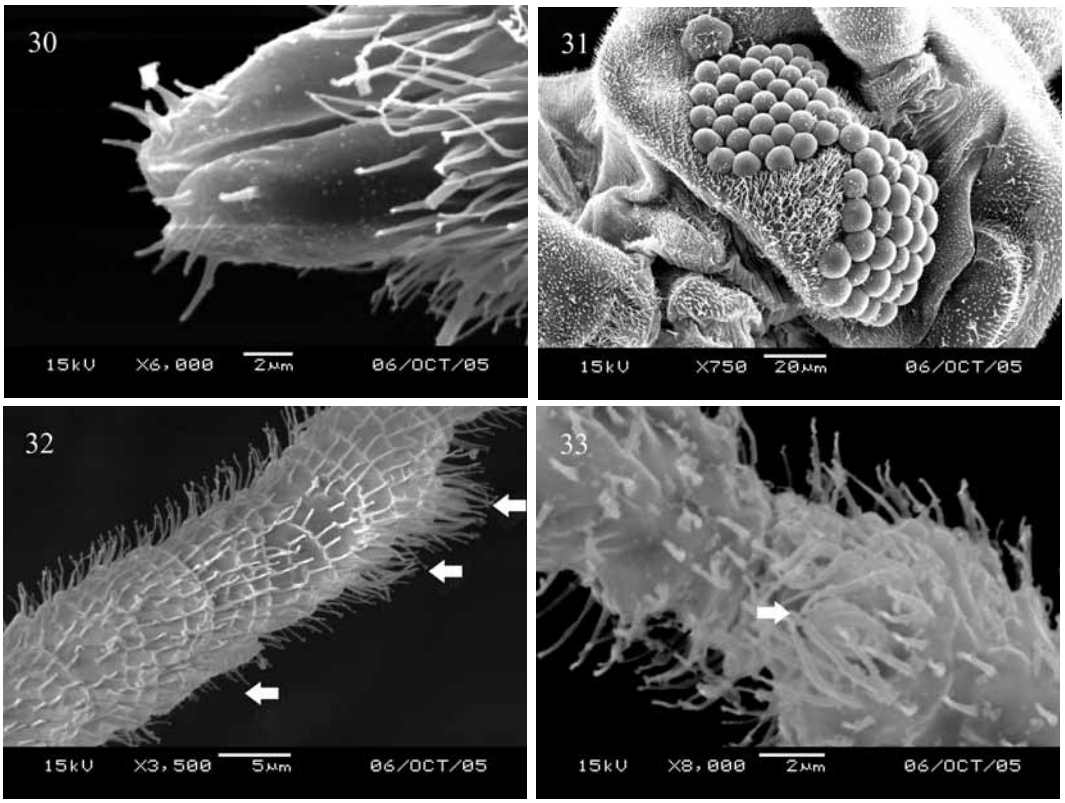


FIGURES 26–29. *Lipaleyrodes emiliae*: 26, 1st instar, posterior area; 27, 1st instar, ventral view; 28, egg; 29, adult, ventral view showing labium.

(TW2357); Ilan Co.: Suao, 11 pupal cases (on 3 microscope slides), 5-III-2004, C. C. Ko (TW2175); Nanao, 8 pupal cases (on 1 microscope slide), 20-II-2004, H. T. Yeh (TW2156); Hualien Co.: Hsinchen, 11 pupal cases (on 1 microscope slide), 20-II-2004, H. T. Yeh (TW2157); Liyutan, 16 pupal cases, 2 adult females (on 2 microscope slides), 2-III-2003, C. H. Hsieh (TW1826); Taitung Co.: Changkung, 16 pupal cases, 9 adult females, 8 adult males (on 16 microscope slides), 20-II-2004, H. T. Yeh (TW2159); Heping, 9 pupal cases (on 1 microscope slide), 24-II-2004, H. T. Yeh (TW2162); Tunghou, 10 pupal cases (on 1 microscope slide), 23-II-2004, H. T. Yeh (TW2160); Painan, 4 pupal cases (on 1 microscope slide), 28-VII-2003, C. H. Hsieh (TW1972); Painan, 7 pupal cases (on 1 microscope slide), 20-II-2004, H. T. Yeh (TW2158); Taitung City, 7 pupal cases (on 1 microscope slide), 20-II-2004, H. T. Yeh (TW2161); Lutao (Green I.), 3 pupal cases (on 1 microscope slide), 26-VI-2004, C. H. Hsieh (TW2284); Lanhsu (Orchid I.), 14 pupal cases (on 1 microscope slide), 29-VII-2003, C. H. Hsieh (TW1976); Penghu Co.: Makung, 2 pupal cases (on 1 microscope slide), 19-X-2003, C. H. Hsieh (TW2099); Chinchen, 7 pupal cases (on 1 microscope slide), 8-IX-2004, C. H. Hsieh (TW2336); Shuanghsi, 1 pupal case (on 1 microscope slide), on *Crassocephalum crepidioides* (Asteraceae), 28-II-

2004, Y. C. Hung (TW2173).

HONG KONG: Kowloon, 6 pupal cases, 1 third instars, 2-XII-1995, C. S. K Lau (IIE23405); New Territories, 21 puparia, 2 third instars, 22-XI-1999, J. H. Martin (Martin 7255) (plus dry material on leaves); New Territories, 23 puparia, 26-XI-2005, J. H. Martin (Martin 8196) (plus dry material on leaves); Hong Kong Island, 28 puparia, 1 adult female, 5-XII-2005, J. H. Martin (Martin 8258) (plus dry material on leaves) (all in BMNH).



FIGURES 30–33. *Lipaleyrodes emiliae*, adult: 30, sensilla on labium; 31, compound eyes; 32, primary sensilla and sensorial cone on antennal segment III; 33, primary sensoria on antennal segment V.

Etymology. The specific name *emiliae* is derived from the type host plant, *Emilia sonchifolia*.

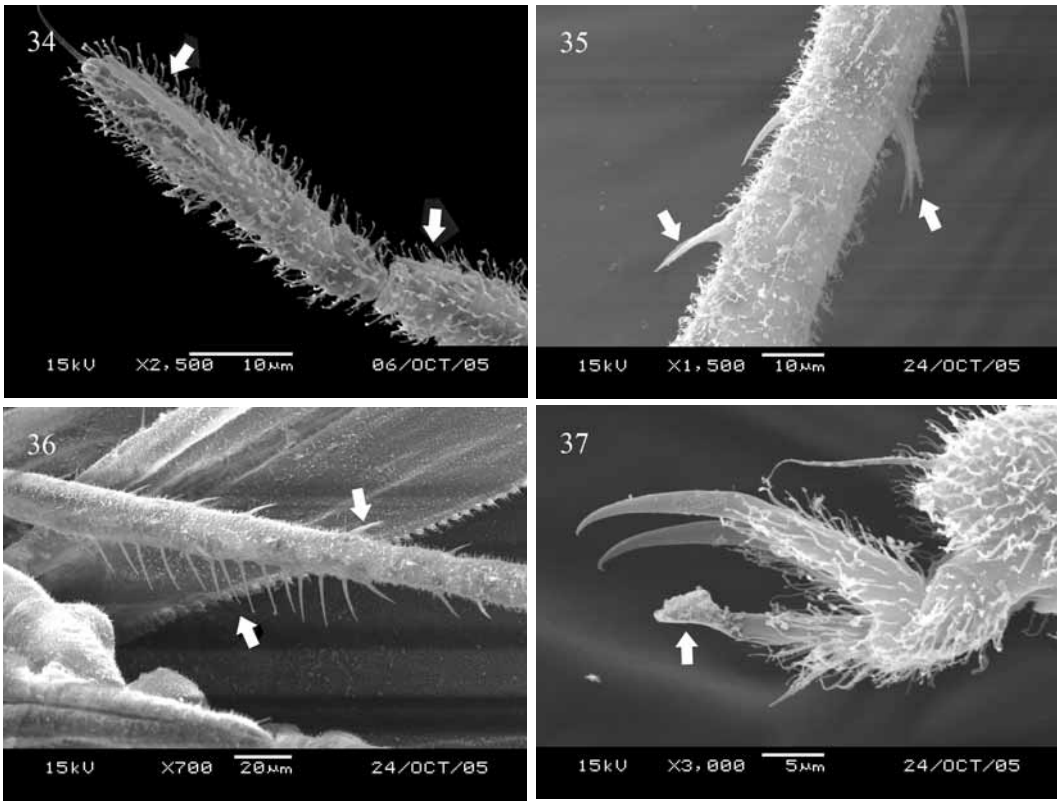
Host plants. Asteraceae: *Crassocephalum crepidioides* and *Emilia sonchifolia*.

Distribution. Taiwan (Fig. 55), Hong Kong.

Natural ememies. Aphelinidae: *Encarsia duorungu* Hayat and *E. sophia* Timberlake. The two species are also parasitoids of *B. tabaci* on *E. sonchifolia*.

Biology. This species is apparently restricted to members of the Asteraceae, and is of no known economic importance. *Emilia sonchifolia* (Asteraceae)(Fig. 54) is an annual weed widely distributed in the South Pacific Islands from Indonesia to eastern Polynesia,

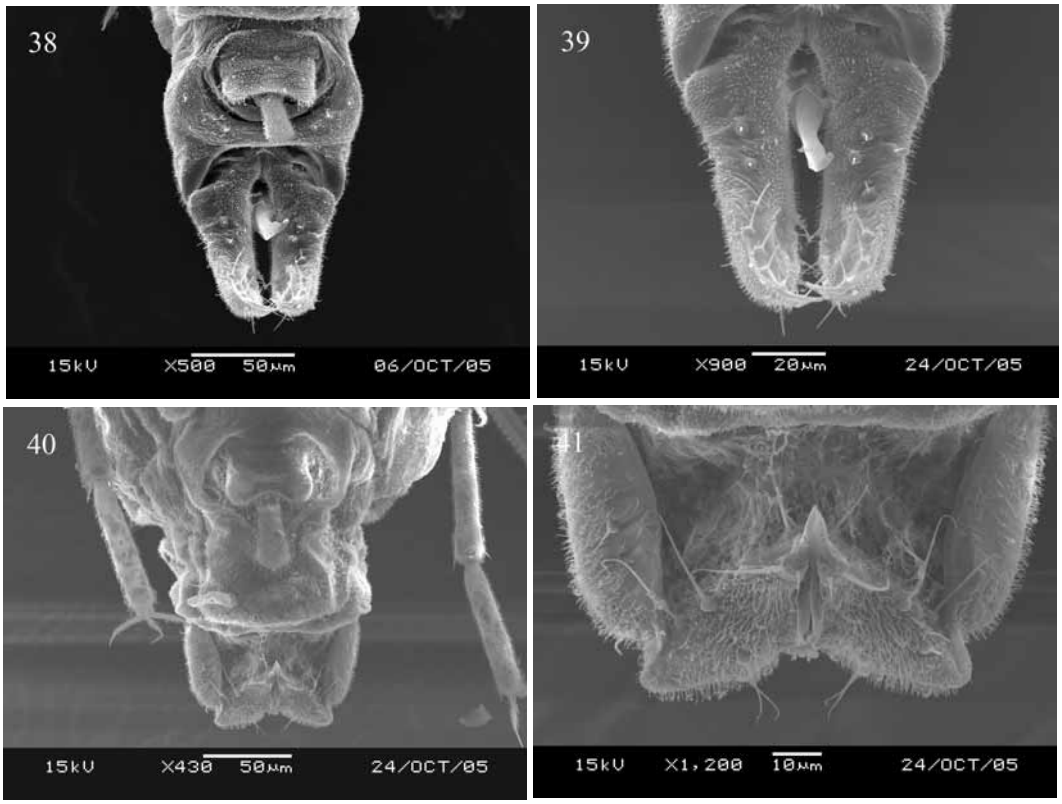
and in Japan, Taiwan, and China, and is common in coastal regions, sandy places, wastelands, roadsides, and paddy ridges, from sea level to about 850 m. The new species of whitefly is therefore likely to have a wider geographic distribution than recorded here. The puparia were found in groups often heavily infestating the undersurfaces of a leaves amid dense white filaments of wax. No ant attendance was observed. It was also found together with *Bemisia tabaci* (Gennadius), intermingling with this species on the lower leaf surfaces of the plants.



FIGURES 34–37. *Lipaleyrodes emiliae*, adult : 34, Sensorial cones on antennal segment VI and VII; 35, mesotibial brushes; 36, metatibial comb and brush; 37, tarsal claws showing paronychium.

Discussion

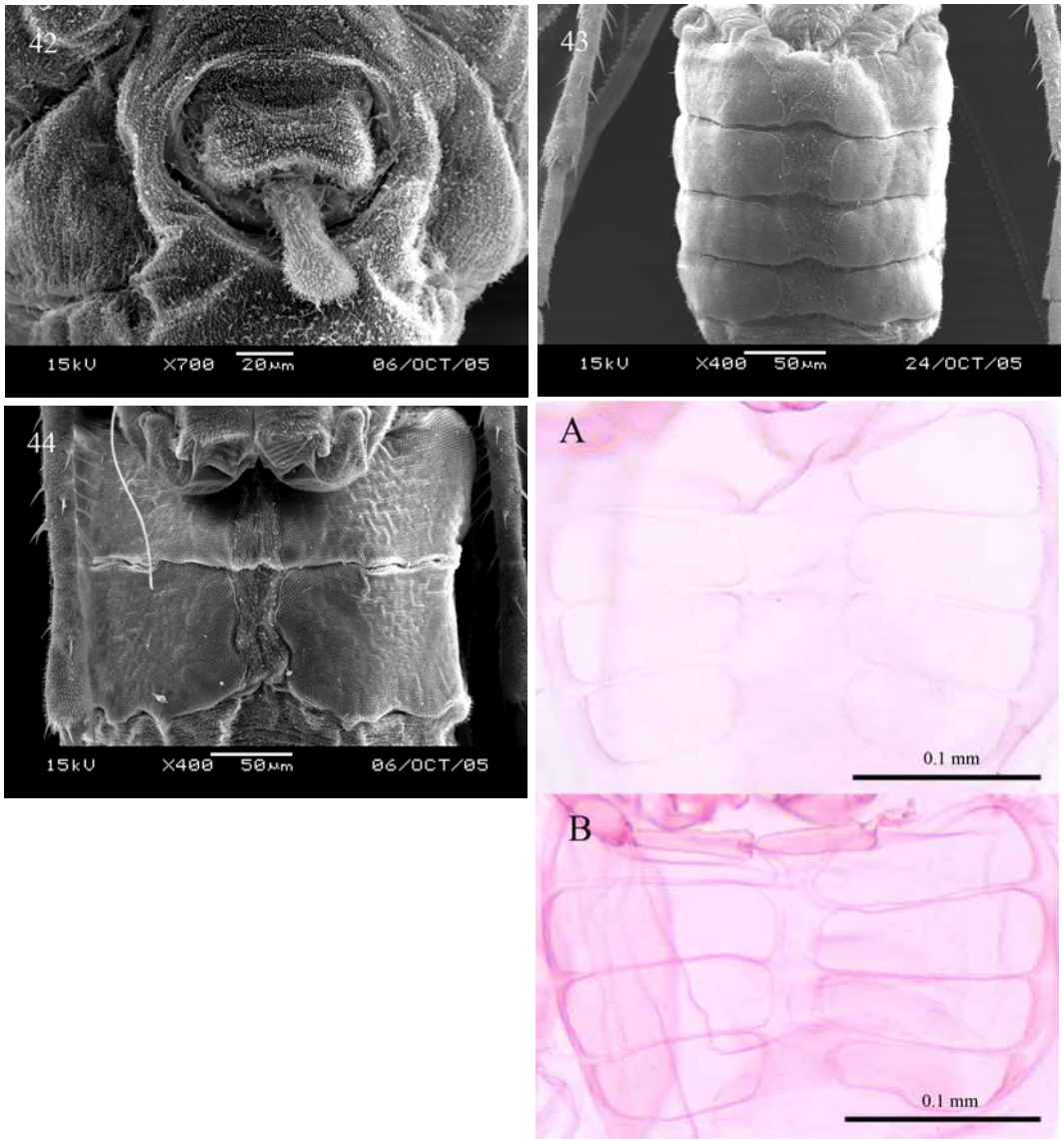
Takahashi (1962) erected the genus *Lipaleyrodes* which is mainly characterized by the submarginal area being distinctly defined by the dorsal submargin with wax plates in large clusters arranged in a row, and abdominal segment VII being extremely reduced medially, with only 7 segments discernible. However, in the general features of the puparial outline, the characters of *L. atriplex* (Froggatt) and *L. leguminicola* (Takahashi) are fairly typical



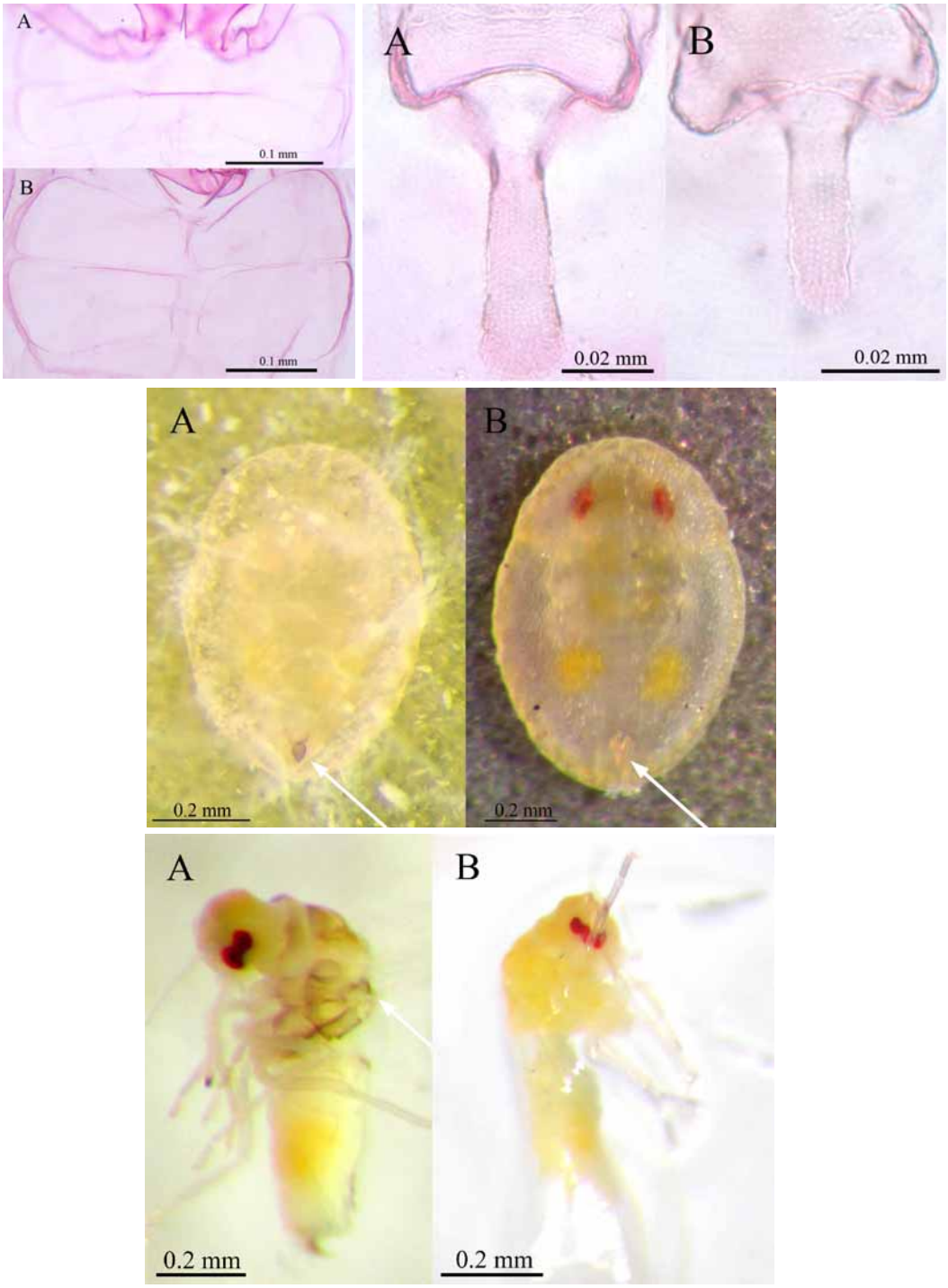
FIGURES 38–41. *Lipaleyrodes emiliae*, adult: 38, Dorsal view of terminal segments, male; 39, aedeagus and claspers; 40, dorsal view of terminal segments, female; 41, ovipositor and gonapophyses.

for *Aleyrodes* and *Bemisia*. The reduction of abdominal segment VII, so that only 7 segments are visible medially between the transverse molting sutures and vasiform orifice, is a character more typical of *Lipaleyrodes*. It may be of interest to note that the pupal cases of *Aleyrodes*, *Bemisia*, and *Lipaleyrodes* species look alike except for the occurrence of the submarginal wax plate clusters of *Lipaleyrodes*. Besides, there are many similarities between *Bemisia* and *Lipaleyrodes*. For example, the margin is irregularly crenulated; the thoracic tracheal openings lack pores and clefts; the transverse molting suture does not reach the margin; anterior and posterior setae are present; the submarginal setae are tiny and in a row; abdominal segment VII is reduced medially; the operculum occupies half of the elongate vasiform orifice; the lingula is always exposed and spinulose, with one pair of long apical setae; in adults, the linking of the compound eyes by a single ommatidium is probably characteristic of the *Bemisia tabaci* complex and *Lipaleyrodes*. After studying the general characters of *L. emiliae*, we suspect that there may be a close relationships between *Lipaleyrodes* and *Bemisia*. The exact relationship between *L. emiliae* and *B. tabaci* is currently under study in this lab and by Dr. Judy Brown in Arizona, USA, using

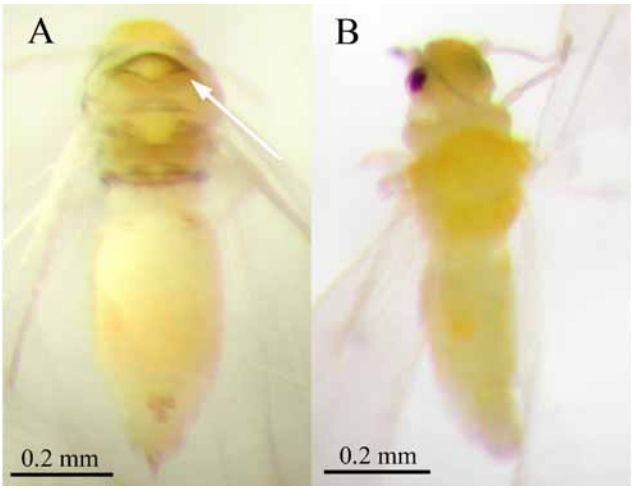
molecular markers (personal communication). Results of these studies will be published at a later date through Dr. Brown's ongoing *Bemisia* molecular projects.



FIGURES 42–45. *Lipaleyrodes emiliae*, adult: 42, Vasiform orifice, female; 43, wax plates, male; 44, wax plates, female; 45, difference of wax plates in male adults. 45A, *Bemisia tabaci*; 45B, *Lipaleyrodes emiliae*.



FIGURES 46–49. 46, Difference in wax plates in female adults. 46A, *Bemisia tabaci*; 46B, *Lipaleyrodes emiliae*; 47, difference in adult lingula. 47A, *Lipaleyrodes emiliae*; 47B, *Bemisia tabaci*; 48, difference in lingula, 4th instar. 48A, *Lipaleyrodes emiliae*; 48B, *Bemisia tabaci*; 49A, heart-shaped spot on thoracic pleuron of *Lipaleyrodes emiliae*; 49B, *Bemisia tabaci*.



FIGURES 50–53. 50A, Mouth-shaped spot on prothoracic tergum of *Lipaleyrodes emiliae*; 50B, *Bemisia tabaci*; 51, wax secretions of *Lipaleyrodes emiliae*; 52, groups of immatures of *Lipaleyrodes emiliae*; 53, live adult of *Lipaleyrodes emiliae*.

FIGURE 54. *Emilia sonchifolia*, host plant of *Lipaleyrodes emiliae*.

Acknowledgements

The authors wish to express hearty thanks to R. J. Gill (Plant Pest Diagnostics Center, California Department of Food and Agriculture, Sacramento, USA), R. Caballero, and J. K. Brown (Department of Plant Sciences, University of Arizona, Tucson, USA) for valuable suggestions, discussions, and editing the manuscript. We would like to acknowledge sincerely thanks to J. H. Martin (BMNH), for kindly arranging the loan of Hong Kong material for comparison, providing the list of material for inclusion in the type series, and for valuable suggestions. Special thanks are to C. H. Hsieh , H. T. Yeh, and Y. C. Hung (NTU) for their kind assistance in collecting materials, Y. T. Shih (NTU) for identification of natural enemies, C. H. Chang (NTU) for polishing the illustrations. Thanks are extended to anonymous reviewers for help in improving the manuscript, to Dan Chamberlin for English editing of the draft. This paper was supported, in part, by grants (NSC91-2313-B-002-370 and NSC 92-2313-B-002-055) from the National Science Council, Taiwan.

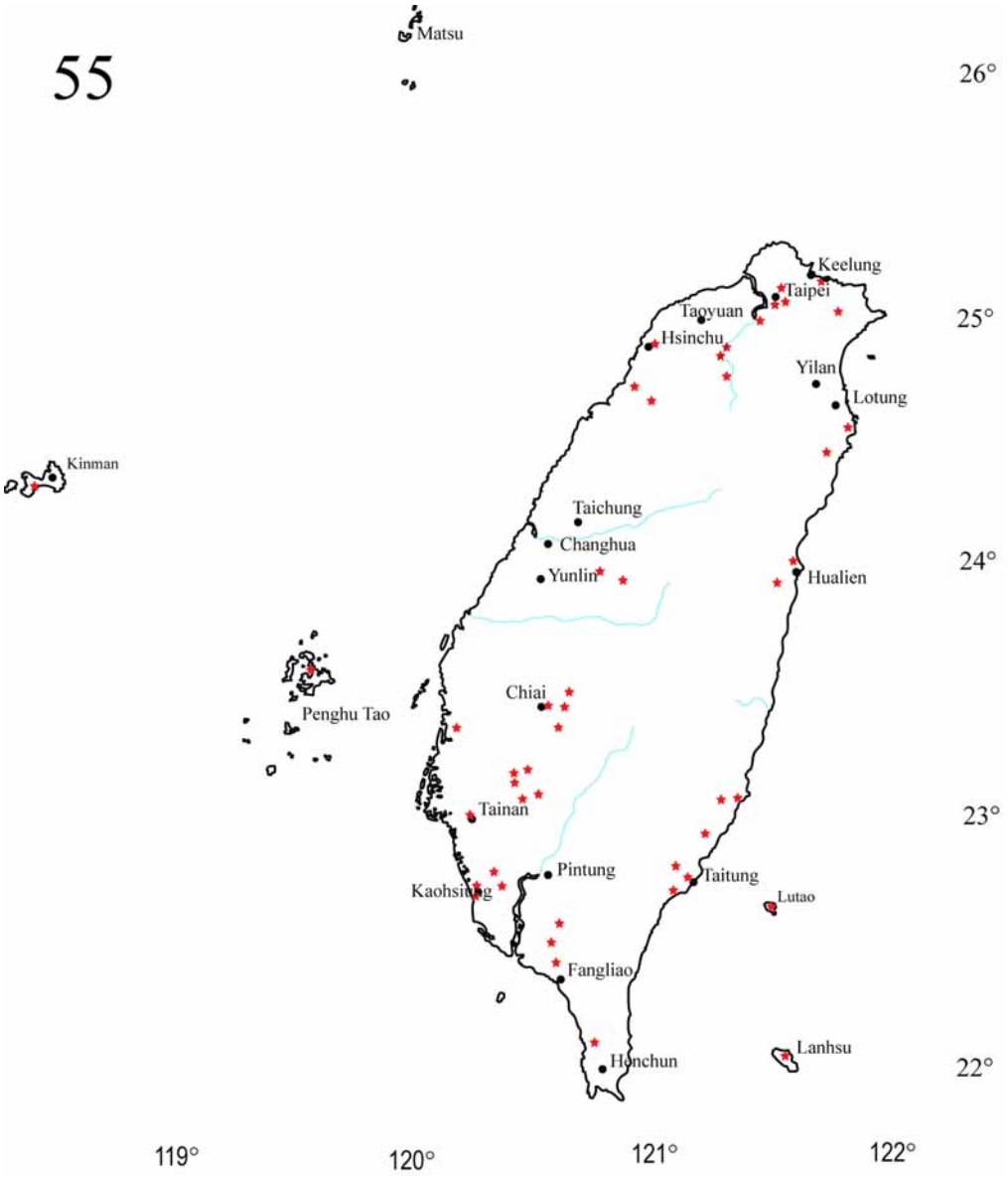


FIGURE 55. Collection localities in Taiwan.

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