

## Additions to the Whitefly Fauna of Korea with a Key to Species (Hemiptera: Aleyrodidae)

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### 한국산 가루이과 종의 추가보고 및 종 검색표 작성 (노린재목, 가루이과)

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**ABSTRACT:** *Aleurolobus marlatti* (Quaintance), *Massilieuodes formosensis* (Takahashi), and *Pealius rhododendri* Takahashi were found for the first time in Korea. This study provides a brief summary and photographs of the major characters of these species and an updated identification key to the whitefly species known to occur in Korea.

**Key words:** *Aleurolobus marlatti*, *Massilieuodes formosensis*, *Pealius rhododendri*, whiteflies, Korea

**초록:** *Aleurolobus marlatti* (Quaintance), *Massilieuodes formosensis* (Takahashi) 및 *Pealius rhododendri* Takahashi는 한국에서 처음으로 기록된다. 이들 종에 대한 요약된 정보 및 사진자료와 함께 한국에 발생하는 가루이과 종 검색표를 업데이트하였다.

**검색어:** 마리티가루이, 대만꿀가루이, 참진달래가루이, 가루이, 한국

The family Aleyrodidae (Hemiptera), commonly known as whiteflies, consists of 1,625 species in 166 genera in two main subfamilies (4 total) (Martin and Mound, 2007). Whiteflies are primarily subtropical and tropical in distribution. All of the 135 species of the subfamily Aleurodicinae are tropical species, with about 84% of the known species described from the Neotropical region. About 19 species have extended their distribution into the Nearctic and Western Palearctic regions; however, most of these are recorded from the warmer parts of these regions, such as in Florida (USA). Of the 1,482 species of the subfamily Aleyrodinae, 83.4% (1,236 species) and 16.6% (246 species) of the species were described from tropical and temperate regions, respectively, and 82.5% (1,223 species) and

17.5% (259 species) were described from the Old World and New World, respectively.

Several of these species are known to cause economic damage to crops and some are serious pests. Recently, whiteflies such as the sweet potato whitefly, *Bemisia tabaci* (Gennadius) and the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood), have become major pests in Korea causing severe damage to agricultural crops in greenhouses.

Recently, we have collected some whiteflies occurring in southern area of Korea and they have been identified as *Aleurolobus marlatti* (Quaintance), *Massilieuodes formosensis* (Takahashi), and *Pealius rhododendri* Takahashi. These collections represent the first record of the occurrence of each of these species in Korea. The host plants on which these three species were collected are native to Korea. No damage to their host plants was observed during the survey. Among the puparia

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collected during this survey, there were emergence holes from parasitic wasps in 4 puparia of *Aleurolobus marlatti* and one puparium of *Massilieurodes formosensis*, and an unemerged endoparasite was found in a puparium of *Pealius rhododendri*.

Quaintance (1903) and Takahashi (1933 and 1935) provided descriptions for three whitefly species that are newly reported in Korean whitefly fauna, herein. Also Evans' catalog of the whiteflies of the world (2008) provided a comprehensive summary of information on the nomenclature, hosts and distribution of whiteflies of the world. Herein we provide a brief summary and photographs of major characters of three species and also an updated identification key to the whitefly known to occur in Korea (Suh and Hodges, 2008), based on characters found in the puparium also known as the fourth instar nymph. This information will not only enable researchers to identify the species known to occur in Korea, but also will aid in the recognition and early detection of accidentally introduced species.

Terminology for morphological structures used in an identification key follows that of Martin (1987) and Gill (1990). An asterisk (\*) is used to indicate a new host or new distribution record. Photographs were taken using an AxioCam MRc5 camera through ZEISS Axio Imager M2 Microscope and a LEICA M165C microscope with Delta pix camera. All specimens were processed and mounted in Canada Balsam on microscope slides and are deposited in the Collection of Yeongnam Regional Office, Animal, Plant and Fisheries Quarantine and Inspection Agency (QIA) in Busan, Korea.

*Aleurolobus marlatti* (Quaintance) 1903 마리티가루이 (신칭) (Figs. 1-4)

*Aleurodes marlatti* Quaintance 1903 [Japan: on *Citrus* sp.].

**Diagnosis.** Black puparium. Puparial margin covered with waxy secretion. Dorsal disc separated from submarginal region by suture. Eyespots present. Thoracic and caudal tracheal comb present, three thoracic and three caudal tracheal teeth. Vasiform orifice surrounded by a trilobed figure. Abdominal segmentation distinct, rhachis present.

**Material examined.** Korea. Gyeongsangnamdo (GN): San 109-beongi, Wahyeon-ri, Ilun-myeon, Geoje-si (Oedo-botania), 11 puparia (on the underside of leaf), on *\*Zanthoxylum schini-folium* (Rutaceae), 6-xi-2008 (S.J. Suh).

**Distribution.** Western Palearctic: Egypt, Iran, Israel, Jordan, Saudi Arabia; Afrotropical: Chad; Eastern Palearctic: China, Japan, \*Korea, Philippines, Taiwan; Oriental: India, Malaysia; Australasian: Java.

**Host.** Twenty eight plant families (Evans, 2008).

*Massilieurodes formosensis* (Takahashi) 1933 대만글가루이(신칭) (Figs. 5-7)

*Dialeurodes (Gigaleurodes) formosensis* Takahashi 1933 [Taiwan: on unidentified host].

**Diagnosis.** Light yellow to brown puparium. Thoracic and caudal tracheal openings marked by invaginated pores; with teeth internally. Caudal furrow distinct, widened on the anterior part, narrowed towards the hind end on the posterior part; 2 pairs of long stout setae on the cephalothorax, first abdominal segment and caudal extremity with a pair of long stout setae. Vasiform orifice U-shaped.

**Material examined.** Korea. GN: San193, Amnam-dong, Seo-gu, Busan (Amnam-park), 9 puparia (on the underside of leaf), on *Symplocos chinensis* (Symplocaceae), 25-ix-2008 (S.J. Suh); 3-ga, Seodaesin-dong, Seo-gu, Busan (Daesin-park), 4 puparia (on the underside of leaf), on *\*Styrax shiraiana* (Styracaceae), 7-ix-2009 (S.J. Suh).

**Distribution.** Eastern Palearctic: Japan, Hong Kong, \*Korea, Taiwan.

**Host.** Many ornamental plants of thirteen plant families (Evans, 2008).

*Pealius rhododendri* Takahashi 1935 참진달래가루이 (신칭) (Figs. 8-11)

*Pealius rhododendri* Takahashi 1935 [Taiwan: on *Rhododendron* sp.].

**Diagnosis.** Light yellow to brown puparium. Puparial margin covered with long waxy secretion. Vasiform orifice situated in a pit and divided into two parts. Marginal teeth prominent, rounded apically; 20 short and fine setae arranged in a row along the margin.

**Material examined.** Korea. GN: 3-ga, Seodaesin-dong, Seo-gu, Busan (Daesin-park), 3 puparia (on the underside of leaf), on *Rhododendron* sp. (Ericaceae), 13-xii-2007 (S.J. Suh); San2-1,

Seodaesin-dong 3-ga, Seo-gu, Busan (Gudeoksan), 2 puparia (on the underside of leaf), on \**Rhododendron schlippenbachii* (Ericaceae), 10-x-2011 (S.J. Suh).

**Distribution.** Nearctic: USA; Neotropical: Jamaica; Eastern Palearctic: Japan, \*Korea, Taiwan; Hawaii: Hawaii.

**Host.** This species is only known to occur on *Rhododendron* species.

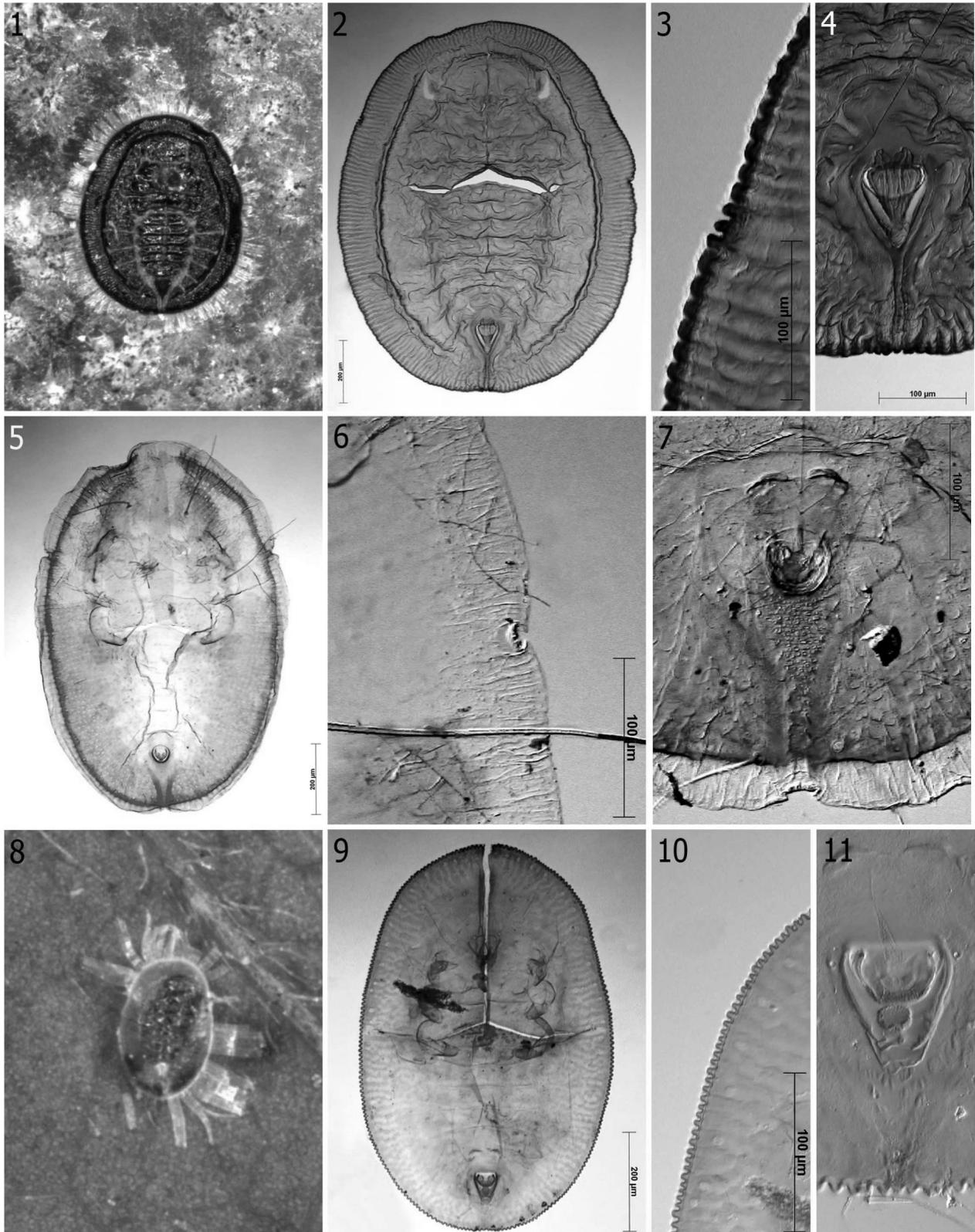
### Key to Whiteflies of Korea (based on the puparium)

- 1. Puparium black ..... 2
- 1b. Puparium white ..... 11
- 2(1). Dorsal disc separated from submarginal region by a suture ..... 3
- 2b. Dorsal disc not separated from submarginal region by a suture ..... 8
- 3(2). Vasiform orifice surrounded by a trilobed figure ..... (*Aleurolobus*) ... 4
- 3b. Vasiform orifice not surrounded by a trilobed figure ... (*Aleuroclava*) ... 6
- 4(3). Thoracic tracheal pore present, tracheal comb distinctly protruding, formed by two fused teeth ..... *Aleurolobus vitis* Danzig (Fig. 12)
- 4b. Thoracic tracheal pore absent; tracheal comb absent or less protruding, and not formed by fused teeth ..... 5
- 5(4b). Thoracic and caudal tracheal comb present, three thoracic and three caudal tracheal teeth ..... *Aleurolobus marlatti* (Quaintance) (Fig. 2)
- 5b. Thoracic and caudal tracheal comb absent; marginal crenulations distinctly bilobed at the tip ..... *Aleurolobus iteae* Takahashi (Fig. 13)
- 6(3b). With thoracic tracheal clefts at the margin of cephalothorax ..... 7
- 6b. Without thoracic tracheal clefts at the margin of cephalothorax ..... *Aleuroclava montanus* (Takahashi) (Fig. 14)
- 7(6). Abdomen with a very sclerotised median rhachis without lateral arms; thoracic tracheal clefts distinct with its fold represented by an oval or semi-circular-shaped area extending into the submarginal area ..... *Aleuroclava aucubae* (Kuwana) (Fig. 15)
- 7b. Abdomen without a sclerotised median rhachis,

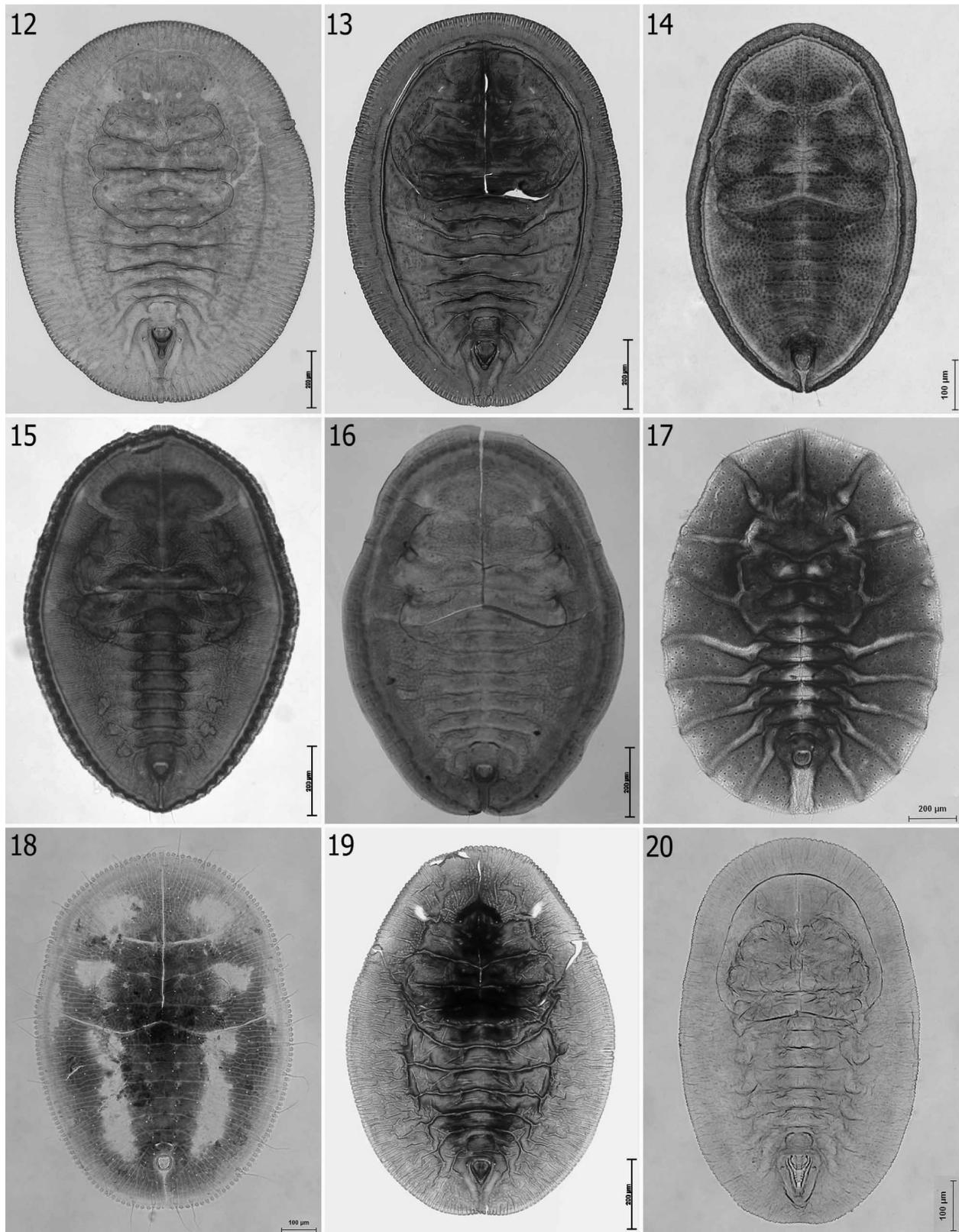
usually with a slightly elevated median area with lateral arms; thoracic tracheal clefts small and not fold as above .....

- ..... *Aleuroclava euryae* (Kuwana) (Fig. 16)
- 8(2b). Vasiform orifice U-shaped ..... 9
- 8b. Vasiform orifice triangular or heart-shaped ..... 10
- 9(8). Rhachis prominent, forming ridges, reaching the margin; without paler patches as below; dorsum with many very short capitates setae and 13 pairs of short lanceolate setae arranged in a single row along the entire margin ..... *Rhachisphora styrachi* (Takahashi) (Fig. 17)
- 9b. Rhachis and ridges undeveloped; prominent paler areas at the ends of the transverse suture between the thorax and abdomen, with 2 pairs of pale patches on the cephalothorax; dorsum with 16 pairs of long fine setae, arising from a very small-tubercle, arranged in a single row along the entire submargin ..... *Pentaleyrodes yasumatsui* Takahashi (Fig. 18)
- 10(8b). Vasiform orifice completely occupied by operculum; transverse moulting suture curved but not forming a closed figure as below ..... *Dialeurolobus pulcher* Danzig (Fig. 19)
- 10b. Vasiform orifice not completely occupied by operculum; transverse moulting suture curved, directed anteriorly, joined at the anterior end of body to a form a closed figure ..... *Asterobemisia atraphaxius* (Danzig) (Fig. 20)
- 11(1b). Dorsal disc separated from submarginal region by a suture ..... *Aleuroclava magnoliae* (Takahashi) (Fig. 21)
- 11b. Dorsal disc not separated from submarginal region by a suture ..... 12
- 12(11b). Dorsum with a pair of prominent, longitudinal cephalothoracic folds; puparial margin with two rows of teeth ..... *Crenidorsum ishigakiensis* (Takahashi) (Fig. 22)
- 12b. Dorsum without a pair of prominent, longitudinal cephalothoracic folds; puparial margin smooth or with one row of teeth ..... 13
- 13(12b). Vasiform orifice U-shaped ..... 14
- 13b. Vasiform orifice triangular or heart-shaped ..... 16

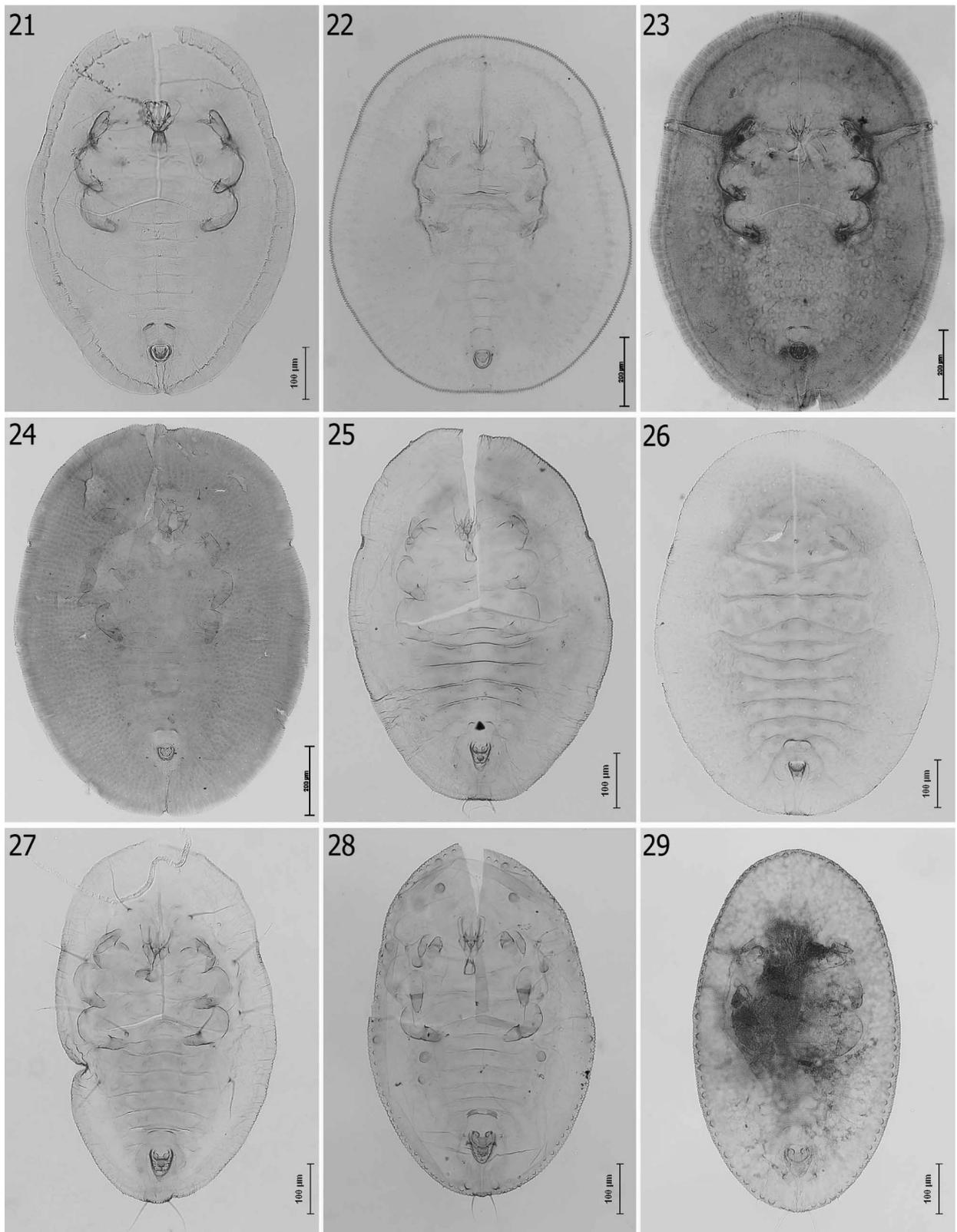
- 14(13). Ventral caudal and thoracic tracheal folds distinct, covered with spinules; dorsal thoracic and caudal tracheal openings at margin marked by invaginated pores, which are nearly smooth internally; first abdominal setae absent .....  
..... *Dialeurodes citri* (Ashmead) (Fig. 23)
- 14b. Ventral caudal and thoracic tracheal folds smooth without spinules; dorsal thoracic tracheal pores at margin small, internal teeth; first abdominal setae present ..... (Massilieurodes) ... 15
- 15(14b). Caudal furrow very narrow, much expanded on the basal two-fifths; a pair of small simple setae present on the cephalothorax, first abdominal segment, and caudal area .....  
..... *Massilieurodes euryae* (Takahashi) (Fig. 24)
- 15b. Caudal furrow distinct, widened on the anterior part, narrowed towards the hind end on the posterior part; 2 pairs of long stout setae on the cephalothorax, first abdominal segment and caudal extremity with a pair of long stout setae .....  
... *Massilieurodes formosensis* (Takahashi) (Fig. 5)
- 16(13b). Vasiform orifice situated in a pit and divided into two parts ..... (Pealius) ... 17
- 16b. Vasiform orifice not situated in a pit and not divided into two parts ..... 20
- 17(16). Only found on *Rhododendron* ..... 18
- 17b. Not found on *Rhododendron* ..... 19
- 18(17). Marginal teeth prominent, rounded apically; 20 short and fine setae arranged in a row along the margin .....  
..... *Pealius rhododendri* Takahashi (Fig. 9)
- 18b. Marginal teeth undeveloped; without a series of setae along the margin; marginal crenulations at thoracic tracheal openings modified to form distinct, but short, combs of teeth .....  
..... *Pealius azaleae* (Baker & Moles) (Fig. 25)
19. Vasiform orifice shorter than caudal furrow; small compared with size of body; thoracic tracheal pore not clearly evident *Pealius polygoni* Takahashi (Fig. 26)
- 19b. Vasiform orifice longer than caudal furrow; thoracic tracheal pore clearly evident .....  
..... *Pealius rubi* Takahashi (Fig. 27)
- 20(16b). Submarginal row of papillae present .....  
..... (Trialeurodes) ... 21
- 20b. Submarginal row of papillae absent ..... 22
21. Lateral margin with relatively broad crenulations, usually fewer than 13 in 100 um; eighth abdominal setae located anterior to widest part of operculum .....  
..... *Trialeurodes vaporariorum* (Westwood) (Fig. 28)
- 21b. Lateral margin with relatively narrow crenulations (fig. 29), at least 22 in 100um; eighth abdominal setae located posterior to widest part of operculum .....  
..... *Trialeurodes packardi* (Morill) (Fig. 29)
- 22(20b). Caudal furrow present ..... (Bemisia in part) ... 23
- 22b. Caudal furrow absent ..... 25
- 23(22). Thoracic tracheal folds absent .....  
..... *Bemisia artemisiae* (Danzig) (Fig. 30)
- 23b. Thoracic tracheal folds present ..... 24
- 24(23b). Vasiform orifice longer than length of caudal furrow; caudal setae always stout at least as long as length of vasiform orifice whose sides are almost straight .....  
..... *Bemisia tabaci* (Gennadius) (Figs. 31-32)
- 24b. Vasiform orifice as long as, or shorter than length of caudal furrow; caudal setae usually stout shorter than length of vasiform orifice whose sides are usually distinctly concave .....  
..... *Bemisia afer* (Priesner & Hosny) (Fig. 33)
- 25(22b). Abdominal segment VII very short, distinctly shorter than abdominal segments VI or VIII (measured along the dorsal midline); transverse suture curved, directed anteriorly, joined at the anterior end of body to form a closed figure; thoracic tracheal folds present; thoracic tracheal folds short with granulations; margin of abdominal segments area with a row of distinct rounded tubercles .....  
..... *Asterobemisia takahashii* Danzig (Fig. 34)
- 25b. Abdominal segment VII similar in length to abdominal segments VI or VIII; transverse suture not forming a closed figure; thoracic tracheal folds absent; abdomen usually with median tubercles on segments II-V or II-VI .....  
..... *Aleyrodes lonicerae* Walker (Fig. 35)



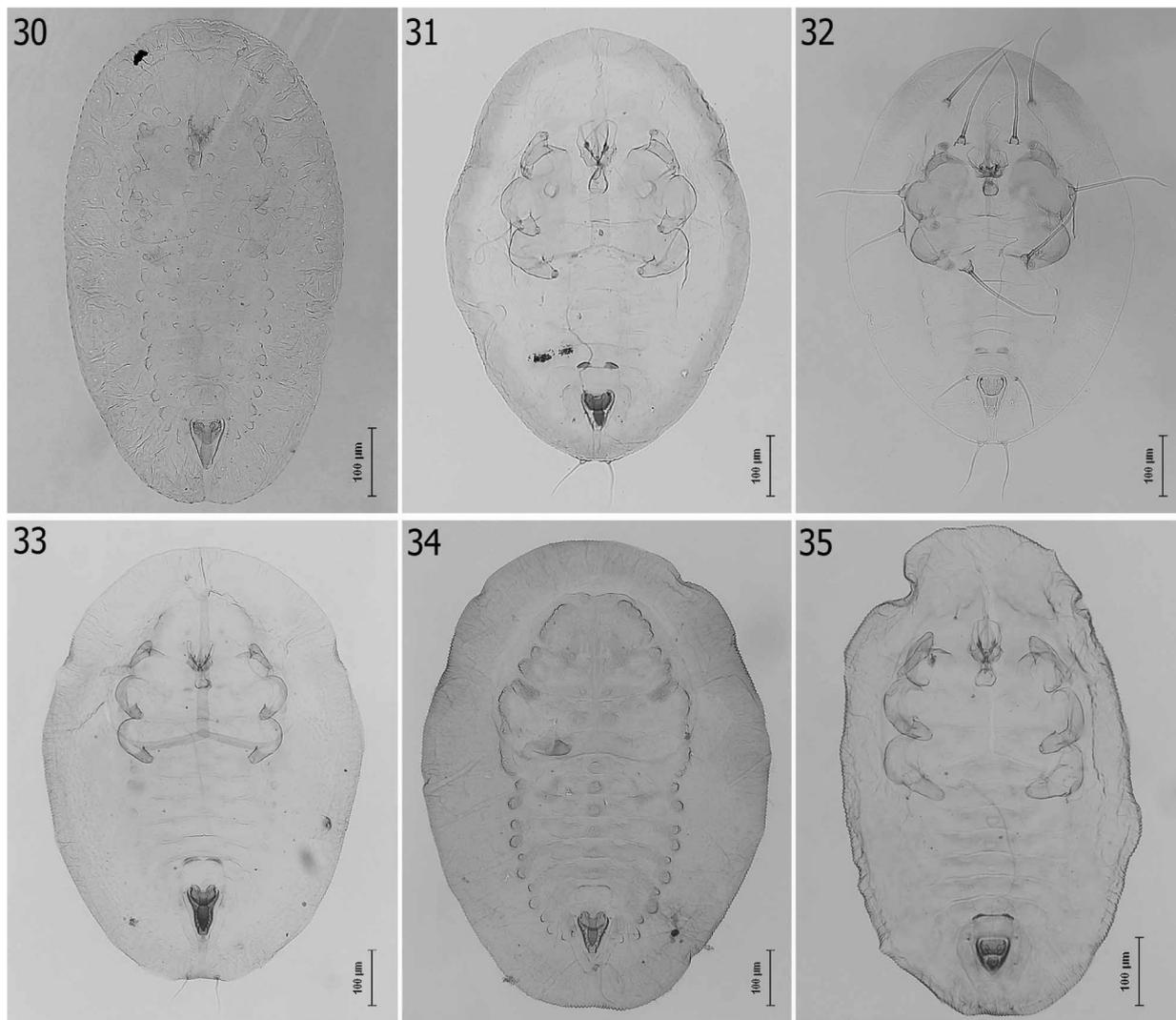
**Figs. 1-11.** 1-2) *Aleurolobus marlatti*, habitus and puparium; 3) *A. marlatti*, tracheal margin; 4) *A. marlatti*, vasiform orifice; 5) *Massilieuodes formosensis*, puparium; 6) *M. formosensis*, tracheal margin; 7) *M. formosensis*, vasiform orifice; 8) *Pealius rhododendri*, puparium containing an endoparasite; 9) *P. rhododendri*, puparium; 10) *P. rhododendri*, thoracic margin; 11) *P. rhododendri*, vasiform orifice.



**Figs. 12-20.** 12) *Aleurolobus vitis*, puparium; 13) *Aleurolobus iteae*, puparium; 14) *Aleuoclava montanus*, puparium; 15) *Aleuoclava aucubae*, puparium; 16) *Aleuoclava euryae*, puparium; 17) *Rhachisphora styrachi*, puparium; 18) *Pentaleyrodes yasumatsui*, puparium; 19) *Dialeurolobus pulcher*, puparium; 20) *Asterobemisia atraphaxius*, puparium.



**Figs. 21-29.** 21) *Aleuoclava magnoliae*, puparium; 22) *Crenidorsum ishigakiensis*, puparium; 23) *Dialeurodes citri*, puparium; 24) *Massilieuodes euryae*, puparium; 25) *Pealius azaleae*, puparium; 26) *Pealius polygoni*, puparium; 27) *Pealius rubi*, puparium; 28) *Trialeurodes vaporariorum*, puparium; 29) *Trialeurodes packardii*, puparium.



**Figs. 30-35.** 30) *Bemisia artemisiae*, puparium; 31-32) *Bemisia tabaci*, puparia; 33) *Bemisia afer*, puparium; 34) *Asterobemisia takahashii*, puparium; 35) *Aleyrodes lonicerae*, puparium.

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