

# ***Aleurochiton orientalis* Danzig, 1966 (Hemiptera: Aleyrodidae), newly recorded from China, with a key to puparia of all described *Aleurochiton* species**

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The genus *Aleurochiton* Tullgren (1907) is here newly recorded from China as *A. orientalis* Danzig (1966). It was collected from *Acer mono* Maxim (Sapindales: Aceraceae) in Shaanxi Province, but was originally described from the Russian Far East (Southern Primor'ye) by Danzig (1966). The puparial morphology of *A. orientalis* is here illustrated by line art, photomicrographs and scanning electron microscope (SEM) photographs. An identification key to the all five described *Aleurochiton* species is provided.

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## **1. Introduction**

The genus *Aleurochiton* was originally established by Tullgren (1907), with *Aleurochiton aceris* (Modeer, 1778) as its type species. Currently, the genus contains the following five described species: *Aleurochiton acerinus* Haupt (1934), *Aleurochiton aceris* (Modeer, 1778), and *Aleurochiton pseudoplatani* Visnya (1936) all from Europe only (Danzig 1966, Martin *et al.*

2000, Martin & Mound 2007); *Aleurochiton forbesii* (Ashmead, 1893), known only from the Nearctic Region (North America); and *Aleurochiton orientalis* Danzig (1966), hitherto only known from the southern Maritime Territory of Russia. Zahradnik (1963) assigned the American species *Aleurochiton forbesii* to a separate subgenus *Nealeurochiton* because it differs from the other species in the size of the lingula and vasiform orifice. However, Mound and Halsey

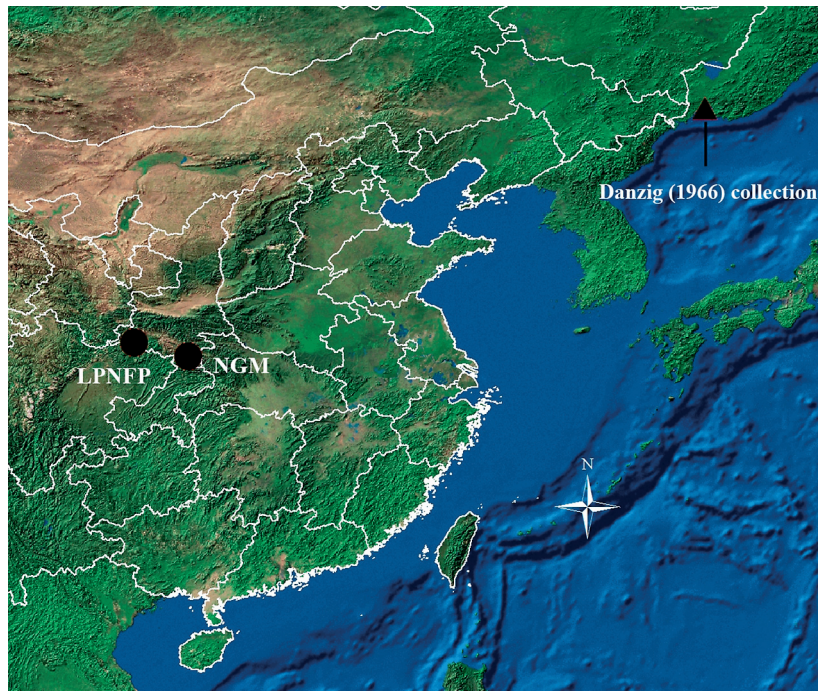


Fig. 1. Collection localities (China and Russia) of *Aleurochiton orientalis* Danzig. LPNFP: Liping National Forest Park, NGM: Nangong Mountain.

(1978) considered *Nealeurochiton* to be a junior synonym of *Aleurochiton* (Martin *et al.* 2000). Martin and Mound (2007) regarded *Nigrinichiton* Zahradnik also as a junior synonym of *Aleurochiton*.

A faunal survey of Aleyrodidae was conducted in two Nature Reserves of Shaanxi Province, China, in July 2012 as the Aleyrodidae fauna in these areas had not been previously investigated in detail. Amongst material collected as part of this survey, we identified the maple-feeding *Aleurochiton orientalis* Danzig, which is a new species record for China, and also represents the first record of *Aleurochiton* from China. Here, we provide an up-to-date description of the puparia, and also describe and illustrate the third instar and second instar nymphs, with traditional line drawings, photomicrographs and scanning electron microscope (SEM) photographs.

## 2. Materials and methods

Puparia of *A. orientalis* were collected from Nangong Mountain and Liping National Forest Park, Shaanxi (Fig. 1), China, in July 2012.

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 an OLYMPUS intelligent microscope BX63 (OLYMPUS Corporation, Tokyo, Japan) located in the Institute of Applied Entomology, Yangzhou University, Yangzhou, China. Two samples were prepared for Scanning Electron Microscope (SEM) studies by cutting the leaf with a puparium still attached, then mounting this on a stub on black carbon conductive adhesive. The SEM images were taken by Philips XL30-Environmental Scanning Electron Microscope (Philips, UK) at 20 kV/EHT and 80 Pa between 157 to 1,000 $\times$  magnification (Wang *et al.* 2014).

The specimens are deposited in the Insect Collection of Yangzhou University (YZU), Yangzhou, China and Natural History Museum, London, UK (BMNH).

## 3. *Aleurochiton*

*Aleurochiton* Tullgren, 1907, Arkiv für Zoologi, 3: 14. Type species: *Chermes aceris ovatus*

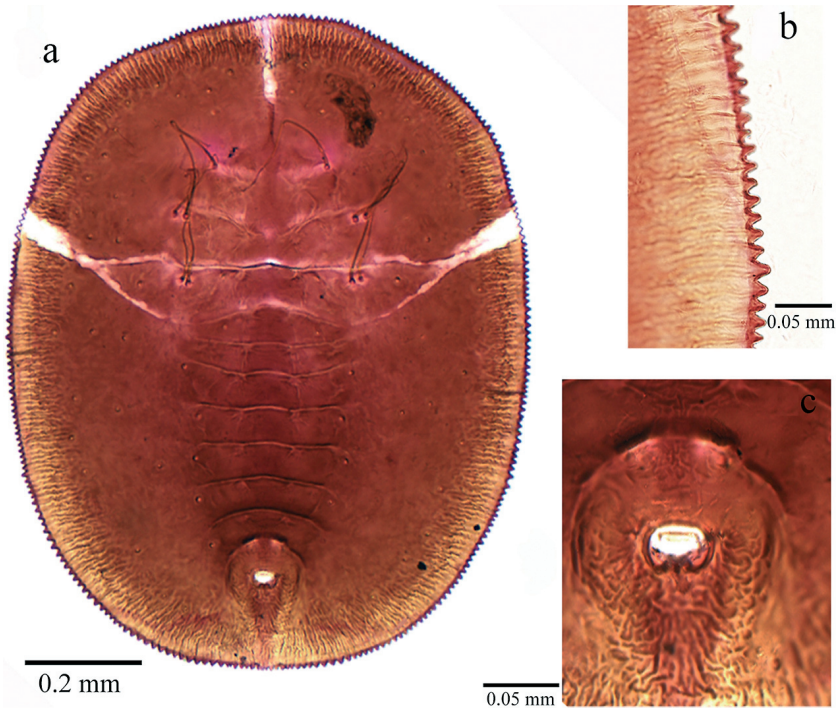


Fig. 2. *Aleurochiton orientalis* Danzig, slide-mounted specimen. – a. Puparium, dorsal view. – b. Margin. – c. Vasiform orifice and caudal furrow.

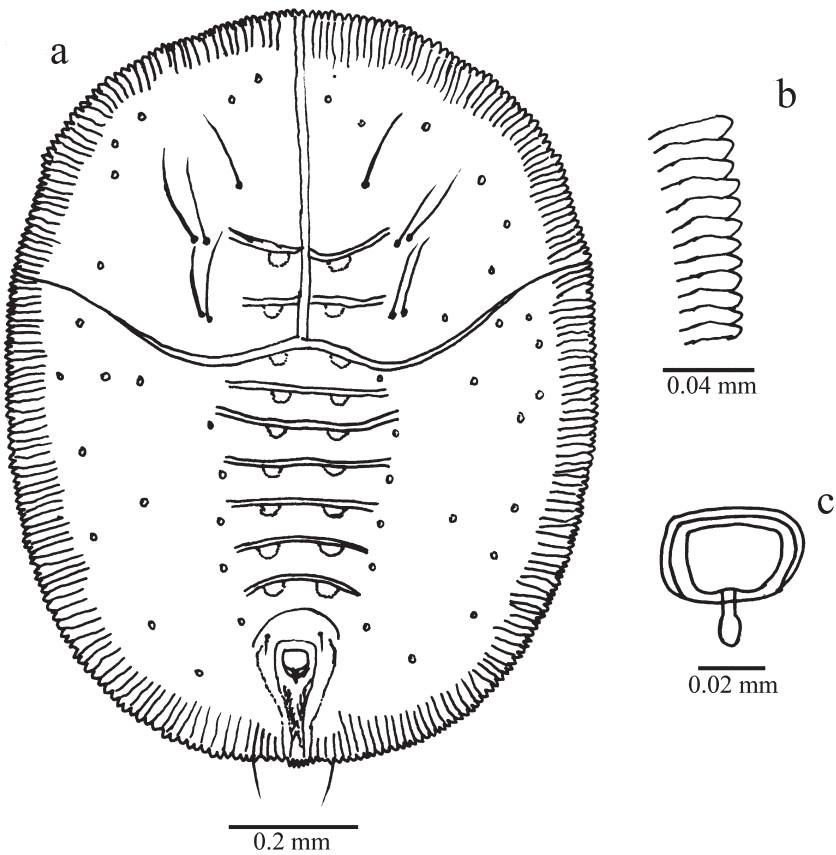


Fig. 3. *Aleurochiton orientalis* Danzig. – a. Puparium, dorsal view. – b. Margin. – c. Vasiform orifice.

Geoffroy, 1762, a rejected trinomial and a synonym of *Coccus aceris* Modeer, 1778, by monotypy.

*Aleurochiton* (*Nealeurochiton*) Sampson, 1943, Entomologica Americana, 23: 201. Type species: *Aleurodes forbesii*, by monotypy. [Synonymised by Mound & Halsey, 1978: 27.]

*Aleurochiton* (*Nigrinichiton*) Zahradnik, 1987, Vestník Československé Společnosti Zoologické, 51: 70. Type species: *Aleurochiton pseudoplatani*, by monotypy. [Synonymised by Martin & Mound, 2007: 9.]

*Diagnosis.* Puparium medium in size, broadly elliptical in outline, cuticular colour variable, margin crenulate, with waxy secretion on dorsum (especially in overwintering puparia) or along margin. Submarginal area not separated from dorsal disk. Vasiform orifice cordate to rectangular, operculum almost fully occupying vasiform orifice, lingula usually slightly overlapping posterior margin of vasiform orifice; transverse moulting suture reaching margin (Martin *et al.* 2000).

Puparia of *Aleurochiton* species somewhat resemble those of some *Pealius* species in the shape of the puparia and vasiform orifice and other characters, but in most species of *Aleurochiton* the operculum almost fully occupies the vasiform orifice, the lingula usually slightly overlaps the posterior margin of the vasiform orifice and the transverse moulting suture reaches the puparial margin. However, in species of *Pealius* the operculum occupies about two-thirds of the vasiform orifice, the lingula is included within the vasiform orifice, and the transverse moulting sutures terminate almost at the margin (Martin *et al.* 2000). There are also several *Pealius* species that have the transverse moulting suture extending to the margin as in *Aleurochiton*.

A characteristic shared by species of *Aleurochiton* and the European species *Pealius quercus* (Signoret, 1868) is overwintering as especially robust puparia that fall to the ground on dead leaves and then yield adult whiteflies in the spring. It is probable that some other *Pealius* species also do this, but the biology of most whiteflies remains unknown. In some *Aleurochiton* species the overwintering puparia significantly differ from the summer forms of the same species.

Puparia of *Aleurochiton* species also resemble

the species of *Apobemisia* in the shape of vasiform orifice and other characters, but in species of *Apobemisia* the operculum occupies about half of the vasiform orifice and the lingula is much longer and larger (Takahashi 1954).

#### 4. Descriptions of *Aleurochiton orientalis*

*Aleurochiton orientalis* Danzig, 1966 (Figs. 2–4)  
*Aleurochiton orientalis*: Danzig, 1966. Entomologicheskoe Obozrenie 45: 365.

*Material examined.* China, Shaanxi, 4 puparia on 4 slides, on *Acer mono* Maxim, Nangong Mountain, 18.VII.2012, J. R. Wang, leg., YZU; 4 puparia on 4 slides, on *Acer mono* Maxim, Liping National Forest Park, 15.VII.2012, J. R. Wang leg., YZU.

*Descriptions.* Puparia (fourth instar) (Figs. 2–3). Cinnamon-brown, broadly oval, slightly narrowed in thoracic region, about 1.1 mm in length, 0.86 mm in width; with a thin wax band along margin, about 124.5 µm long.

Lateral margin: With sclerotized denticles, single row, teeth triangular, about 7–9 denticles in 0.1 mm; anterior and posterior marginal setae absent. Tracheal folds distinct, broad, without special structure. Tracheal combs consisting of 3–4 denticles, smaller than marginal denticles.

Dorsum: Sub-marginal region not clearly separate from dorsal disk, with many transverse striae along sub-marginal area, also with some small pores. Longitudinal and transverse molting suture both extending to margin. A pair of prothorax setae approximately 255 µm long and 194 µm apart; a pair of conjugate setae on mesothorax and also on metathorax, approximately 261 µm long and 305 µm apart. Thorax and abdominal segment sutures well-defined, abdominal segment I 69.4 µm long, abdominal segment II–VI 55.6 µm long, abdominal segment VII 50 µm long. A pair of depressions present at median of each thoracic and abdominal segment sutures. A pair of small pores present on each side of abdominal segments.

Vasiform orifice: Situated in a rugose depression, rectangular, about 42.7 µm wide and 28.1 µm long. Operculum rectangular, almost completely covering orifice. Lingula head, about 20

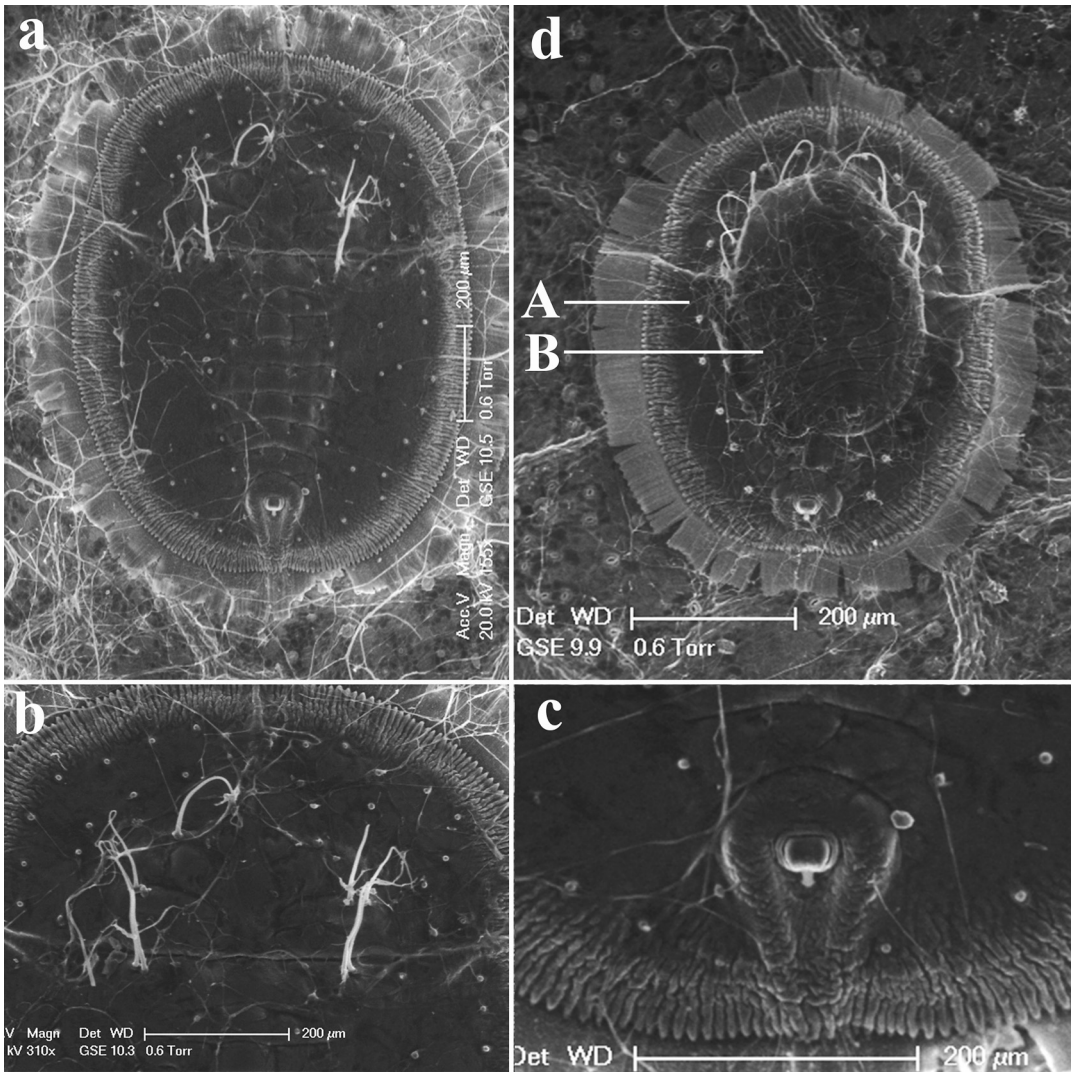


Fig. 4. SEM of *Aleurochiton orientalis* Danzig. – a. Puparium, dorsal view. – b. Cephalothorax and conjugate setae. – c. Vasiform orifice and caudal furrow. – d. 2<sup>nd</sup> larval exuvium (B) present on dorsum of 3<sup>rd</sup> larval instar (A), dorsal view.

$\mu\text{m}$  long, extending beyond orifice. Caudal furrow more strongly sclerotized than surrounding surface. Caudal setae about  $137.9 \mu\text{m}$  long.

Third instar (Fig. 4d: A). Shallow brown, elliptical, about  $0.59\text{--}0.62 \text{ mm}$  long,  $0.41\text{--}0.43 \text{ mm}$  wide, with wax band along margin, about  $59.6 \mu\text{m}$  long. Other morphological characteristics basically identical with puparia but with only 10 pairs of pores along submarginal.

Second instar (Fig. 4d: B) (based on two specimen, 2<sup>nd</sup>/3<sup>rd</sup> instar molt). Pale white, elliptical, about  $0.34 \text{ mm}$  long,  $0.22 \text{ mm}$  wide, with a thin

wax band along margin, about  $35.4 \mu\text{m}$  long. Marginal, cephalic and thoracic setae not discernible, but caudal setae about  $57.1 \mu\text{m}$  long. Submarginal pore absent. Abdominal segment sutures well-defined and sutures extending to margin. Vasiform orifice rectangular, wider than long, operculum rectangular, almost completely covering orifice. Lingula exposed, extending beyond orifice.

First instar and adult. Unknown.

*Host plants.* *Acer mono* Maxim (Sapindales: Aceraceae).

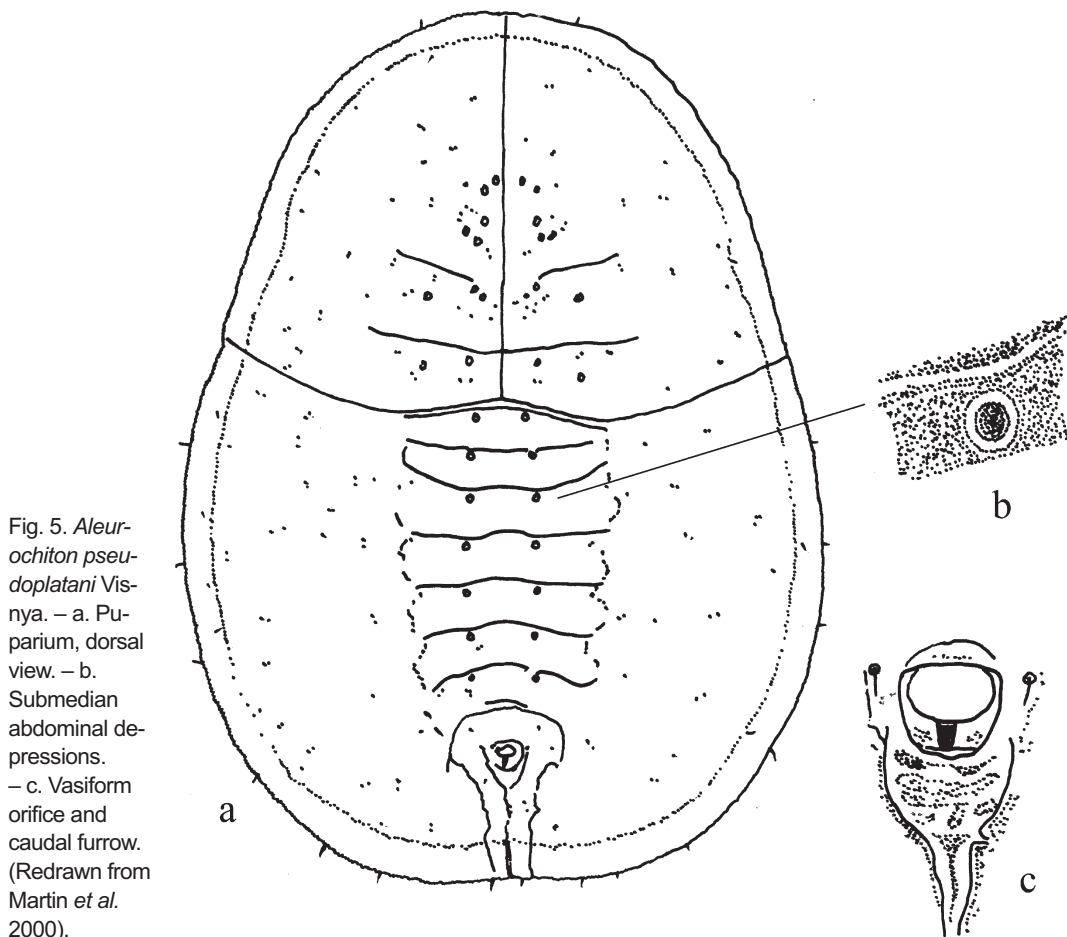


Fig. 5. *Aleurochiton pseudoplatani* Visnya. – a. Puparium, dorsal view. – b. Submedian abdominal depressions. – c. Vasiform orifice and caudal furrow. (Redrawn from Martin *et al.* 2000).

**Distribution.** China (Shaanxi); Russian Far East (Okeanskaya) (Danzig 1966).

**Comments.** *Aleurochiton orientalis* is closest to *Aleurochiton aceris* (Modeer), but the structure of the anal cleft is different and it has considerably more twin pores in compact groups, and also has one pair of conjugate setae on the dorsal mesothorax and also on metathorax. The phenomenon of conjugate setae (pairs of adjacent setal bases actually contiguous) is most unusual and Danzig appears to have used the term solely for *A. orientalis*. Danzig clearly stated that *A. orientalis* has just two generations annually, with summer and overwintering puparia, a characteristic shared only by other *Aleurochiton* species and by *Pealius quercus*. Therefore, it will be interesting to investigate the biologies of other cool-to-cold temperate whiteflies with that characteristic.

## 5. Biological aspects of *Aleurochiton orientalis*

Mainly because of the seasonal dimorphism, this new genus and species record is an interesting addition to the whitefly fauna of China and to the worldwide distribution of *Aleurochiton*. Based on the known distribution of *A. orientalis*, it should be regarded as a Palearctic species, and it may be also distributed in northern China and northeastern China. How far westwards this species may occur may be governed by the distribution of the host, *Acer mono*.

The specimens of *A. orientalis* were found 1–2 per leaf, centrally on the under surface of leaves and only few specimens could be found. There was no evident damage to the maple. No parasitoids were obtained from cultures. No ant attendance was observed.

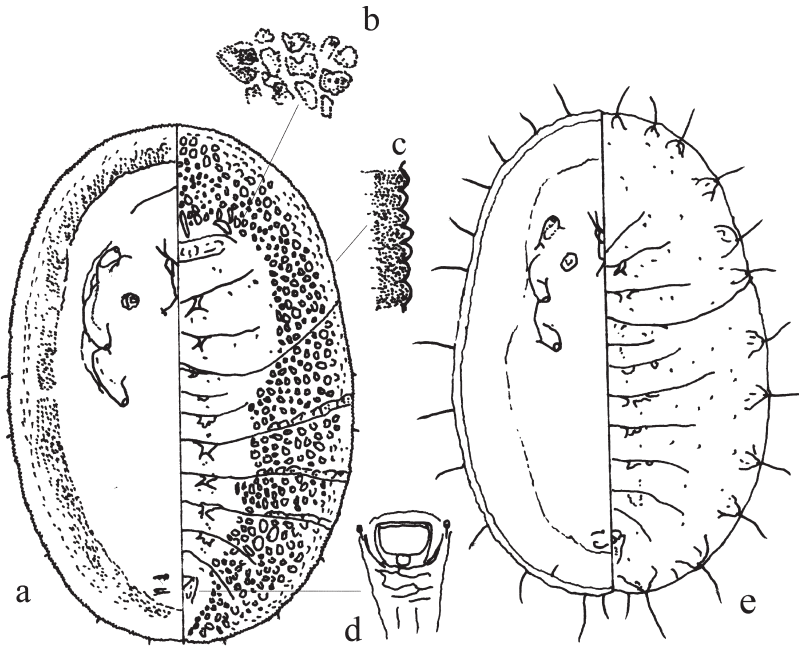


Fig. 6. *Aleurochiton acerinus* Haupt. – a. Overwintering puparium, ventral (left) and dorsal (right) view. – b. Pores and granules. – c. Margin. – d. Vasi-form orifice and caudal furrow. – e. Summer puparium, ventral (left) and dorsal (right) view. (Redrawn from Martin et al. 2000).

As Danzig (1966), we also observed a particular feature of *A. orientalis*, namely that the larval exuviae of the three earlier instars are present on the dorsum of the puparium firmly attached to each other. This has not been found in other spe-

cies of *Aleurochiton*. All of the described species of *Aleurochiton* are only known from maples (*Acer*) (Haupt 1934, Müller 1962, Danzig 1966, Martin et al. 2000, Evans 2008), including our specimens of *A. orientalis*, from *Acer mono*. With

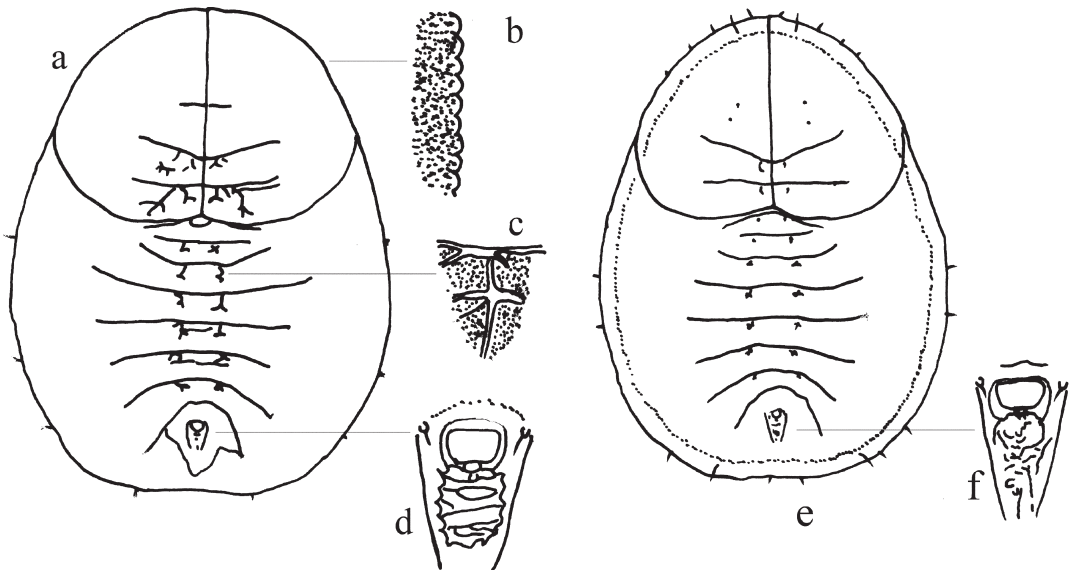


Fig. 7. *Aleurochiton aceris* (Modeer). – a. Overwintering puparium, dorsal view. – b. Margin. – c. Submedian abdominal depressions. – d. Vasi-form orifice. – e. Summer puparium, dorsal view. – f. Vasi-form orifice. (Redrawn from Martin et al. 2000).

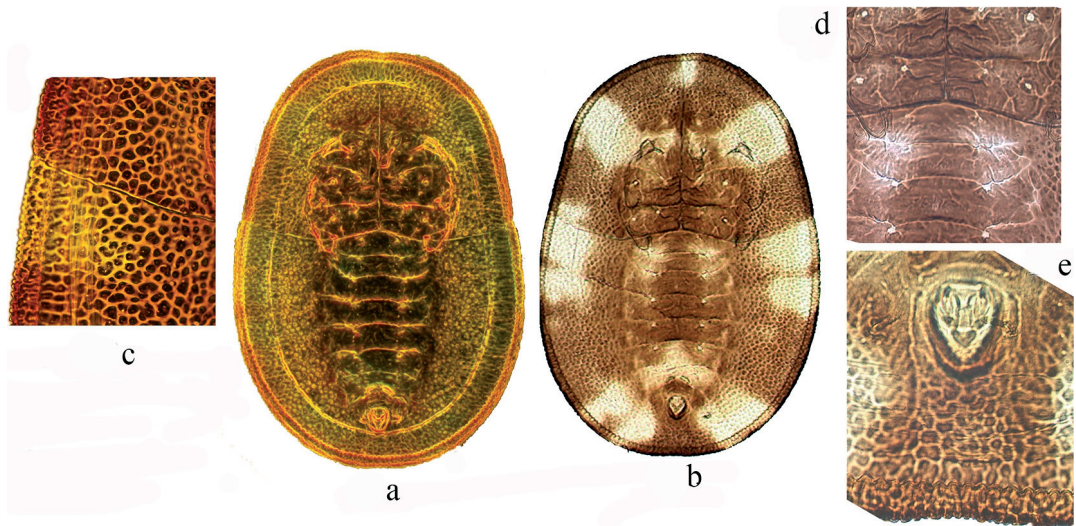


Fig. 8. *Aleurochiton forbesii* (Ashmead), USA, Pennsylvania, Millersville, on *Acer saccharium*, 19.IX.1973, Col. W. Blosser. – a. Puparium, dorsal view. – b. Slide-mounted specimen, puparium, dorsal view. – c. Margin and submarginal area. – d. Submedian abdominal depressions. – e. Vasiform orifice. (USDA – United States Department of Agriculture) (from John W. Dooley and Gregory A. Evans)

the higher taxonomy of many whitefly groups being poorly known *Aleurochiton* stands out as one of only a few whitefly genera that appear only to colonise hosts of a single plant genus.

### 6. Key to puparia of *Aleurochiton* species

The tendency for species of *Aleurochiton* to have two more-or-less dissimilar puparial forms makes the construction of a puparial key very difficult, despite there only being five species. The key below was constructed with the aid of actual specimens of all of the *Aleurochiton* species and we hope it will aid identification despite the difficulties.

1. With 1 or 2 pairs of conjugate setae (Figs. 2a, 3a, 4b) on dorsum. On *Acer mono*, far eastern Palearctic *orientalis* Danzig
  - Without conjugate setae on dorsum 2
2. Submedian abdominal depressions small but well-defined, subcircular (Fig. 5b). On *Acer pseudoplatanus*, Europe, western Russia *pseudoplatani* Visnya
  - Submedian abdominal depressions poorly defined (Fig. 6a, e, 7c, e, 8d) 3
3. Vasiform orifice (Fig. 8e) relatively large, cordate, a little longer than wide, situated on a shallow elevation, lingula well developed and with a pair of terminal setae. Overwintering puparia often with a characteristic brown pigmented pattern (Fig. 8a, b). On several *Acer* species, Nearctic Region (North America) *forbesii* (Ashmead)
  - Vasiform orifice smaller, trapezoidal, not elevated, operculum occupying most of the orifice. Not found in Nearctic Region 4
4. Outer submargin of summer puparia with 12 pairs of long, stout submarginal setae, much longer than the caudal setae (Fig. 6e); overwintering puparia with minute submarginal setae, much shorter than 8<sup>th</sup> abdominal setae (Fig. 6a); overwintering puparia with submedian zone of venter delineated by an irregular fold, best defined cephalically and close to posterior abdominal spiracles (Fig. 6a). On *Acer campestre*, Europe *acerinus* Haupt
  - Spring/summer puparia with short, minute setae in outer submargin (Fig. 7a, 7e). Overwintering puparia with submedian zone of venter not well defined. On *Acer platanoides*, Europe *aceris* (Modeer)



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## References

- Ashmead, W. H. 1893: Monograph of the North American Proctotrypidae. *Amitus* Haldemann. — *Bulletin of the United States National Museum* 45: 292–294.
- Bink-Moenen, R. M. 1983: Revision of the African whiteflies (Aleyrodidae). — *Monografieën van de Nederlandse Entomologische Vereniging*. Amsterdam 10: 1–211.
- Danzig, E. M. 1966: The whiteflies (Homoptera, Aleyrodoidea) of the southern Primor'ye (Soviet Far East). — *Entomologicheskoe Obozrenie* 45: 364–386. [English translation in *Entomological Review*. Washington 45: 197–209 (1974).]
- Evans, G. A. 2008: The whiteflies (Hemiptera: Aleyrodidae) of the world and their host plants and natural enemies. Version 070606. [www document]. URL [http://keys.lucidcentral.org/keys/v3/whitefly/PDF\\_PwP%20ETC/world-whitefly-catalog-Evans.pdf](http://keys.lucidcentral.org/keys/v3/whitefly/PDF_PwP%20ETC/world-whitefly-catalog-Evans.pdf). (Site visited on 21 March, 2016).
- Gill, R. J. 1990: The morphology of whiteflies. — In: Gerling, D. (ed.), *Whiteflies: Their Bionomics, Pest Status and Management*: 13–46. Intercept. Andover. 347 pp.
- Haupt, H. 1934: Neues er die Homoptera Aleurodina. — *Deutsche Entomologische Zeitschrift*: 127–141.
- Martin, J. H. 1985: The whitefly of New Guinea (Homoptera: Aleyrodidae). — *Bulletin of the British Museum (Natural History) (Entomology)* 50: 303–351.
- Martin, J. H. 1987: An identification guide to common whitefly pest species of the world (Homoptera, Aleyrodidae). — *Tropical Pest Management* 33: 298–322.
- Martin, J. H., Mifsud, D. & Rapisarda, C. 2000: The whiteflies (Hemiptera: Aleyrodidae) of Europe and the Mediterranean Basin. — *Bulletin of Entomological Research* 90: 407–448.
- Martin, J. H. & Mound, L. A. 2007: An annotated checklist of world whiteflies (Insecta: Hemiptera: Aleyrodidae). — *Zootaxa* 1492: 1–84.
- Mound, L. A. & Halsey, S. H. 1978: Whitefly of the World. A systematic catalogue of the Aleyrodidae (Homoptera) with host plant and natural enemy data. — *British Museum (Natural History)*, Chichester, 340 pp.
- Modeer, A. 1778: Om fastflyet Coccus. — *Göteborgs Kungl. Vetenskaps och Vitterhets Samhälles Handlingar*. — *Ny Tidsföljd* 1: 11–50.
- Müller, H. J. 1962: Zur biologie und morphologie der saisonformen von *Aleurochiton complanatus* (Baerensprung 1849) (Homoptera: Aleyrodidae). — *Zeitschrift Für Morphologie Und Ökologie Der Tiere* 51(3): 345–374.
- Sampson, W. W. 1943: A generic synopsis of the Hemipterous Superfamily Aleyrodoidea. — *Entomologica Americana* 23: 173–223.
- Signoret, V. 1868: Essai monographique sur les aleurodes. — *Annales de la Soci Entomologique de France* 8: 369–402.
- Takahashi, R. 1954: Key to the tribes and genera of Aleyrodidae of Japan, with descriptions of three new genera and one new species (Homoptera). — *Insecta Matsu-murana* 18: 47–53.
- Tullgren, A. 1907: Über einige Arten der Familie Aleurodidae. — *Arkiv für Zoologi* 3: 1–18.
- Visnya, A. 1936: További molytetvek köszegröl és vidékéről. Weitere Mottenläuse aus der Umgebung von Köszeg. — *Folia sebariensis vasi Szle* 3: 116–117.
- Wang, J. R., Dubey, A. K. & Du, Y. Z. 2014: Description of a new species of *Aleuroclava* Singh (Hemiptera: Aleyrodidae) from China. — *Florida Entomologist* 97(2): 685–91.
- Zahradnik, J. 1963: Aleyrodina. — *Die Tierwelt Mitteleuropas (N.S.)* 4: 1–9.
- Zahradnik, J. 1987: La révision des aleurodes des pays Tchêques (Sternorrhyncha: Aleyrodinea). II. — *Vestník Československé Společnosti Zoologické* 51: 60–80.