

## ***Uroleucon formosanum* (Takahashi) and *Uroleucon sonchellum* (Monell) (Hemiptera, Aphididae): Morphological Comparison and Diagnosis**

**K. S. Pike<sup>1</sup>, R. G. Foottit<sup>2</sup>, R. H. Miller<sup>3</sup>, O. Idechiil<sup>3</sup>, D. W. Allison<sup>1</sup>**

<sup>1</sup>Washington State University, 24106 N. Bunn Rd., Prosser, WA 99350.

<sup>2</sup>Eastern Cereal Oilseed Research Centre, Agriculture and Agri-Food Canada, Central Experimental Farm, K.W. Neatby Bldg., 960 Carling Ave., Ottawa, Ontario K1A 0C6, Canada.

<sup>3</sup>University of Guam, CNAS, AES, UOG Station, Mangilao, Guam 96923.

**Abstract.** *Uroleucon formosanum* (Takahashi) and *U. sonchellum* (Monell) (Hemiptera: Aphididae: Aphidinae: Macrosiphini) are species of very similar morphology. Descriptions, illustrations, morphological measurements and a diagnosis are provided.

**Key words:** aphid, description, morphology, distribution, host plants, *Uroleucon formosanum*, *Uroleucon sonchellum*

*Uroleucon formosanum* (Takahashi) and *Uroleucon sonchellum* (Monell) (Hemiptera: Aphididae: Aphidinae: Macrosiphini) are widely separated geographically, but very similar in morphological characters and biological association. Ghosh et al. (1971) recognized this and stated that an examination of extensive material of apterae and alatae of the two might serve to determine whether they are the same or separate species. *Uroleucon formosanum* is recognized from east Asia and the Mariana Islands of Guam and Rota (Takahashi 1921, 1962, Paik 1965, Ghosh et al. 1971, Miyazaki 1971, Raychaudhuri 1980, Lee et al. 2002b, Miller et al. 2003); *U. sonchellum* (syn. *williamsi*, see Hille Ris Lambers 1939) is recognized from eastern and central USA and California (Monell 1879, Williams 1910, Gillette and Palmer 1929, Smith and Parron 1978, Moran 1984). From present studies, we affirm that the two species are distinct. Provided are descriptions, illustrations, biometric data (morphological measurements and character comparisons) and a diagnosis.

### **Materials and Methods**

Aphids studied were from loans from the Korean Research Institute of Bioscience and Biotechnology and Center for Insect Systematics (KRI), Seoul; the North Carolina State University Insect Collection, Raleigh (NCSSU); the United States National Museum of Natural History, Smithsonian Institution, Beltsville, Maryland (USNM); and authors' collections from the Mariana Islands of Guam and Rota. Evaluated *Uroleucon formosanum* material originated from China, North Korea, South Korea, Guam, and Rota; *U. sonchellum* material was from the United States. All evaluations were based on slide mounted material; authors' specimens were cleared and mounted in Canada balsam using techniques by Foottit and Maw (see website: <http://www.zoology.ubc.ca/~mawe/bcaphid>). Descriptive terminology used follows Foottit and Richards (1993) and Pike et al. (2003).

**Biometric data.** Morphological measurements and comparisons (see Tables 1–3) were based on characters photographed with a Nikon Coolpix 990™ digital camera through a Zeiss Axiolab™ microscope at magnifications of 50–400x. Measurements were made using image-measuring software by D. W. Allison (unpublished). Line-illustrations of the key

features were drawn from digital images (Figs. 1–6).

**Specimens examined and measured.** [aphid morph abbreviations: al, alate vivipara; ap, apterous vivipara; m, aptera male; ov, ovipara] *Uroleucon formosanum*: China – Hangzhou, 25-Jun-1936, on *Lactuca squarrosa*, coll. H. C. Yao (2 ap, USNM); South Korea – Dodong, Ulreung-do, Gyeongsangbuk-do, 5-Jun-2000, on *Lactuca indica*, coll. S. H. Lee (2 ap, KRI); Kongi-dong, Mt. Weolak-san, Chungju-si, Cheongcheongbuk-do, 15-Sep-1999, on *L. indica*, coll. S. H. Lee (3 ap, KRI); Jinsan, Keumsan, Chungcheongnam-do, 6-Sep-2000, on *Ixeris dentata*, coll. Y. S. Jeong (1 al, KRI); Sara-bong, Jeju-si, Jeju-do, 25-Oct-2000, on *Sonchus oleraceus*, coll. S. Lee (2 ap, KRI); North Korea – Pyongsong-al, Chongryong-san, 3-Jul-1988, on *S. asper*, coll. J. Havelka (1 al, KRI); USA, Guam, Mangilao, University of Guam, Marine Lab – 21-Feb-2003, on *Youngia japonica*, coll. R. G. Foottit and R. H. Miller (5 ap); 11-Aug-2003, on *Youngia japonica*, coll. O. Idechiil (9 al); Northern Marianas, Rota, – Rota Golf Course, 27-Feb-2003, on *Youngia japonica*, coll. R. H. Miller and R. G. Foottit (10 ap). *Uroleucon sonchellum* [specimens from NCSU, unless otherwise indicated]: USA, Maryland – Beltsville, 8-Oct-1997, on *Hieracium* sp., coll. A. Jensen (2 ap, 1 m, 1 ov, USNM); USA, North Carolina – Boone, 11-Oct-1958, on *Lactuca* sp. (1 ap, 1 ov); Carthage, 7-Aug-1959, on *L. canadensis* (1 al, 1 ap); Clarks Landing, 9-Jun-1960, on *L. canadensis*, coll. A. T. Olive (1 ap); Cliffs of Neuse, 5-Jun-1958, on *L. hirsuta* (1 ap); Grandfather Mtn., 11-Oct-1958 on *L. sp.* (1 al); Jonas Ridge, 11-Oct-1958, on *L. sp.* (3 ap, 2 ov); Lumber Bridge, 8-Jun-1960, on *L. canadensis*, coll. A. T. Olive (1 al); Lumberton, 10-Jun-1960, coll. A. T. Olive, on *L. sp.* (1 ap); Mocksville, 21-Jun-1959 (1 al) and 8-Jun-1963 (1 ap), on *L. canadensis*, coll. A. T. Olive; NE Wilkes Co., 18-Apr-1959, on *L. sp.* (1 ap); Norman, 30-Oct-1958 (1 ap) and 24-Apr-1959, on *L. sp.* (1 al, 1 ap); Plantation, 1-May-1959, on *L. sp.* (6 ap, 3 al); Raleigh, 10-Jun-1958 (2 ap, 1 al) and 26-Apr-1959 (1 al, 1 ap), on *L. scariola* and *L. sp.*, coll. A. T. Olive; State College, 24-Jul-1959, on *L. canadensis*, coll. A. T. Olive (1 al, 2 ap); Twin Tunnel, Blue Ridge Pkwy, 23-Oct-1961, on *L. sp.*, coll. C. F. Smith (4 ov); Wallace, 30-Apr-1959, on *L. sp.* (1 ap); Wilmington, 1-May-1959 (1 al, 1 ap) and 10-May-1960 (3 ap), on *L. canadensis* and *L. sp.*, coll. A. T. Olive; USA, Pennsylvania – Spruce Creek, 11-Aug-1962, on *L. sp.*, coll. J. O. Pepper (3 al, 3 ap); Waddle State College, 19-Aug-1962, on *L. sp.*, coll. J. O. Pepper (1 ap); USA, South Carolina, Pickens (10 mi N), 27-Oct-1959, on *L. sp.*, coll. C. F. Smith (1 al, 3 ap); USA, Virginia, South Hill, 25-Aug-1959, on *L. sp.* (5 ap); USA, Washington D.C., Chain Bridge, 25-Aug-1959, on *L. sp.* (1 al, 1 ap).

### ***Uroleucon (Uroleucon) formosanum* (Takahashi)**

*Macrosiphum formosanum* Takahashi 1921

*Dactynotus formosanus* (Takahashi 1962)

**Distribution:** China, India, Japan, North and South Korea, Mariana Islands (Guam and Rota), Siberia, Taiwan, and Vietnam (Takahashi 1921, 1962, Paik 1965, Ghosh et al. 1971, Miyazaki 1971, Raychaudhuri 1980, Lee et al. 2002a, Miller et al. 2003)

**Biology:** Anholocyclic in mild winter areas; holocyclic in colder areas.

**Plant hosts.** Many of the plant hosts are in the subtribe Crepidinae (Asteraceae: Cichorieae), viz. *Crepis* [association known only for *U. formosanum* subsp. *crepidis* A. K. Ghosh, M. R. Ghosh and D. N. Raychaudhuri (1971)], *Ixeridium gracilie*, *Ixeris dentata*, *Ixeris sonchifolia*, *Lactuca brevirostris*, *L. debilis*, *L. laciniata*, *L. scariola*, *Pterocypsel a formosana*, *P. indica*, *P. triangulata*, *Sonchus asper*, *S. oleraceus*, *Taraxacum platycarpum* and *Youngia japonica*. Four other Asteraceae hosts have been reported: *Aster scaber* (Astereae), *Centaurea monanthos* and *Cirsium japonicum* (Cynareae) (from Korea, see Paik 1965, Lee et al. 2002a), and *Senecio* sp. (Senecioneae) (from China, see Tao 1963).

*Description.* *Apterous vivipara* (Table 1, Fig. 1). Color in life, dark red with central body area dark (metathorax and anterior part of abdomen), antennae, distal areas of femora and tibiae, tarsi, and siphunculi dark; cauda pale yellow. Prepared specimens (cleared and mounted): adult, body length 2.27–3.38 mm. Body relatively pale, cauda pale, legs partially pigmented. Frontal tubercles (= antennal tubercles) well developed, diverging, and smooth. Median tubercle undeveloped. Antennae longer than body, 6-segmented with conspicuously prominent tuberculate secondary rhinaria over length of segment III (Fig. 1b). Antenna III usually  $> 1.8x$  IV+V. Antenna III setae length usually  $\leq$  basal width of antennal III. Setae on body and appendages mainly blunt, but some capitate and acuminate. Rostrum extending beyond mesocoxae; ultimate rostral segment tapering, rounded distad of preapical primary setae, with 2–9 accessory setae, and approximately equal in length to hind tarsal II. Tarsal claws simple; empodial setae acuminate, short, about half the length of the claw; tarsal I chaetotaxy, 5-5-5. Abdominal dorsum membranous, pale, except for pigmented antesiphuncular and postsiphuncular sclerites, with small sclerites at base of abdominal setae. Abdominal spiracles subcircular, without opercula. Siphunculus long (0.20–0.29x body; 1.2–1.4x cauda), tapering (narrower at apex than base), flanged, not reaching to apex of cauda, and conspicuously reticulate on distal 25–30%. Cauda long and tapering, with pointed apex and 15–25 setae. Table 1 provides a full range of measured features and comparisons.

*Alate vivipara* (Table 1, Fig. 2). Color in life dark red, head and thorax blackish to blackish-red, otherwise similar to aptera. Measured features similar or smaller than the aptera vivipara (see Table 1 for the full range of comparisons). Antenna III  $> 1.8x$  IV+V. Wings hyaline, stigma pale yellow, veins yellow-brown; hind wing with two parallel oblique veins and three hamuli.

*Ovipara* and *male* not observed.

### ***Uroleucon (Uroleucon) sonchellum* (Monell)**

*Siphonophora sonchella* Monell 1879

*Macrosiphum williamsi* Gillette and Palmer 1929

*Distribution:* USA – California, Colorado, Connecticut, Florida, Illinois, Kansas, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, and Washington D.C. [Monell 1879, Williams 1910, Gillette and Palmer 1929, Palmer 1952, Smith and Parron 1978, Moran 1984, and from slide collections (NCSU and USNM)].

*Biology:* Monoecious holocyclic, possibly anholocyclic in areas of warm winter climate.

*Plant hosts.* All in the subtribe Crepidinae (Asteraceae: Cichorieae), viz., *Hieracium* sp., *Lactuca canadensis*, *L. graminifolia*, *L. hirsuta*, *L. pulchilla*, *L. scariola*, *Sonchus asper* and *S. oleraceus*.

*Description.* *Apterous vivipara* (Table 2, Fig. 3). Color in life [not observed by authors; after Gillette and Palmer 1929, see *M. williamsi* (= *U. sonchellum*) and Robinson 1985], reddish brown, dull red, or brick-red, lighter on pronotum, head and terminal segment, with distal areas of femora and tibiae, tarsi, and siphunculi dark; antennae dark except base of segment III; cauda pale. Prepared specimens (cleared and mounted): adult, body length 2.47–3.52 mm. Body pale, cauda pale, legs pale except distal areas of femora and tibiae, and entire tarsi dark. Body surface relatively smooth. Frontal tubercles (= antennal tubercles) well developed, diverging, and smooth; median tubercle undeveloped. Antennae longer than body, 6-segmented with lightly tuberculate secondary rhinaria on segment III. Antenna III usually  $< 1.6x$  IV+V. Antenna III setae length  $\leq$  basal width of antenna III. Antenna III

secondary rhinaria numerous (46–97), IV sometimes with rhinaria (0–4). Tarsal claws simple; empodial setae acuminate, short, about half the length of the claw; tarsal I chaetotaxy, 5-5-5. Siphunculus long (0.17–0.22x body; 1.0-1.4x cauda), tapering (narrower at apex than base), flanged, not reaching to apex of cauda, and conspicuously reticulate on distal portion. Cauda long and tapering, with 10–19 setae. For a full range of measured features and comparisons, see Table 2.

*Alate vivipara* (Table 2, Fig. 4). Color in life (not observed by authors, after Palmer 1952), head and thorax pale red, otherwise as in aptera vivipara. Measured features similar to aptera (see Table 2 for the full range of comparisons). Antenna III secondary rhinaria (80–127) usually more numerous than aptera vivipara. Antenna III usually  $< 1.6 \times IV+V$ . Wings hyaline, stigma pale; hind wing with two parallel oblique veins.

*Ovipara* (Table 3, Fig. 5). Measured features are very similar to the aptera vivipara. Hind tibia with 18-64 rhinaria. Cauda shape tending to be slightly different than that of aptera vivipara (compare Figs. 3h and 5h). For the full range of measured features and comparisons, see Table 3.

*Apterous Male* (Table 3, Fig. 6). Only one specimen observed. Body 1.89 mm, smaller than other morphs. Measured features consistently smaller than other morphs. Antenna III with 52 rhinaria, less than the number usually encountered in other morphs. Cauda shape similar to ovipara. For the full range of measured features and comparisons, see Table 3.

### Diagnosis

*Uroleucon formosanum* and *U. sonchellum* are easily distinguished from most other *Uroleucon* (*Uroleucon*) spp. [worldwide, ~109 spp. in the subgenus (see Remaudière and Remaudière 1997)] by their long antennal III segment [III/(IV+V) usually  $> 1.45$ ], and from each other using the following characters:

protuberance of antenna III secondary rhinaria [in *U. formosanum* rhinaria are distinctively raised or pronounced (see Figs. 1b, 2b); in *U. sonchellum* rhinaria only minimally protuberant (Figs. 3b, 4b)];

antenna III/(IV+V) [in *U. formosanum* value is usually  $> 1.8$  (range 1.61-2.21, aptera and alate viviparae); in *U. sonchellum* value is usually  $< 1.6$  (range 1.11-1.71, all morphs)];

siphuncular length in aptera viviparae [in *U. formosanum* usually  $> 0.65$  mm (range 0.51-0.92 mm); in *U. sonchellum* usually  $< 0.65$  mm (range 0.46-0.65 mm)];

antenna IV secondary rhinaria in alate viviparae [in *U. formosanum* not observed; in *U. sonchellum* usually present.

Aside from the diagnostic characters above, the two species are morphologically very similar; in fact, the ranges in measured features and comparisons generally overlap (see table). Of the diagnostic characters shown above, the most readily distinguished is the difference in protuberance of the secondary rhinaria.

As global commerce and travel expands, so does the distribution of many aphid species through inadvertent introductions. The presence of *U. formosanum* in the Mariana Islands is an expansion of its distribution from mainland Asia (Miller et al. 2003), and an indication of its capacity to adapt to new environments. If the distribution of *U. formosanum* and *U. sonchellum* overlap in the future, the diagnostic characters above should be adequate to distinguish the species.

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### Literature Cited

- Footitt, R. G.** and **H. E. L. Maw.** Website. <http://www.zoology.ubc.ca/~mawe/bcaphid>.
- Footitt, R. G.** and **W. R. Richards.** 1993. The genera of the aphids of Canada, Homoptera: Aphidoidea and Phylloxeroidea. The Insects and Arachnids of Canada, Part 22, Publication 1885. Agriculture Canada, Ottawa. 766 p.
- Gillette, C. P.** and **M. A. Palmer.** 1929. Five new Aphididae from Colorado. Ann. Entomol. Soc. Amer. 22: 468–479.
- Ghosh, A. K., M. R. Ghosh** and **D. N. Raychaudhuri.** 1971. Studies on aphids (Homoptera: Aphididae) from eastern India. IX. One new genus, five new species, a new subspecies and further new records from the Darjeeling District, West Bengal. Oriental Insects 5: 324–336.
- Hille Ris Lambers, D.** 1939. Contributions to a monograph of the Aphididae of Europe. II. The genera *Dactynotus* Rafinesque, 1818; *Staticobium* Mordvilko, 1914; *Macrosiphum* Passerini, 1860; *Masonaphis* nov. gen.; *Pharalis* Leach, 1826. Temminckia 4: 1–134.
- Lee, S., J. Holman** and **J. Havelka.** 2002a. Illustrated Catalogue of Aphididae in the Korean Peninsula. Part I, Subfamily Aphidinae (Hemiptera: Sternorrhyncha). Insects of Korea Series 9. Korea Research Institute of Bioscience and Biotechnology and Center for Insect Systematics. Printed by Junghaeng-Sa, Seoul, Korea. 329 pp.
- Lee, S., J. Holman** and **J. Havelka.** 2002b. The genus *Uroleucon* (Hemiptera: Aphididae) from the Korean Peninsula. Part I. The nominotypical subgenus *Uroleucon* with descriptions of three new species. Oriental Insects 36: 59–77.
- Miller, R. H., O. Idechil, R. G. Footitt** and **K. S. Pike.** 2003. *Uroleucon formosanum* (Takahashi) (Homoptera: Aphididae) found on *Youngia japonica* (L.) DC on Guam and Rota in the Mariana Islands. Proc. Hawaiian Entomol. Soc. 36: 125–126.
- Miyazaki, M.** 1971. A revision of the tribe Macrosiphini of Japan (Homoptera: Aphididae, Aphidinae). Insecta Matsumurana 34: 1–247.
- Monell, J.** 1879. Part II. Notes on Aphidinae, with descriptions of new species, pp. 18–32. In C. V. Riley and J. Monell, Notes on the Aphididae of the United States, with descriptions of species occurring west of the Mississippi. Bull. U. S. Geol. Survey 5: 1–32.
- Moran, N.** 1984. The genus *Uroleucon* (Homoptera: Aphididae) in Michigan: key, host records, biological notes, and descriptions of three new species. J. Kan. Entomol. Soc. 57: 596–616.
- Paik, Woon Hah.** 1965. Aphids of Korea. P. K. Ryu (Publisher), Publishing Center of Seoul, National University, Seoul, Korea. 160 pp.
- Palmer, M. A.** 1952. Aphids of the Rocky Mountain Region. The Thomas Say Foundation Vol. 5. A. B. Hirschfeld Press, Denver, Colorado. 452 pp.
- Pike, K. S., L. L. Boydston** and **D. W. Allison.** 2003. Aphids of western North America north of Mexico with keys to subfamilies and genera for female alatae. Washington State University, Cooperative Extension MISC0523, Pullman, Washington. 282 pp.
- Raychaudhuri, D. N.** 1980. Aphids of North-East India and Bhutan. The Zoological Society, Calcutta. 521 pp.
- Remaudière, G.** and **M. Remaudière.** 1997. Catalogue of the World's Aphididae, Homoptera Aphidoidea. Institut National de la Recherche Agronomique, Paris. 473 pp.
- Robinson, A. G.** 1985. Annotated list of *Uroleucon* (*Uroleucon*, *Uromelan*, *Satula*) (Homoptera: Aphididae) of America north of Mexico, with keys and descriptions of new species. Can. Entomol.

Table 1. Morphological measurements (mm) and comparisons for adult morphs of *Uroleucon formosanum* (measurements from original description [Takahashi 1921] in italics).

	Apterous viviparae		Alate viviparae	
	original description	mean n=24 (range)	original description	mean n=11 (range)
Body (length)	3.0	2.89 (2.27–3.38)	2.2	2.19 (1.77–3.07)
<b>Head</b>				
Head (width)		0.53 (0.47–0.62)		0.47 (0.43–0.54)
Antenna				
I–VI (length)	3.5	3.52 (3.17–3.98)	3.5	3.36 (2.89–3.60)
III (length)	<i>1.42</i>	1.33 (0.97–1.70)	<i>1.34</i>	1.30 (1.09–1.53)
III (width at base)		0.043 (0.033–0.062)		0.036 (0.032–0.048)
IV (length)	0.36	0.37 (0.28–0.46)	0.41	0.32 (0.28–0.37)
V (length)	0.35	0.37 (0.25–0.44)	0.40	0.32 (0.28–0.41)
Processus terminalis (length)	0.92	0.94 (0.85–1.05)	0.95	0.89 (0.82–0.98)
Base of antennal VI (length)	0.12	0.15 (0.13–0.17)	0.13	0.14 (0.13–0.17)
Base of antennal VI (width at base)		0.020 (0.015–0.025)		0.017 (0.014–0.020)
Antenna III secondary rhinaria	~ 80	68.7 (34–108)	~80–90	85.6 (63–129)
Antenna IV secondary rhinaria		0		0
Antenna V secondary rhinaria		0		0
Longest seta on antennal III (length)		0.033 (0.027–0.037)		0.027 (0.025–0.032)
Longest seta on vertex (length)		0.056 (0.041–0.074)		0.036 (0.029–0.051)
Ultimate rostral segment (length)		0.16 (0.14–0.18)		0.15 (0.14–0.18)
Ultimate rostral segment (width at base)		0.061 (0.052–0.078)		0.055 (0.049–0.069)
Ultimate rostral segment accessory setae		6.3 (2–9)		7.0 (5–8)
<b>Thorax</b>				
Hind tibia (length)		2.03 (1.47–2.58)		1.72 (1.41–2.23)
Longest seta near apex of tibia (length)		0.042 (0.031–0.057)		0.029 (0.021–0.035)

Tarsal II chaetotaxy					
Hind tarsus II (length)	5-5-5				(0.13-0.17)
Hind tarsus II (width at mid-segment)	0.16		(0.14-0.19)		(0.021-0.027)
Hind tarsal II accessory setae	0.026		(7-10)		(7-9)
	8.5				
<b>Abdomen</b>					
Siphunculus (length)	0.73	0.80	(0.51-0.92)	0.68	(0.49-0.75)
Siphunculus (width at base)	0.18		(0.12-0.26)		(0.11-0.14)
Cauda (length)	0.55		(0.39-0.69)		(0.28-0.50)
Cauda (width at base)	0.18		(0.15-0.23)		(0.11-0.19)
Caudal setae	18.9	~16	(15-25)	~16	(13-20)
<b>Comparisons</b>					
Head/antennal III (width/length)	0.40		(0.34-0.50)		(0.33-0.41)
Antenna/body (length)	1.16		(1.04-1.31)		(1.17-1.56)
Antenna III/Antenna IV+V(length)	1.83		(1.61-2.03)		(1.84-2.21)
Length of longest seta on antennal III / basal width of antennal III	0.78		(0.57-1.05)		(0.55-0.88)
Antenna VI base (length/width at base)	7.5		(6.4-9.4)		(8.0-9.0)
Processus terminalis/antennal VI base (length)	6.4		(5.7-7.5)		(4.9-6.5)
Length of longest seta on vertex / basal width of antennal III	1.33		(0.96-1.79)		(0.86-1.17)
Ultimate rostral segment (length/width at base)	2.6		(2.0-3.0)		(2.5-2.9)
Ultimate rostral segment/hind tarsus II (length)	1.0		(0.9-1.1)		(1.0-1.1)
Hind tarsus II (length/width at mid-segment)	6.0		(5.1-6.8)		(5.5-6.6)
Siphunculus (length/width at base)	4.3		(3.4-5.9)		(4.0-5.9)
Siphunculus/body (length)	0.25		(0.20-0.29)		(0.24-0.30)
Siphunculus/antennal III (length)	0.55	0.56	(0.48-0.64)	0.51	(0.42-0.53)
Siphunculus/cauda (length)	1.3	~1.5	(1.2-1.4)		(1.5-1.8)
Cauda (length/width at base)	3.1		(2.5-3.8)		(2.1-3.1)
Cauda/body (length)	0.19		(0.17-0.22)		(0.15-0.20)

**Table 2. Morphological measurements (mm) and comparisons for apterous and alate viviparae of *Uroleucon sonchellum* [original description (Monell 1879) gave alate body length range as 2.28–2.78].**

	Apterous viviparae n=42		Alate viviparae n=18	
	mean	(range)	mean	(range)
Body (length)	2.85	(2.47–3.52)	2.83	(2.31–3.24)
<b>Head</b>				
Head (width)	0.54	(0.48–0.63)	0.53	(0.49–0.59)
Antenna				
I–VI (length)	3.36	(2.92–3.70)	3.71	(3.07–4.26)
III (length)	1.24	(1.04–1.42)	1.41	(1.22–1.58)
III (width at base)	0.048	(0.039–0.058)	0.046	(0.037–0.054)
IV (length)	0.43	(0.35–0.64)	0.46	(0.35–0.58)
V (length)	0.42	(0.33–0.62)	0.46	(0.36–0.58)
Processus terminalis (length)	0.91	(0.77–1.04)	1.01	(0.79–1.15)
Base of antennal VI (length)	0.13	(0.11–0.16)	0.13	(0.11–0.15)
Base of antennal VI (width at base)	0.022	(0.018–0.025)	0.021	(0.018–0.024)
Antenna III secondary rhinaria	72.9	(46–97)	107.5	(80–127)
Antenna IV secondary rhinaria	0.2	(0–4)	2.8	(0–6)
Antenna V secondary rhinaria	0	—	0	—
Longest seta on antennal III (length)	0.035	(0.026–0.041)	0.032	(0.027–0.040)
Longest seta on vertex (length)	0.044	(0.031–0.063)	0.032	(0.025–0.040)
Ultimate rostral segment (length)	0.15	(0.14–0.19)	0.16	(0.15–0.19)
Ultimate rostral segment (width at base)	0.068	(0.053–0.098)	0.066	(0.052–0.084)
Ultimate rostral segment accessory setae	6.5	(5–8)	7.0	(5–10)
<b>Thorax</b>				
Hind tibia (length)	2.09	(1.78–2.71)	2.23	(1.93–2.78)
Longest seta near apex of tibia (length)	0.032	(0.027–0.040)	0.028	(0.026–0.031)

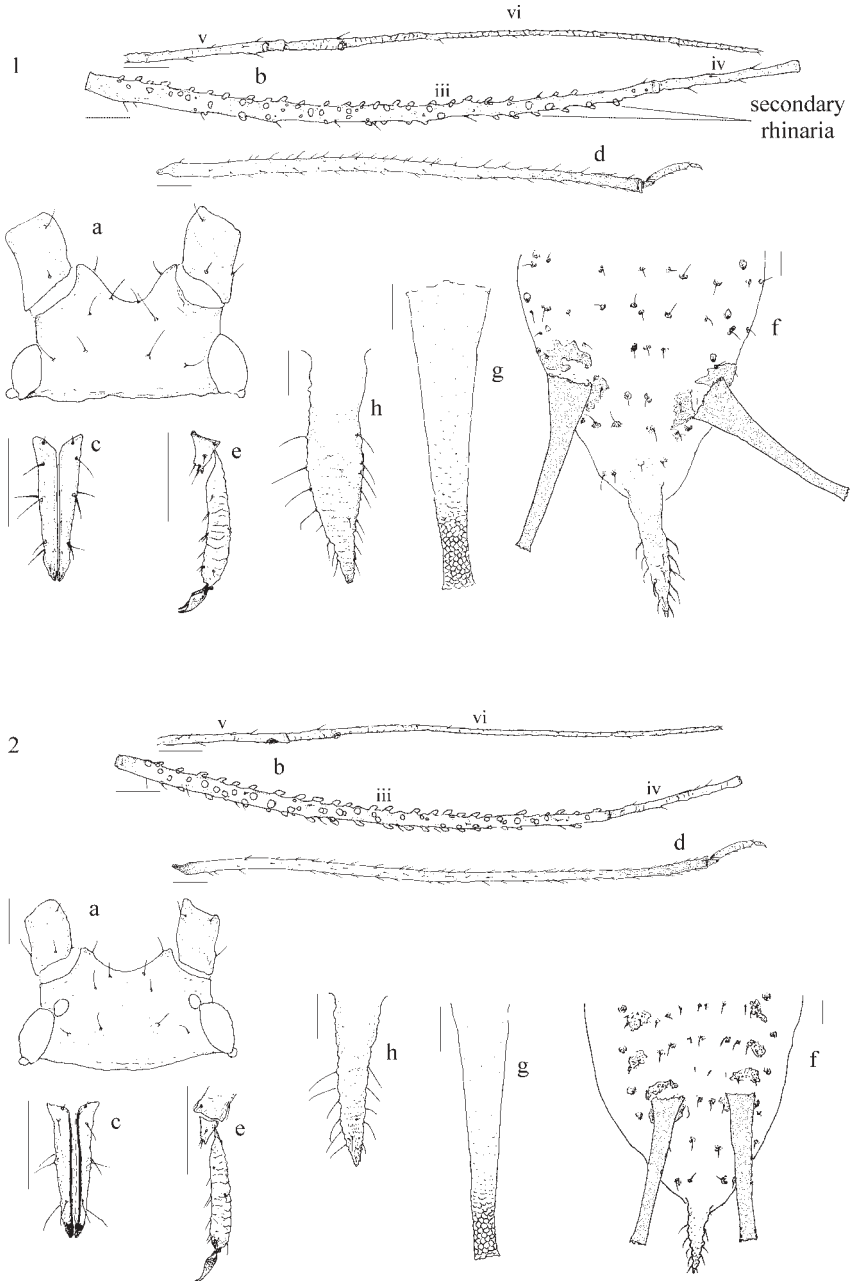


Tarsal I chaetotaxy	5-5-5		5-5-5
Hind tarsus II (length)	0.16	(0.14-0.18)	0.16
Hind tarsus II (width at mid-segment)	0.027	(0.023-0.032)	0.024
Hind tarsal II accessory setae	7.8	(5-10)	7.9
<b>Abdomen</b>			
Siphunculus (length)	0.54	(0.46-0.65)	0.58
Siphunculus (width at base)	0.14	(0.10-0.16)	0.13
Cauda (length)	0.46	(0.38-0.55)	0.40
Cauda (width at base)	0.18	(0.15-0.20)	0.16
Caudal setae	13.1	(10-19)	12.8
<b>Comparisons</b>			
Head/antennal III (width/length)	0.44	(0.37-0.54)	0.37
Antenna/body (length)	1.18	(1.02-1.41)	1.29
Antenna III/Antenna IV+V (length)	1.47	(1.12-1.64)	1.54
Length of longest seta on antennal III / basal width of antennal III	0.73	(0.57-1.01)	0.70
Antenna VI base (length/width at base)	6.2	(4.5-7.9)	6.5
Processus terminalis/antennal VI base (length)	6.8	(6.2-7.8)	7.5
Length of longest seta on vertex / basal width of antennal III	0.92	(0.67-1.44)	0.70
Ultimate rostral segment (length/width at base)	2.3	(1.7-2.9)	2.5
Ultimate rostral segment/hind tarsus II (length)	0.9	(0.8-1.2)	1.0
Hind tarsus II (length/width at mid-segment)	6.1	(5.1-7.3)	6.8
Siphunculus (length/width at base)	4.0	(3.3-5.9)	4.5
Siphunculus/body (length)	0.19	(0.17-0.22)	0.21
Siphunculus/antennal III (length)	0.43	(0.38-0.51)	0.41
Siphunculus/cauda (length)	1.2	(1.0-1.4)	1.5
Cauda (length/width at base)	2.6	(2.2-3.3)	2.5
Cauda/body (length)	0.16	(0.15-0.18)	0.14

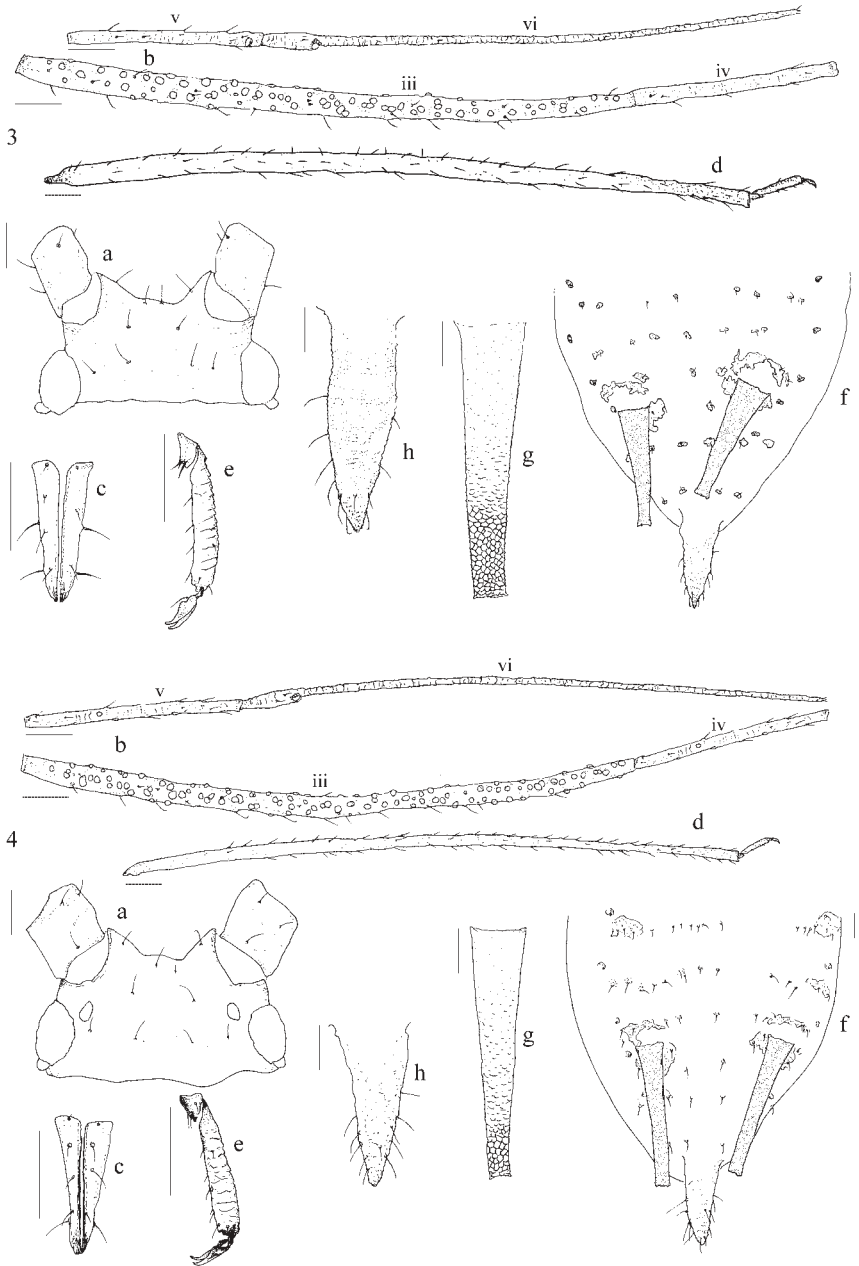
Table 3. Morphological measurements (mm) and comparisons for oviparae and male of *Uroleucon sonchellum*.

	Oviparae n=8		Male n=1
	mean	(range)	
Body (length)	2.85	(2.16–3.16)	1.89
<b>Head</b>			
Head (width)	0.56	(0.47–0.60)	0.46
<b>Antenna</b>			
I–VI (length)	3.61	(3.14–4.01)	2.58
III (length)	1.21	(1.11–1.36)	0.83
III (width at base)	0.048	(0.034–0.052)	0.29
IV (length)	0.48	(0.37–0.58)	0.35
V (length)	0.49	(0.38–0.61)	0.33
Processus terminalis (length)	0.99	(0.94–1.07)	0.77
Base of antennal VI (length)	0.14	(0.13–0.15)	0.11
Base of antennal VI (width at base)	0.021	(0.018–0.024)	0.018
Antenna III secondary rhinaria	85.3	(67–101)	52
Antenna IV secondary rhinaria	0	—	6
Antenna V secondary rhinaria	0	—	4
Longest seta on antennal III (length)	0.038	(0.032–0.045)	0.027
Longest seta on vertex (length)	0.055	(0.050–0.065)	0.028
Ultimate rostral segment (length)	0.18	(0.14–0.18)	0.12
Ultimate rostral segment (width at base)	0.077	(0.060–0.103)	0.058
Ultimate rostral segment accessory setae	6.8	(6–8)	6
<b>Thorax</b>			
Hind tibia (length)	2.37	(1.79–2.75)	1.45
Longest seta near apex of tibia (length)	0.037	(0.030–0.055)	0.027
Tarsal I chaetotaxy	5–5–5		5–5–5

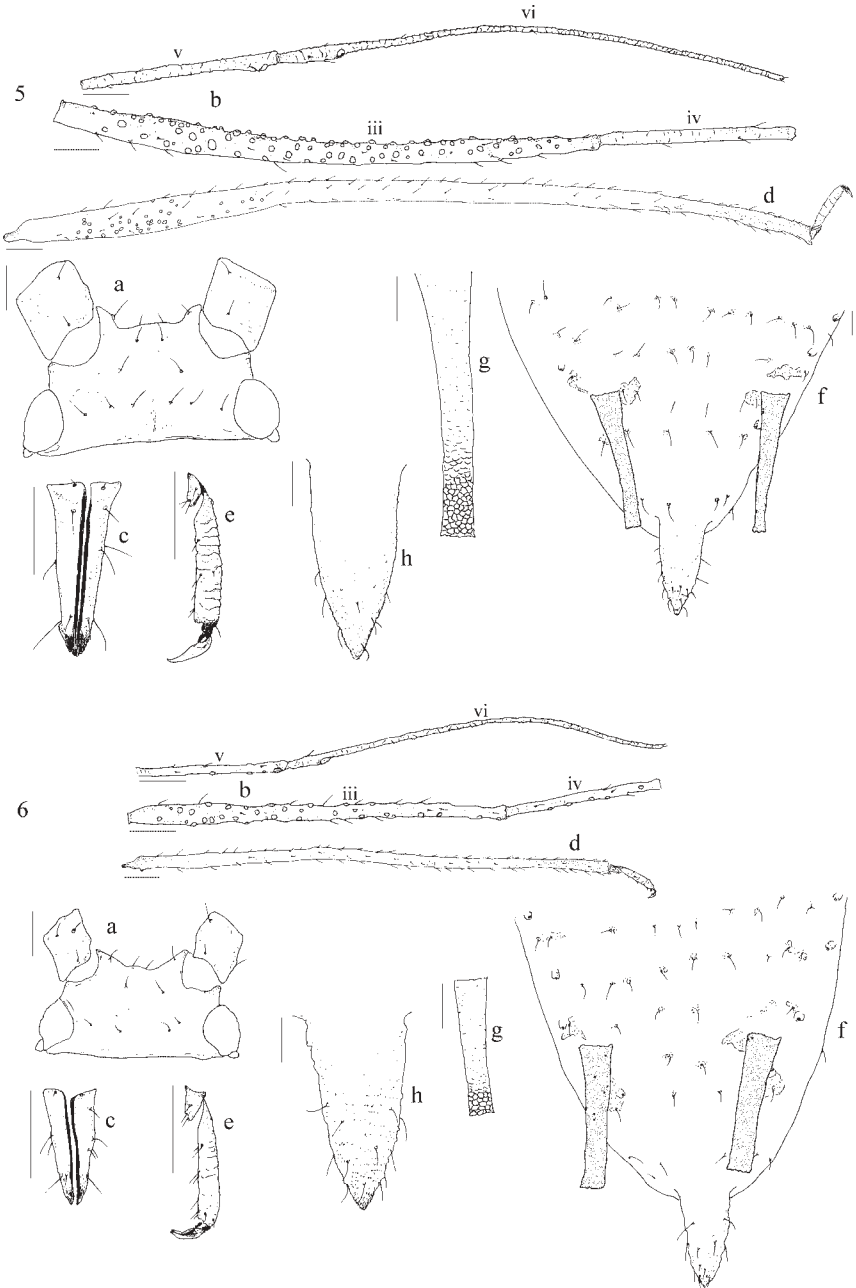
Hind tarsus II (length)	0.17	(0.16-0.17)	0.14
Hind tarsus II (width at mid-segment)	0.028	(0.022-0.032)	0.024
Hind tarsal II accessory setae	7.3	(7-8)	7
<b>Abdomen</b>			
Siphunculus (length)	0.57	(0.45-0.66)	0.30
Siphunculus (width at base)	0.13	(0.12-0.14)	0.07
Cauda (length)	0.40	(0.35-0.43)	0.21
Cauda (width at base)	0.19	(0.14-0.22)	0.14
Caudal setae	21.3	(17-26)	12
<b>Comparisons</b>			
Head/antennal III (width/length)	0.47	(0.43-0.49)	0.56
Antenna/body (length)	1.28	(1.18-1.45)	1.37
Antenna III/Antenna IV+V(length)	1.25	(1.11-1.47)	1.22
Length of longest seta on antennal III / basal width of antennal III	0.78	(0.63-0.95)	0.93
Antenna VI base (length/width at base)	7.0	(6.4-7.7)	5.9
Processus terminalis/antennal VI base (length)	6.8	(6.4-7.5)	7.2
Length of longest seta on vertex / basal width of antennal III	0.85	(0.72-0.92)	0.98
Ultimate rostral segment (length/width at base)	2.3	(1.8-3.0)	2.1
Ultimate rostral segment/hind tarsus II (length)	1.0	(0.9-1.1)	0.9
Hind tarsus II (length/width at mid-segment)	6.0	(5.1-7.3)	5.7
Siphunculus (length/width at base)	4.6	(3.8-5.1)	4.1
Siphunculus/body (length)	0.20	(0.19-0.21)	0.16
Siphunculus/antennal III (length)	0.48	(0.41-0.51)	0.36
Siphunculus/cauda (length)	1.4	(1.3-1.4)	1.4
Cauda (length/width at base)	2.1	(1.9-2.4)	1.5
Cauda/body (length)	0.15	(0.14-0.16)	0.11



**Figures 1–2.** *Uroleucon formosanum* (Takahashi): 1, apterous vivipara. 2, alate vivipara. Features: a, head; b, antennal segments iii–vi; c, ultimate rostral segment; d, hind tibia and tarsus; e, tarsus (close-up); f, abdomen; g, siphunculus with distal reticulation; h, cauda. Bar scale = 0.1 mm.



**Figures 3-4.** *Uroleucon sonchellum* (Monell): 3, apterous vivipara. 4, alate vivipara. Features: a, head; b, antennal segments iii-vi; c, ultimate rostral segment; d, hind tibia and tarsus; e, tarsus (close-up); f, abdomen; g, siphunculus with distal reticulation; h, cauda. Bar scale = 0.1 mm.



**Figures 5–6.** *Uroleucon sonchellum* (Monell): 5, ovipara. 6, apterous male. Features: a, head; b, antennal segments iii–vi; c, ultimate rostral segment; d, hind tibia and tarsus; e, tarsus (close-up); f, abdomen; g, siphunculus with distal reticulation; h, cauda. Bar scale = 0.1 mm.

117: 1029–1054.

(continued after figures)

- Smith, C. F.** and **C. S. Parron.** 1978. An annotated list of Aphididae (Homoptera) of North America. North Carolina Agric. Exp. Sta. Tech. Bull. No. 255. 428 pp.
- Takahashi, R.** 1921. Aphididae of Formosa, Part I. Agricultural Experiment Station, Government of Formosa Report 20: 1–97.
- Takahashi, R.** 1962. Key to Japanese species of *Dactynotus*, with descriptions of four new species. Kontyu 30:73–81.
- Tao, C. Chia-Chu.** 1963. Revision of Chinese Macrosiphinae. Plant Protection Bull. Taiwan 5: 162–179.
- Williams, T. A.** 1910. The Aphididae of Nebraska. University Studies (Nebraska) X: 85–175.

