



Nurudea zhengii Ren and Qiao, A New Species of the *Rhus* Gall Aphids (Aphididae: Eriosomatinae: Fordini) from Eastern China

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ABSTRACT

A new *Rhus* gall aphid species *Nurudea zhengii* Ren and Qiao, sp. nov. collected from the Mountain Qixing in Shangrao County, Jiangxi Province, China is described and illustrated from alate viviparous female. The new species differs from the other *Nurudea* species in the length and proportion of antennal segments, the structure of antennal secondary sensilla, and the flower-like shape of the galls that are formed on its primary host. Its primary host plant is *Rhus hypoleuca*, whereas other *Nurudea* species are on *R. chinensis*.

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Authors' Contribution

ZR collected the samples, observed the morphological characters and drafted the manuscript. XS performed the experiments, analyzed and interpreted the data. GQ provided the guidance for the observation of morphological characters. CDD and JW revised and polished the manuscript.

Key words

Rhus gall aphid, *Nurudea zhengii*, New species, Morphology, China.

INTRODUCTION

The *Rhus* gall aphids refer to a lineage of host-alternating aphids that live on species of *Rhus* (sumacs) as their primary host, on which they induce galls known as *Woo-pei-tsze* or Chinese gall (Bell, 1851; Tang and Tsai, 1957). The first species described in this group was recorded from China as *Aphis chinensis* (Bell, 1851); subsequently, a similar species was described from North America. Although initially considered the same species, they were later recognized as members of different genera by various taxonomists (Fitch, 1866; Lichtenstein, 1883; Baker, 1917; Arshad *et al.*, 2017). Eastop and Lambers (1976) designated the species from China and North America as *Schlechtendalia chinensis* (Lichtenstein, 1883) and *Melaphis rhois* (Fitch, 1866), respectively. Additional genera and species of this group from eastern Asia were described and analyzed (Matsumura, 1917; Tsai and Tang, 1964; Xiang, 1980; Tang, 1986). So far, six genera and 12 species (the genus *Kaburagia* including three subspecies) have been recognized in this group

(Eastop and Lambers, 1976; Zhang *et al.*, 1999; Yang *et al.*, 2010; Ren *et al.*, 2013, 2017), and they have been placed in the subtribe Melaphidina of tribe Fordini (Hemiptera, Aphididae, Eriosomatinae) (Eastop and Lambers, 1976; Blackman and Eastop, 1994; Favret, 2013). Matsumura (1917) erected the genus *Nurudea* based on *Nurudea ibofushi* from Japan, and distinguished this species from *Schlechtendalia chinensis* by the regularly ringed secondary sensoria on the 3rd antennal joint. Tsai and Tang (1964) described *N. sinica* as closely allied to *N. ibofushi*, noting that they differ in the structure of sensoria on the apical two joints of the antennae. Eastop and Lambers (1976) synonymized the two species as *N. ibofushi*. Meanwhile, Matsumura (1917) described two species *N. shiraii* and *N. yanoniella* under the new genus *Nurudeopsis*, which was subsequently merged into *Nurudea* by later taxonomists (Eastop and Lambers, 1976; Zhang *et al.*, 1999). Therefore, the genus *Nurudea* currently includes three species: *N. ibofushi*, *N. shiraii* and *N. yanoniella* from China and Japan, and all of them form galls on their primary host plant *Rhus chinensis*.

In 2009, we collected several galls formed by an aphid species feeding on *Rhus hypoleuca* Champion ex Benth in China. After the morphological examinations, we concluded that the collections are similar to the two species, *N. shiraii* and *N. yanoniella*, and should be

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recognized as a new species of *Nurudea*. Here, we formally described this new species.

MATERIALS AND METHODS

Materials

Samples of galls were collected from leaf rachises of *Rhus hypoleuca* on the Mountain Qixing in Shangrao County, Jiangxi Province, China in 2009. Slide-mounted specimens of 15 alate viviparous females from the same gall were used for morphological observations. The remaining samples were observed as references. The holotype of the new species (alate viviparous female) and host-plant vouchers (Ren and Li A402 and Ren and Li P402, respectively) were deposited at School of Life Science, Shanxi University, Taiyuan, China. Paratypes of the new species were also deposited in the National Zoological Museum of China, Institute of Zoology, Chinese Academy of Sciences, Beijing, China (NZMC).

Methods

Freshly collected aphid samples were immersed in 70% ethanol, then macerated 2-3 min in 15% KOH solution before making permanent slides. Adult alate viviparous specimens were cleared and mounted individually in Canada balsam on microscope slides according to the techniques described by Maw and

Footitt (1998). Morphological analyses were performed using a stereomicroscope and an electron microscope, and measurements were taken using a Leica DM2500B microscope.

Aphid morphology was characterized by measuring several morphological features and ratios, and descriptive qualitative features. A total of 50 morphological characters including 20 quantitative characteristics, nine ratios from two measured characters, and the qualitative features from head, thorax and abdomen of the 15 alate adults were evaluated. Aphid terminology in this paper follows Quednau (2003) and Qiao *et al.* (2005). The unit of measurements is millimeters (mm).

Nurudea zhengii Ren and Qiao sp. nov. (Figs. 1 and 2)

Diagnosis

The body of alate viviparous females oval, surface smooth. Head, thorax and abdomen without wax plates, middle frons curved. Antennae 5-segmented, smooth, processus terminalis one-fourth as long as base of the segment V. Rostrum short and small. First tarsal chaetotaxy: 3, 3, 3. Siphunculi absent. Fore wings with four oblique veins, media veins unbranched. Cauda half-moon shaped, smooth. Anal plate oblong.

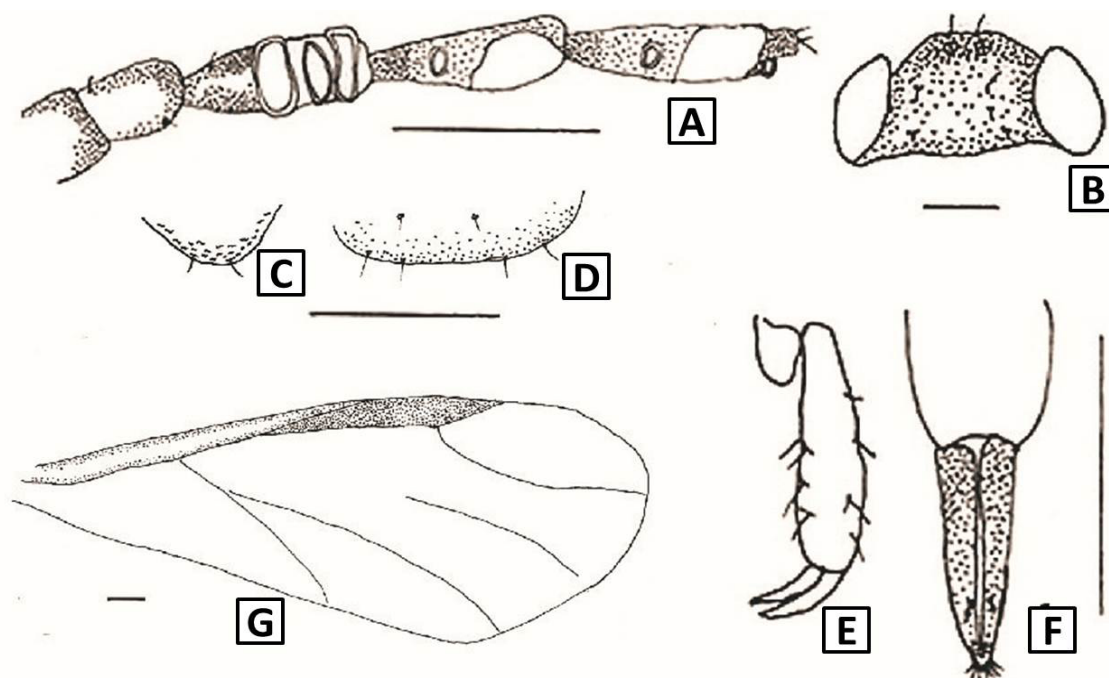


Fig. 1. Morphology of *Nurudea zhengii* Ren and Qiao sp. nov. alate viviparous female: A, antennal segments; B, dorsal view of head; C, hind tarsal segments; D, ultimate rostral segments; E, cauda; F, anal plate; G, forewing. Scale bars = 0.10 mm.

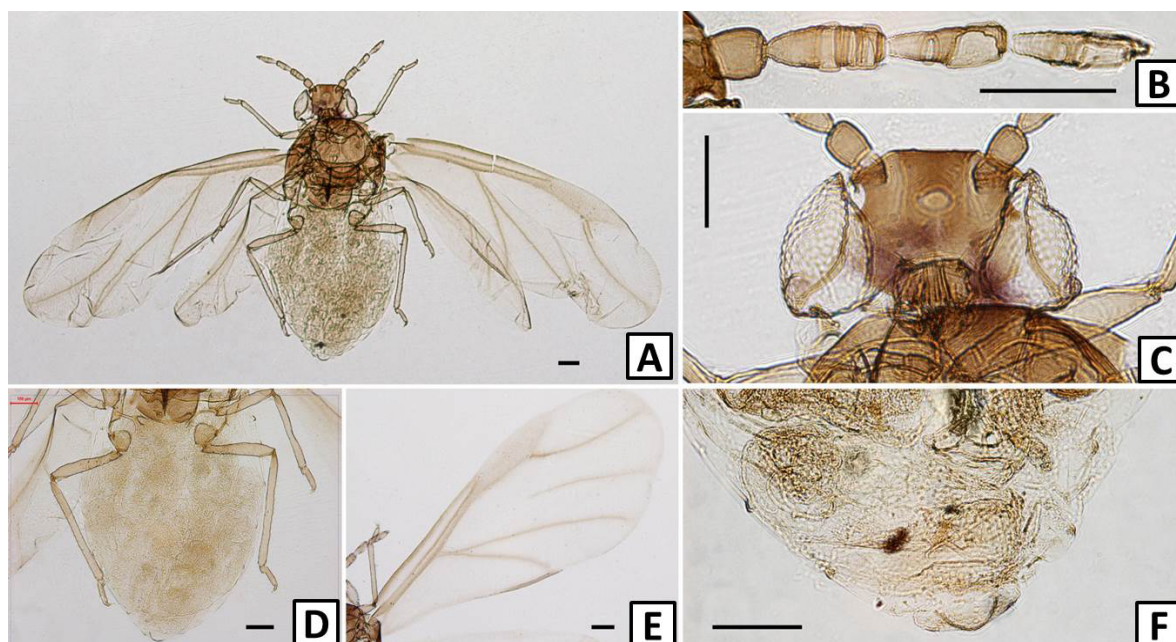


Fig. 2. Morphological characters of *Nurudea zhengii* Ren and Qiao sp. nov. alate viviparous female: A, dorsal view of body; B, antennal segments; C, dorsal view of head; D, dorsal view of abdomen; E, fore wing; F, siphunculus. Scale bars = 0.10 mm.



Fig. 3. Galls formed by three *Nurudea* aphid species. A, *N. shiraii*; B, *N. yanoniella*; C, *N. zhengii*. The diameter of the gall formed by *N. shiraii* in real life is approximately 2-3 times larger than that of *N. yanoniella* and *N. zhengii*.

Description

Alate viviparous females oval (Fig. 2). Head and thorax dark brown, abdomen tinge without stripes. Antennae, rostrum and each segment of legs brown, cauda and anal plate light brown. Body surface smooth, front margins of dorsum of head with one pair of small round wax plates and each with 4-6 waxy cells. Thorax and abdomen without wax plates, spiracle round to oval, open or closed. One pair of hairs on the head top and 4-6 pairs of dorsal setae on head. One pair of hairs on the spinal of abdominal tergite I, 4-8 hairs on abdominal tergite III, and length of abdominal tergite I and abdominal tergite III about 0.25-0.50 and 1.33-4.00 times as long as the widest diameter of antennal segment III, respectively. Middle

frons curved, antennae 5-segmented, smooth, entire length 0.32-0.35 and 0.45-0.55 times as long as body; antennal segment III 0.07-0.09, 5-9 times as long as the diameter of the base of the segment, length in proportion to segments I-V: 28-41: 44-60: 100: 88-106: 75-120+19-50, respectively. Processus terminalis one-fourth as long as base of the segment V, antennal segment III with three circular secondary sensoria, and antennal segments IV and V with one small and one large oval secondary sensoria, respectively. Antennal setae short and pointed, segments II and III each with 2 or 3 setae, respectively, and apex of processus terminalis with three short pointed setae. Rostrum short and small, not reaching the base of the middle coxae, rostral segment IV+V sphenoid, 0.06-0.08

in length, and 1.00-1.60 times as long as the second hind tarsal segment, with two pairs of primary and one pair of accessory setae. Hind femur 0.23-0.28, and 2.63-3.06 times as long as antennal segment III, hind tibia 0.35-0.47, and 0.49-0.69 times as long as body. Length of setae on hind tibia 0.01, 0.25-0.40 times as long as middle width of the tibia. First tarsal chaetotaxy: 3, 3, 3. Siphunculi absent. Fore wings with four oblique veins, media veins unbranched, and two cubitus veins converging at the base. Cauda half-moon shaped, smooth, and 0.50-0.75 times as long as its basal width, with 2 or 3 short setae. Anal plate oblong, with 5-9 short setae, and genital plate transversely oval with 14-20 short setae.

Biology

The galls of this aphid species are formed on the leaves of the apical part of the stem of *Rhus hypoleuca*. They are rosy red and flower-like with branches irregularly from the base. The shapes of galls were similar to those formed by *Nurudea shiraii*, measuring approximately 120 by 100 mm. The alate viviparae appear in late September. The mature galls formed by three *Nurudea* species on their *Rhus* primary hosts are shown in Figure 3.

Comments

Nurudea zhengii Ren and Qiao, sp. nov. is closely related to the two other species of *Nurudea*, *N. shiraii* and *N. yanoniella*, and it is readily distinguished from the two congeneric species by the length of antennal segments, the secondary sensoria on the antennal segments, the shape of the gall formed on *Rhus* host plants, and the species of the primary host plant. Compared to *N. shiraii* and *N. yanoniella*, *N. zhengii* differs in the following points: antennal segment III and IV have nearly the same length as the base of antennal segment V, antennal segment III with three circular secondary sensoria, and antennal segments IV and V with one small and one large oval sensorium, respectively, and its primary host plant is *R. hypoleuca*. Therefore, the morphological data support the recognition of *N. zhengii* as a new species in *Nurudea*.

Key to *Nurudea* species (alate viviparous female)

1. Segment III subequal to segment V, segment IV shortest, segment V with a large oval secondary sensorium, galls single-celled.....*N. ibofushi*
- Antennal segments III-V each gradually increasing its length, with a few round incomplete secondary sensoria, galls multi-chambered.....2
2. Antennal segment III subequal to segment IV and V, segment III with three ringed secondary sensoria, segments IV and V each with one oval secondary sensoria, galls rosy red, colonizing *Rhus hypoleuca*.....*N. zhengii*

- Antennal segments III-V prominently different in length, IV and V each with a few broader incomplete ringed secondary sensoria, colonizing *Rhus chinensis*.....3
- 3. Antennal segment V longest, nearly twice as long as segment III, segments III-V each with three or four broad incomplete rings, galls not prominently reddish.....*N. shiraii*
- Antennal segment III somewhat shorter than segment V, but distinctly longer than segment IV, segments III-V each with more than five distinct annulations, galls rosy red.....*N. yanoniella*

Table I.- Biometric measurements of alate viviparae *Nurudea zhengii* collected in Jiangxi, China. Values are means with standard deviation.

Parts*	Alate viviparae (n=15) Mean ± SD (Range)
Length (mm)	
Body length	1.38±0.065 (1.26-1.48)
Body width	0.64±0.022 (0.60-0.67)
Whole antennae	0.34±0.014 (0.32-0.35)
Ant. I	0.03±0.004 (0.02-0.03)
Ant. II	0.04±0.003 (0.03-0.05)
Ant. III	0.08±0.006 (0.07-0.09)
Ant. IV	0.08±0.005 (0.07-0.09)
Ant. Vb	0.08±0.010 (0.07-0.09)
PT	0.02±0.007 (0.01-0.04)
URS	0.07±0.006 (0.06-0.08)
Hind femur	0.26±0.015 (0.23-0.28)
Hind tibia	0.38±0.036 (0.35-0.47)
2HT	0.06±0.005 (0.05-0.07)
Cauda	0.03±0.003 (0.02-0.04)
BW Cauda	0.04±0.008 (0.03-0.06)
Ant. III BW	0.01±0.003 (0.01-0.02)
MW Hind tibia	0.03±0.002 (0.02-0.03)
Cephalic setae	0.004±0.001 (0.002-0.06)
Setae on Ant. III	0.005±0.002 (0.003-0.06)
Setae on Hind tibia	0.01±0 (0.01)
Ratio	
Whole antennae/body	0.25±0.014 (0.22-0.28)
Hind femur/Ant. III	3.10±0.245 (2.63-3.50)
Hind tibia/body	0.28±0.029 (0.25-0.35)
PT/Ant. Vb	0.24±0.154 (0.15-0.25)
URS/2HT	1.25±0.181 (1.00-1.60)
Cauda/BW Cauda	0.60±0.102 (0.50-0.75)
Cephalic setae/Ant. III BW	0.40±0 (0.40)
Setae on Ant. III/Ant. III BW	0.05±0 (0.05)
Setae on hind tibia/MW	0.33±0.045 (0.25-0.40)
Hind tibia	

Ant. I-IV, antennal segments I-IV; Ant. Vb, base of antennal segment V; PT, processus terminalis; Ant. III; BW, basal width of antennal segment III; URS, ultimate rostral segment; 2HT, second hind tarsal segment; MW hind tibia, mid-width of hind tibia; BW Cauda, basal width of cauda.

Etymology

The new species was named in honor of Professor Zhe-Min Zheng for his outstanding contribution to the systematic entomology.

Type material

Holotype, alate viviparous female, with labels as follows: China, Jiangxi Province, Shangrao County, Qixing mountain, 1240 m, N 27°57'52.6", E117°50'40.3", 26 Sept. 2009, on *Rhus hypoleuca*, Coll. Number Ren and Li, A402, deposited at School of Life Science, Shanxi University, Taiyuan, China.

Paratypes, 38 alate viviparous females with the same collection data as the holotype, deposited at School of Life Science, Shanxi University, Taiyuan, China and the National Zoological Museum of China, Institute of Zoology, Chinese Academy of Sciences, Beijing, China.

Distribution

China, Jiangxi Province, Shangrao County, Qixing mountain.

Host

Primary host

Rhus hypoleuca (Anacardiaceae).

Secondary host

Unknown, but, as for other *Rhus* gall aphids, it is almost certainly a moss.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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