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First record of the lac-producing species *Kerria nepalensis* Varshney (Hemiptera, Kerriidae) from China, with a key to Chinese species

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Abstract

Lac insects include astonishing species responsible for lac production. Lac is composed of resins, dyes, and shellac wax with significant economic importance. Previously, 11 species of the genus *Kerria* were reported from China, with the highest species diversity in Yunnan province. Another lac-producing species of the genus *Kerria*, namely *Kerria nepalensis* Varshney, is recorded for the first time in Yunnan province, China, on *Dalbergia cochinchinensis* Pierre ex Laness. (Fabaceae), a new host plant. In addition, a key to the 12 *Kerria* species recorded in China is also given.

Keywords

Coccoidea, lac insects, Oriental China, taxonomy

Introduction

Scale insects (Hemiptera, Coccoidea) are classified into 35 extant families, with more than 8300 described species to date (García Morales et al. 2016). These are phytophagous insects found in all zoogeographical realms except Antarctica (Ahmad et al. 2014). Lac insects belong to family Kerriidae, which is comprised of nine genera and 101 species worldwide (García Morales et al. 2016). Currently, the genus *Kerria* contains 29 species known in Asia (Table 1) and distributed in tropical and subtropical regions

(Varshney and Sharma 2020). More than 20 species of *Kerria* have been described and recorded from India, Myanmar, Nepal, Pakistan, and Thailand. So far, 11 species of the genus *Kerria* have been reported from China (Varshney 1976; Chen et al. 2011), with *K. ruralis* (Wang, Yao, Teui & Liang) and *K. yunnanensis* (Ou & Hong) being endemic species (Chen et al. 2013).

Lac insects are fully depending on their host plant and till now, more than 400 host plants have been recorded (Sharma 2017). Ber (*Ziziphus mauritiana* Lam.: Rhamnaceae), Kusum (*Schleichera oleosa* Lour.: Sapindaceae), and Palas (*Butea monosperma* Lam.: Fabaceae) are the common host plants for the production of lac in India (Bhatnagar et al. 2020), whereas *Acacia catechu* Willd., *A. nilotica* Willd. ex Delile (Fabaceae), *Butea monosperma*, *Samanea saman* (Jacq.) Merr., (Fabaceae), and *Ziziphus mauritiana* are potential lac host plants in Bangladesh (Ferdousee et al. 2010). Lac host plants in China are *Dalbergia szemaoensis* Prain, *D. assamica* Benth, *D. obtusifolia* Prain, *Pueraria tonkinensis* Gagn. (Fabaceae), *Ficus altissima* Blume, and *F. racemosa* L. (Moraceae) (Chen et al. 2010, 2011).

Herein, we redescribe and illustrate *K. nepalensis* Varshney, a species recorded for the first time from Yunnan province and China. We also provide a key to the 12 Chinese species of *Kerria*.

Table 1. Worldwide distribution of the genus *Kerria*.

No.	Species	Distribution	Reference
1	*Kerria albizziae* (Green, 1911)	India, Myanmar, Sri Lanka	Varshney 1976; Chen et al. 2013
2	*Kerria brancheata* Varshney, 1966	India	Varshney 1976
3	*Kerria canalis* Rajgopal, 2021	India	Rajgopal et al. 2021
4	*Kerria chamberlini* Varshney, 1966	Bhutan, China, India, Myanmar, Nepal, Thailand	Varshney 1976; Chen et al. 2013
5	*Kerria chinensis* (Mahdihassan, 1923)	Bhutan, Cambodia, China, India, Myanmar, Nepal, Thailand, Vietnam	Chen et al. 2011, 2013; Varshney and Sharma 2020
6	*Kerria communis* (Mahdihassan, 1923)	India	Varshney 1976
7	*Kerria destructor* Talukder & Das, 2020	India	Talukder and Das 2020
8	*Kerria dubeyi* Ahmad & Ramamurthy, 2013	India	Ahmad et al. 2013a
9	*Kerria ebrachiata* (Chamberlin, 1923)	India, Myanmar, Nepal, Pakistan	Varshney 1976; Chen et al. 2013
10	*Kerria fici* (Green, 1903)	China, India, Pakistan, Thailand	Varshney and Sharma 2020
11	*Kerria greeni* (Chamberlin, 1923)	China, Philippine, Thailand	Chen et al. 2013
12	*Kerria indicola* (Kapur, 1958)	India	Varshney 1976
13	*Kerria javana* (Chamberlin, 1925)	India, Indonesia, Malaysia	Chamberlin 1925; Chen et al. 2013
14	*Kerria lacca* (Kerr, 1782)	Azerbaijan, Bangladesh, China, Georgia, Guyana, India, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand	Chen et al. 2013; Varshney and Sharma 2020
15	*Kerria maduraiensis* Ahmad & Ramamurthy, 2013	India	Ahmad et al. 2013b
16	*Kerria manipurensis* Ahmad & Ramamurthy, 2013	India	Ahmad et al. 2013b
17	*Kerria mengdingensis* Zhang, 1993	China	Zhang 1993
18	*Kerria meridionalis* (Chamberlin, 1923)	China, Philippines, Thailand	Chen et al. 2013
19	*Kerria nagoliensis* (Mahdihassan, 1923)	Bangladeshi, India, Pakistan	Varshney 1976; Chen et al. 2013
20	*Kerria nepalensis* Varshney, 1976	China, India, Myanmar, Nepal	Varshney 1976; Chen et al. 2011
21	*Kerria pennyae* Ahmad & Ramamurthy, 2013	India	Ahmad et al. 2013a
22	*Kerria pusana* (Misra, 1930)	India, Indonesia, Malaysia, Myanmar	Varshney 1976; Chen et al. 2013, 2011;
23	*Kerria rangoonensis* (Chamberlin, 1925)	China, India, Indonesia, Myanmar, Thailand	Chamberlin 1925; Varshney 1976; Chen et al. 2013
24	*Kerria ruralis* (Wang, Yao, Teui & Liang, 1982)	China	Chen et al. 2011
25	*Kerria sharda* Mishra & Sushil, 2000	India	Varshney and Sharma 2020
26	*Kerria sindica* (Mahdihassan, 1923)	Bangladesh, China, India, Pakistan	Chen et al. 2011, 2013
27	*Kerria thrissurensis* Ahmad & Ramamurthy, 2013	India	Ahmad et al. 2013b
28	*Kerria varshneyi* Ahmad & Ramamurthy, 2013	India	Ahmad et al. 2013a
29	*Kerria yunnanensis* (Ou & Hong, 1990)	China	Chen et al. 2011

Materials and methods

Twigs bearing *K. nepalensis* (new record) were collected by Dr Juan Liu from roadside *Dalbergia cochinchinensis* trees at Mengzi city (22°56'N, 103°32'E), Yunnan province, China, on 15 September 2020. Fresh samples of adult females were preserved in 75% ethanol. Specimens were placed in 10% KOH for few hours and rinsed in 5–8 changes of distilled water for preparation of permanent slides as described previously (Chen et al. 2008). The photographs and measurements were taken with a Keyence VHX-1000 digital microscope. Terminology mainly follows Kondo and Gullan (2007) and Ahmad et al. (2013b). All specimens are deposited in the museum of Research Institute of Resource Insects, Kunming, China (**RIRI-CAF**).

More than 10 individuals were selected for observation under electron microscope. The dehydration of specimens was accomplished by passing through a series of increasing alcohol concentrations as 30%, 50%, 70%, 80%, 90%, and 95% alcohol (Mehdizadeh et al. 2014). They were placed on a conductive resin and gilded for 60 sec in an ion plating machine (JS-1600, Beijing Htcy Technology Co., Ltd, China) and then observed under an electron microscope (TM3000, Hitachi High-Technologies Corporation, Japan). Photographs were arranged by using Adobe Photoshop 8.0.

Taxonomy

Class Insecta Linnaeus, 1758
Order Hemiptera Linnaeus, 1758
Suborder Sternorrhyncha Amyot & Audinet-Serville, 1843
Superfamily Coccoidea Handlirsch, 1903
Family Kerriidae Lindinger, 1937
Genus *Kerria* Targioni Tozzetti, 1884

***Kerria nepalensis* Varshney, 1976**
Figures 1, 2

Material examined. China: Yunnan: Mengzi city, 22°56'N, 103°32'E, 15.IX.2020, coll. Juan Liu, *Dalbergia cochinchinensis* (Fabaceae), 5 slides (10 adult ♀♀).

Diagnosis. Adult female: body generally large globular to elongate in shape, 1.7–3.87 mm long, 1.16–2.42 mm wide (Fig. 1F, G).

***Dorsum*.** Anal tubercle well developed, elongate, 320–1100 μm long, 170–680 μm wide, apparently two-segmented (Figs 1A, 2B) and bearing 6–15 anal ring setae, each 80–90 μm long (Fig. 2A); supra anal plate heavily sclerotized, a little longer than broad, with few small setae on each side (Fig. 2B); brachia oval, elongate (Figs 1B, 2E), heavily sclerotized; brachial plate nearly circular, broader than long; brachial crater circular and small, 80–160 μm long, 70–130 μm wide, 0.03–0.07 mm^2 in center; brachial tube 210–460 μm long, dimples inconspicuous, uncountable due to thick sclerotiza-

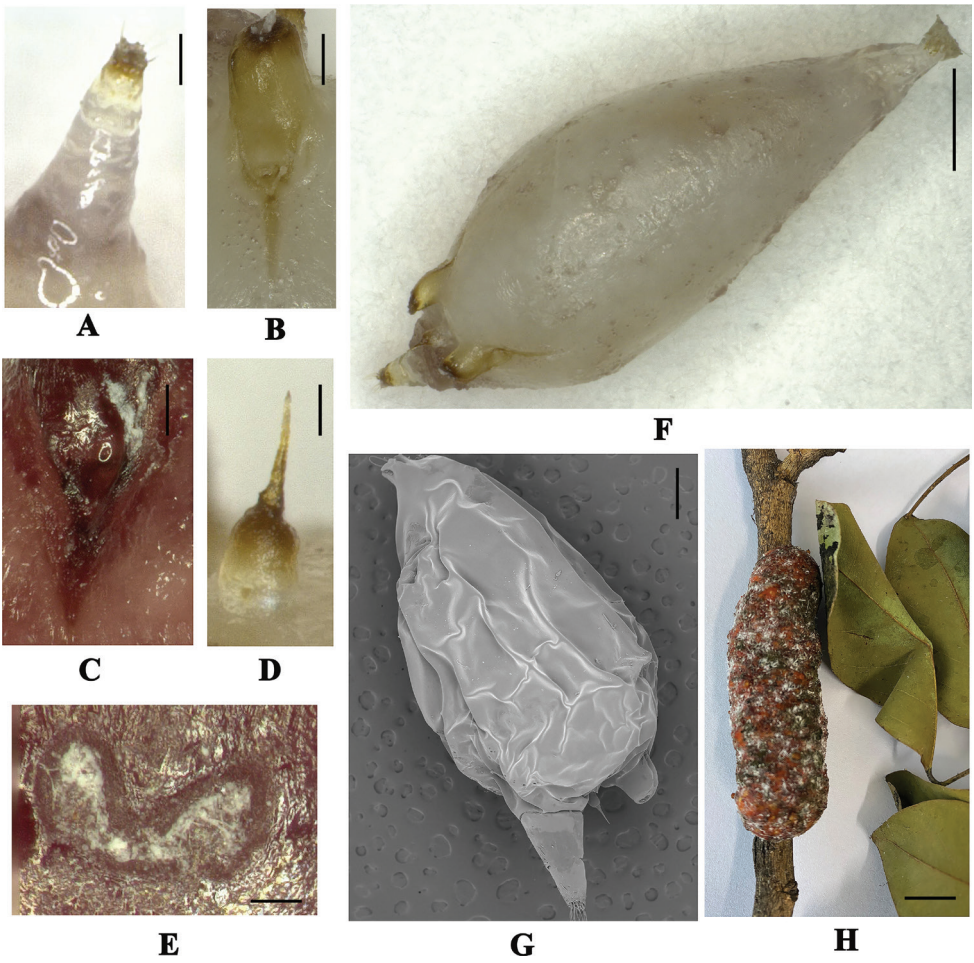

Figure 1. *Kerria nepalensis*. **A** anal tubercle **B** brachia **C** anterior spiracle **D** dorsal spine **E** marginal duct cluster **F, G** body **H** lac tests, ex *Dalbergia cochinchinensis* (**A–F, H** Light micrographs **G** Scanning electron micrographs). Scale bars: 1000 µm (**A**), 200 µm (**B–G**), 1 cm (**H**).

tion (Fig. 2F); anterior spiracles widely separated (Figs 1C, 2G), 220–400 µm away from brachial plate, canellar bands below anterior spiracles as a chitinous extension 150–300 µm long (Fig. 1B, C); dorsal spine 170–190 µm long, pedicel longer and tubular in shape 80–160 µm long, 70–130 µm wide at widest point (Figs 1D, 2K).

Venter. Antennae very small, conical shaped, probably one segmented, with 4 fleshy and 2 short hair-like setae (Fig. 2J); mouthparts with labium length 600–780 µm, width 70–180 µm, post oral lobes each 75–140 µm wide (Fig. 2L); legs vestigial; posterior spiracles much smaller with fine pores on each side; perivulvar pores 14–31 in number on each side of anal tubercle (Fig. 2C, D); marginal duct clusters convoluted (Figs 1E, 2H), 6 in number, each with 30–36 ducts (Fig. 2I); ventral duct clusters with 3 pairs, irregular in shape.

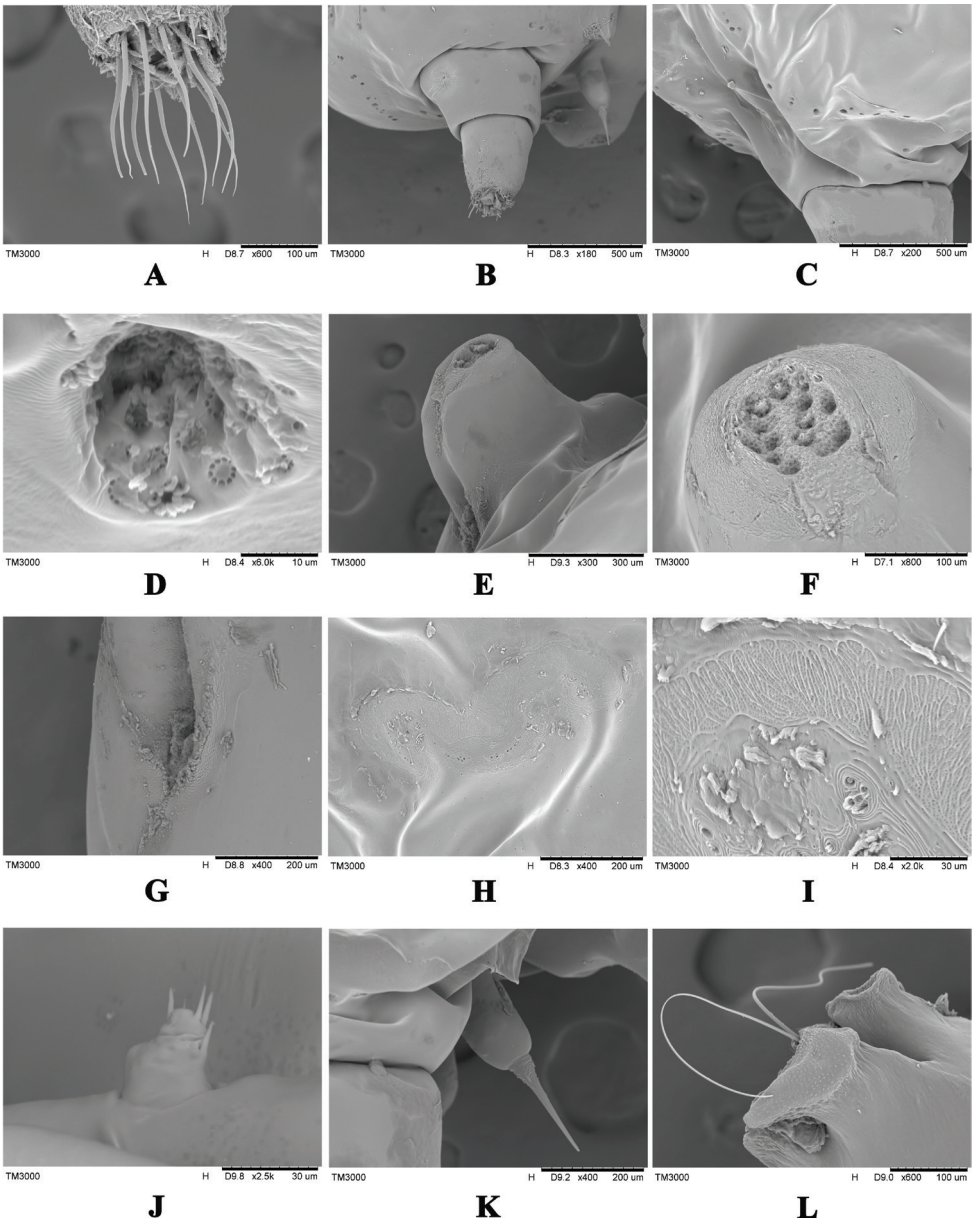

Figure 2. *Kerria nepalensis* scanning electron micrographs **A** anal ring setae **B** anal tubercle and dorsal spine **C** perivulvar pore cluster **D** magnified single perivulvar pore **E** brachia **F** brachial plate with dimples **G** anterior spiracle **H** a marginal duct cluster **I** a magnified marginal duct cluster **J** antenna **K** dorsal spine **L** mouthparts. Scale bars: 10 μm (**D**), 30 μm (**I, J**), 100 μm (**A, F, L**), 200 μm (**G, H, K**), 300 μm (**E**), 500 μm (**B, C**).

Distribution. India, Myanmar, Nepal (Varshney and Sharma 2020), China (Yunnan).

Host plants. *Dalbergia cochinchinensis* (specimens collected in this study), *Litchi chinensis* (Varshney 1976), and *Ficus* sp. (Chen et al. 2011).

Key to species of the genus *Kerria* from China

1 Anal tubercle (supra anal plate) elongate, distinctly longer than broad **2**
– Anal tubercle (supra anal plate) abbreviated, length subequal to width or broader than long **6**
2 Canellar pore bands present as a chitinous extension below anterior spiracles.... **3**
– Canellar pore bands absent **4**
3 Canellar pore bands below anterior spiracles short, 150–300 μm long; dorsal spine 170–190 μm long ..... ***K. nepalensis* Varshney**
– Canellar pore bands below anterior spiracles very long, 300–500 μm long; dorsal spine 190–240 μm long ..... ***K. chinensis* (Mahdihassan)**
4 Length of brachia subequal or shorter than length of supra anal plate ..... ***K. chamberlini* Varshney**
– Length of brachia distinctly greater than length of supra anal plate **5**
5 Supra anal plate smooth; brachial plate with 10–12 distinct dimples; each marginal duct cluster with 25–30 ducts..... ***K. lacca* (Kerr)**
– Supra anal plate hispid; brachial plate with 8–15 indistinct dimples; each marginal duct cluster with 30–36 ducts..... ***K. yunnanensis* (Ou & Hong)**
6 Each marginal duct cluster with 70–75 ducts; distance between anterior spiracle and brachial plate 17–34 μm..... ***K. mengdingensis* Zhang**
– Each marginal duct cluster with more than 20 ducts; distance between anterior spiracle and brachial plate greater than 34 μm..... **7**
7 Brachial plate diameter equal or greater than length of supra anal plate..... **8**
– Brachial plate diameter distinctly less than length of supra anal plate **10**
8 Brachial tube 65–90 μm long; anterior spiracles 180–260 μm long..... ***K. ruralis* (Wang, Yao, Teui & Liang)**
– Brachial tube 170–340 μm long; anterior spiracles 130–180 μm long..... **9**
9 Brachial crater not in center of plate, found near the margin; dimples obscure and small; crater rim open ..... ***K. sindica* (Mahdihassan)**
– Brachial crater in center of plate; dimples large and distinct; crater rim closed .... ***K. fici* (Green)**
10 Brachial crater not well defined; number of perivulvar pore clusters 68–70 ..... ***K. rangoonensis* (Chamberlin)**
– Brachial crater well defined; number of perivulvar pore clusters less than 60.... **11**
11 Marginal duct clusters duplex, with large nuclear ducts; number of perivulvar pore clusters 58 ..... ***K. greeni* (Chamberlin)**
– Marginal duct clusters simplex, no large nuclear ducts present; number of perivulvar pore clusters less than 50 ..... ***K. meridionalis* (Chamberlin)**

Discussion

Kerria nepalensis was identified and described on host *Litchi chinensis* from India and Nepal by Varshney (1976). Later it was also recorded from Myanmar (Chen et al.

2011), where it was used for commercial lac production. This species is present in tropical monsoon climates with an average annual precipitation of 800–1000 mm, temperature of 23–29 °C, and at low elevations about 200 m (Chen et al. 2011). *Litchi chinensis* (Sonn.) and *Ficus* sp. were the known host plant of *K. nepalensis* (Chen et al. 2011; Varshney and Sharma 2020). We here report *Dalbergia cochinchinensis* as a host of *K. nepalensis*. *Dalbergia cochinchinensis* Pierre ex Laness. is commonly known as Siam Rosewood or Rosewood (Sriudorn and Benchawattananon 2018). It prefers sandy-clay soil, where the mean annual rainfall is 1200–1650 mm and the temperature ranges from 20–32 °C (So et al. 2010; Phunchaisri et al. 2019). It is a perennial tree and distributed in China (Yunnan province), Cambodia, Laos, Thailand, and Vietnam (He 2014; Liu et al. 2016).

The presence of *K. nepalensis* in Yunnan province increases the number of known *Kerria* species in China that could be used for lac production. The natural lac-plant resources are abundant in Yunnan Province (Chen et al. 2010). The Chinese diversity of the genus *Kerria* needs further investigation, and taxonomic studies particularly in Oriental China promise to find new species and new country records of this genus.

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