Journal of Asia-Pacific Entomology 19 (2016) 995–1000

Contents lists available at ScienceDirect

Journal of Asia-Pacific Entomology

journal homepage: www.elsevier.com/locate/jape

First record from Korea of the jumping plant-louse *Bactericera gobica* (Loginova) (Hemiptera: Triozidae), a pest on *Lycium chinense* Mill., with comments on psyllids associated with *Lycium* (Solanaceae)

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ARTICLE INFO

Article history:
Received 9 June 2016
Revised 22 August 2016
Accepted 30 August 2016
Available online 04 September 2016

Keywords:
Psylloidea
Wolfberry
Goji berry
Chinese boxthorn
Host plant
Taxonomy
New record

ABSTRACT

Bactericera gobica (Loginova) is reported for the first time from Korea on Chinese boxthorn, *Lycium chinense* Mill. In North and Northeast China, *B. gobica* is an important pest of boxthorn (*Lycium chinense* and L. *barbarum*) whose fruits, known as wolfberry or goji berry, are used in traditional medicine. *B. gobica* is diagnosed and illustrations of taxonomically relevant structures are provided along with information on its biology. Worldwide 17 psyllid species are associated with *Lycium*. These belong to the genera *Bactericera* (5 spp.), *Diaphorina* (2 spp.) and *Trioza* (1 sp.) in the Old World as well as *Bactericera* (2 spp.) and *Russelliana* (7 spp., including 5 undescribed spp.) in the New World. One species of each *Bactericera* and *Russelliana* is polyphagous which is very rare in psyllids.

Introduction

Goji berries or wolfberries are the fruits of two closely related species of boxthorn, *Lycium barbarum* and L. *chinense* (Solanaceae), that probably both originate from east Asia. The berries and leaves of these plants are used in traditional Chinese medicine and were already known 2800 BCE. Today they are considered functional food with many beneficial effects. They have become more popular recently, also in Europe, North America and Australia, as they are seen as superfood with highly nutritive and antioxidant properties (Amagase and Farnsworth, 2011; Jeon et al., 2011; Kim and Baek, 2014; Mocan et al., 2014). *Lycium*, or boxthorn, contains approximately 70 species of spiny shrubs and small trees growing mostly in arid and subarid regions in South America (ca. 30 spp.), North America (ca. 20 spp.), southern Africa (ca. 20 spp.), Eurasia (ca. 10 spp.) and Australia and some Pacific islands (3 spp.) (Fukuda et al., 2001).

Lycium chinense and L. *barbarum* are cultivated mostly in China, Japan and Korea. In the last few decades, their economic importance and, in parallel, the surface on which they are cultivated has increased rapidly (Ryu et al., 2013, 2014; Mocan et al., 2014). In Korea, *L. chinense* grows nearly everywhere on the Peninsula but is mainly cultivated in Cheongyang-gun and Jin-do under environment friendly management (Ryu et al., 2013). The cultivated area is constantly expanding to meet demands. Recently the Korean production has been suffering from foreign imports and the aging of Korean farmers (Ryu et al., 2013, 2014). In addition to these problems, harmful pests diminish drastically the yield. Not much is known about these pests. Some information exists so far only for a few environment friendly farms where 14 species of Thysanoptera, Hemiptera, Coleoptera and mites were observed (Ryu et al., 2013, 2014).

During recent field work in Korea, the jumping plant-louse *Bactericera gobica* (Loginova, 1972) was discovered on boxthorn in large numbers. The species is an important pest of *Lycium chinense* and L. *barbarum* in North and Northeast China (Yang and Li, 1982; Burckhardt and Lauterer, 1997; Li, 2011). It has not been reported yet from Korea. The present note provides the collection details, a diagnosis of the species with illustrations of morphological relevant characters and discusses psyllids associated with *Lycium* in general.

Material and methods

Material was examined from following institutions: MHNG – Muséum d'histoire naturelle, Genève, Switzerland; NHMB – Naturhistorisches Museum Basel, Switzerland; SNU – College of Agriculture and Life Science, Seoul National University, Seoul, Korea. Specimens are preserved dry, permanently mounted on microscopical slides in Canada balsam or stored in 70% or 95% ethanol.

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http://dx.doi.org/10.1016/j.aspen.2016.08.015
1226-8615/

The morphological terminology follows mostly Ossiannilsson (1992) and Hollis (2004). Measurements were taken from slide-mounted specimens. Information on the *Lycium*-feeding psyllids was mostly gathered from the world Psylloidea Database Psyl'list (Ouvrard, 2016).

Taxonomy

Bactericera gobica (Loginova, 1972)
(Figs. 1–15)

Paratrioza gobica Loginova, 1972: 300.
Paratrioza sinica Yang and Li, 1982; synonymised by Burckhardt and Lauterer, 1997: 126.
Paratrioza turcamanica Andrianova and Klimaszewski, 1987; synonymised by Burckhardt and Lauterer, 1997: 126.
Bactericera gobica (Loginova, 1972): Burckhardt and Lauterer, 1997: 126.

Material examined. South Korea: 1 ♂, 1 ♀, Gyeonggi-do, Gunpo-si, Sokdal-dong, Mt. Suri, 24.iv.2015, *Lycium chinense* (M.S. Oh) (SNU); 7 ♂, 24 ♀, same data but 8.v.2015, *Lycium chinense* (G. Cho) (SNU); 382 ♂, 275 ♀, 1 exuvia, eggs, same data but 31.v.2015 (D. Burckhardt & G. Cho) (NHMB, SNU). **China:** 2 ♂, 2 ♀, 25 immatures, paratypes of *Paratrioza sinica*, Ningxia, Zhongning, 19.vii. 1980 (MHNG).

Measurements. (5 ♂/5 ♀; in mm). Head width 0.64–0.66/0.67–0.68; vertex width 0.36–0.40/0.38–0.40; vertex length 0.17–0.19/0.20–0.20; length of genal processes 0.10–0.13/0.09–0.11; length of first antennal flagellomere 0.05–0.06/0.05–0.06; antennal length 1.21–1.26/1.13–1.24; forewing length 2.73–2.91/2.99–3.15; forewing width 1.08–1.16/1.21–1.26; vein Rs length 1.02–1.27/1.22–1.37; length of line connecting apices of veins Rs and Cu_{1a} 0.91–1.01/0.99–1.11; length of line connecting base and apex of vein M_{1+2} 0.36–0.54/0.46–0.61; length of line connecting apices of veins M_{1+2} and M_{3+4} 0.29–0.35/0.38–0.41; length of line connecting apices of veins Cu_{1a} and Cu_{1b} 0.48–0.53/0.52–0.58; length of line connecting base and apex of vein Cu_{1b} 0.29–0.33/0.28–0.37; metatibia length 0.65–0.69/0.65–0.69; male proctiger length 0.21–0.26; paramere length 0.17–0.18; length of distal segment of aedeagus 0.16–0.17; female proctiger length 0.32–0.35; circumanal ring length 0.12–0.14; female subgenital plate length 0.18–0.22.

Diagnosis. Adult. Head with genal processes which are shorter than half vertex length, pointed apically (Fig. 3). Antennal segments 3–8 light, segments 4–8 more or less darkened at apex, segments 9 and 10 dark brown to almost black; segment 3 not markedly thicker than segment 4. Forewing (Fig. 4) transparent, radular areas dark brown; broadest in the middle, pointed apically; surface spinules absent except for base of cell cu_2. Male proctiger with relatively short posterior lobes (Fig. 5). Paramere (Fig. 7) sickle-shaped, acute at apex, evenly curved. Distal segment of aedeagus (Fig. 8) relatively short with strongly expanded apex, evenly curved subapical margin on ventral side and subapically curved hook on dorsal side; sclerotised end tube of ductus ejaculatorius moderately long, sinuous. Female terminalia (Fig. 6) short; proctiger blunt apically; subgenital plate ending in very short, broad process. – Fifth instar immature. Body broadly ovate (Fig. 9). Humeral lobes large, reaching beyond anterior eye margin. Marginal sectasetae truncate, short, present in following numbers (one side only): head (Fig. 10) 24–29, forewing pad (Fig. 11) 88–109, hindwing pad (Fig. 12) 10–19, caudal plate (Fig. 13) 87–94. Dorsal body surface lacking sectasetae. Circumanal ring transversely oval (Fig. 14), 0.2 times as wide as caudal plate, in distance from hind margin of caudal plate by 4.5 times its own length; consisting of a single row of pores.

According to Burckhardt and Lauterer (1997), *Bactericera gobica* is closely related to *B. petiolata*. *B. gobica* has an apically slender paramere and is slightly smaller in body size (in *B. petiolata*, paramere slightly expanded subapically, body size slightly larger). The two species are easily diagnosed by the shape of the distal aedeagal segment which bears a subapical ventral hook in *B. petiolata* lacking in *B. gobica*.

Distribution. China (Beijing, Gansu, Ningxia, Shaanxi, Xinjiang) (Yang and Li, 1982; Burckhardt and Lauterer, 1997; Li, 2011), Mongolia (Loginova, 1972), South Korea (new record), Tadzhikistan (Andrianova and Klimaszewski, 1987).

Host plants. *Lycium barbarum* L., *L. chinense* Mill., *L. depressum* Stocks, *L. ruthenicum* Murray (Solanaceae). The record of *L. barbatum* Thunb. as host of *Paratrioza sinica* by Hodkinson (1986), citing Yang and Li (1982), is a likely misspelling of *L. barbarum*.

Biology. In North and Northeast China, *B. gobica* is an important pest on *Lycium barbarum* and *L. chinense* (Yang and Li, 1982). The removal of plant sap by large populations damages young leaves and shoots.

According to Yang and Li (1982), the adults of *B. gobica* overwinter on the host or in leaf litter around the host. The overwintered adults re-appear on *L. chinense* in late April, where they feed on the branches and leaves. When resting, the adults hold the body with the folded wings obliquely in the air making oscillating movements. From time to time small droplets of honeydew are discharged from the anus. During daytime the psyllids mate and the females lay eggs. The eggs densely cover both sides of the leaves, which look like a layer of yellow powder. In Korea we made similar observations where we found hundreds of adults and thousands of eggs in a small stand of *L. chinense*, covering not more than a few square meters. The eggs were so densely laid that the leaves looked hairy. The adults

Figs. 1–2. Habitus of *Bactericera gobica*. **1.** Adult male. **2.** Adult female.