A new record of the genus *Froggattiella* Leonardi (Hemiptera, Coccomorpha, Diaspididae) in South Korea

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Abstract

Background

The genus *Froggattiella* Leonardi, 1900 belongs to the family Diaspididae, and five species of *Froggattiella* have been recorded worldwide. In this study, *Froggattiella penicillata* (Green, 1905), which attacks bamboos, is newly recorded in South Korea. The colonies of *F. penicillata* were collected on a bamboo forest located in Gajwa-dong, Jinju-si, Gyeongsangnam-do, South Korea (35.1599, 128.1029). Description of the adult female, host plant, adult female illustrations, and global distribution of this species are provided.

New information

Froggattiella penicillata (Green, 1905) is reported for the first time in South Korea. This species occurrs under sheathing bases of the leaves and is observed attached on the stem and not on the leaf.

Keywords

Odonaspidini, New mention, Asia, Armored scale

Introduction

The family Diaspididae (Hemiptera, Coccoidea) is the most diverse family in the Coccoidea, with more than 2,700 species of 418 genera worldwide (García Morales et al.

2016). The genus *Froggattiella* Leonardi, 1900 belongs to the subfamily Aspidiotinae and the tribe Odonaspidini (Normark et al. 2019) and is a small group including five species in the world: *F. gigantochloae* Aono 2009, *F. pentapeniculata* Aono, 2009, *F. inusitata* (Green, 1896), *F. mcclurei* Ben-Dov, 1988, and *F. penicillata* (Green, 1905) (Green 1905, Ben-Dov 1988, Aono 2009). These species have been recorded from mostly zoogeographical regions (Ben-Dov 2015, García Morales et al. 2016). There are only found on Poaceae, but there are mainly bamboo-feeding species (Amouroux et al. 2020).

Froggattiella penicillata (Green, 1905) was originally described from bamboo, namely *Gigantochloa aspera* (Schult. & Schult.f.) Kurz in Paradeniya, Sri Lanka (Ben-Dov 1988), since then, it has been recorded only from bamboo in various territories of Asian, African, and American countries (Ben-Dov 1988). This species was intercepted most frequently in quarantine at U.S. ports of entry on bamboo from the Caribbean islands, China, Japan, South and Central America, and Vietnam (Miller and Davidson 2005). In South Korea, it was detected in the quarantine inspection of bamboo imported from China at the port of entry (Suh and Gregory 2007, Suh 2016). To date, information related to the life cycle and damage of this species has not been well known.

In the present paper, we report *F. penicillata* for the first time in South Korea and provide an identification key to adult females of seven armored scales in Korea that are found on bamboos.

Materials and methods

These specimens were collected in Mt. Gajwa, Jinju-si, Gyeongsangnam-do, South Korea (35.1599, 128.1029), and were identified on collecting the part from the stem of the host plant (Poaceae: *Sasa quelpaertensis* Nakai). The samples of adult females were preserved in 90% ethanol. The specimens were examined under an optical microscope (DM6, LEICA, Germany) and habitus photographs were taken using a stereoscopic microscope (M205C, LEICA, Germany). To prepare slide-mounted specimens, samples were placed in hot 10% potassium-hydroxide (KOH) solution for 30 minutes or 1 hour at 70°C. After then, samples were put in distilled water for 5 minutes, and few drops of stain was added to distilled water and stayed for 5 minutes (Miller and Davidson 2005). The identification of adult females was conducted, based on Ben-Dov (1988). Permanent slide mounts of adult females (ID: 230131HS148) were deposited in the Institute of Agriculture & Life Science, Gyeongsang National University, South Korea.

Taxon treatment

Froggattiella penicillata (Green, 1905)

Nomenclature

Odonaspis penieillata Green, 1905: 346 - Green 1905

Anoplaspis penicillata (Green) Kuwana, 1933: 38 - Kuwana 1933

Froggattiella penicillata (Green) Rutherford, 1915: 104 - Rutherford 1915

Materials

a. scientificName: ***Froggattiella penicillata***; kingdom: Animal; phylum: Arthropoda; class: Insecta; order: Hemiptera; family: Diaspididae; genus: Froggattiella; specificEpithet: penicillata; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Jinju-si; locality: Gajwa-dong 803; verbatimLatitude: 35°09'35.6"N; verbatimLongitude: 128°06'10.4"E; georeferenceProtocol: label; eventDate: 01/31/2023; individualCount: 5; sex: female; lifeStage: adult; recordedBy: Hyeongsu Kim; identifiedBy: Hyeongsu Kim; dateIdentified: 2023; language: en; collectionCode: Insects; basisOfRecord: PreservedSpecimen; occurrenceID: 8AC36059-D135-5459-8C0B-16037B401B65

b. scientificName: ***Froggattiella penicillata***; kingdom: Animal; phylum: Arthropoda; class: Insecta; order: Hemiptera; family: Diaspididae; genus: Froggattiella; specificEpithet: penicillata; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Jinju-si; locality: Gajwa-dong 803; verbatimLatitude: 35°09'35.6"N; verbatimLongitude: 128°06'10.4"E; georeferenceProtocol: label; eventDate: 01/31/2023; individualCount: 5; sex: female; lifeStage: adult; recordedBy: Hyeongsu Kim; identifiedBy: Hyeongsu Kim; dateIdentified: 2023; language: en; collectionCode: Insects; basisOfRecord: PreservedSpecimen; occurrenceID: 6D3CF3D9-AD8E-582B-8347-49CC64B12140

c. scientificName: ***Froggattiella penicillata***; kingdom: Animal; phylum: Arthropoda; class: Insecta; order: Hemiptera; family: Diaspididae; genus: Froggattiella; specificEpithet: penicillata; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Jinju-si; locality: Gajwa-dong 803; verbatimLatitude: 35°09'35.6"N; verbatimLongitude: 128°06'10.4"E; georeferenceProtocol: label; eventDate: 01/31/2023; individualCount: 5; sex: female; lifeStage: adult; recordedBy: Hyeongsu Kim; identifiedBy: Hyeongsu Kim; dateIdentified: 2023; language: en; collectionCode: Insects; basisOfRecord: PreservedSpecimen; occurrenceID: FC5257E0-7B25-5DDA-AAB5-AC62229B3D91

d. scientificName: ***Froggattiella penicillata***; kingdom: Animal; phylum: Arthropoda; class: Insecta; order: Hemiptera; family: Diaspididae; genus: Froggattiella; specificEpithet: penicillata; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Jinju-si; locality: Gajwa-dong 803; verbatimLatitude: 35°09'35.6"N; verbatimLongitude: 128°06'10.4"E; georeferenceProtocol: label; eventDate: 01/31/2023; individualCount: 5; sex: female; lifeStage: adult; recordedBy: Hyeongsu Kim; identifiedBy: Hyeongsu Kim; dateIdentified: 2023; language: en; collectionCode: Insects; basisOfRecord: PreservedSpecimen; occurrenceID: 8AC36059-D135-5459-8C0B-16037B401B65

e. scientificName: ***Froggattiella penicillata***; kingdom: Animal; phylum: Arthropoda; class: Insecta; order: Hemiptera; family: Diaspididae; genus: Froggattiella; specificEpithet: penicillata; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Jinju-si; locality: Gajwa-dong 803; verbatimLatitude: 35°09'35.6"N; verbatimLongitude: 128°06'10.4"E; georeferenceProtocol: label; eventDate: 01/31/2023; individualCount: 5; sex: female; lifeStage: adult; recordedBy: Hyeongsu Kim; identifiedBy: Hyeongsu Kim; dateIdentified: 2023; language: en; collectionCode: Insects; basisOfRecord: PreservedSpecimen; occurrenceID: D55BE239-421C-55A9-A5D9-1959E4E36B6B

Description

The scale covers of female adults are generally yellow in color, and the color of the larval exuviae, located at the front of the scale cover, is a deep yellow (Fig. 1); shed scale covering marginal; light purple or light brown. Adult male scale cover is smaller and narrower than that of female scale cover. The male cover looks more oval compared to that of the female cover. Color of the male cover is similar to the female cover. On the slide-mounted female, the body shape is round to oval (Fig. 2); Body length 1.07-1.18 (median 1.16) mm, Width 0.72-0.82 (median 0.8) mm; the end of the median lobes is pointed and there are approximately five to six gland spines between median lobes; ventral marginal setae slightly shorter than dorsal marginal setae in abdominal segment 8. Margin of the pygidium, with a pair of pygidial sclerosis. Perivulvar pores absent; marginal setae located on segment 4, 5, 6, and 7; Several creulae between dorsal abdominal segments. Anterior spiracle with approximately four or six spiracular pores, posterior spiracle without pores; many secretory ducts are concentrated on the dorsal and dorsal surfaces.

Distribution

Asia: South Korea (new record), Japan, China, Georgia, India, Iran, Pakistan, Philippines, Sri Lanka, Taiwan. Africa: Algeria, South Africa. North America: United States, Hawaii, Puerto Rico, Mexico. South America: Guyana, Jamaica. Oceania: Australia, Fiji, Palau (García Morales et al. 2016).

Notes

This species had been not found in South Korea before.

Host plants

Sasa quelpaertensis Kakai (in this study), *Arundinaria* sp., *Arundo donax* L., *Bambusa blumeana* Schult.f., *Bambusa merrilliana* (Elmer) Rojo & Roxas, *Bambusa multiplex* (Lour.) Raeusch. ex Schult. & Schult.f., *Bambusa pervariabilis* McClure., *Bambusa vulgaris* (L.), *Dendrocalamus asper* (Schultes f.), *Dendrocalamus latiflorus* Munro, *Gigantochloa levis* (Blanco) Merr., *Ochlandra travancorica* (Bedd.), *Panicum* sp., *Phyllostachys aurea* Carrière ex. A., *Phyllostachys bambusoides* Siebold & Zucc., *Phyllostachys edulis* (Carrie) J.Houz., *Phyllostachys nigra* (Lodd.) Munro, *Pleioblastus argenteostriatus* (Regel) Nakai, *Pseudosasa hindsii* (Munro) S.L.Chen & G.Y.Sheng ex T.G.Liang, *Sasa* sp., *Schizostachyum glaucifolium* (Rupr.) Munro , *Schizostachyum lumampao* (Blanco), and *Spartina* sp. (García Morales et al. 2016).

Identification keys

Identification key to adult females of armored scale insects on bamboos in South Korea (modified from Suh and Hodges (2007))		
1	Without two-barred macroducts on margin of abdomen	2
–	With two-barred macroducts on margin of abdomen	3
2	With perivulvar pores on pygidium of abdomen	*Odonaspis secreta* (Cockerell)
–	Without perivulvar pores on pygidium of abdomen	*Froggattiella penicillata* (Green)
3	Median lobes yoked	*Pinnaspis buxi* (Bouché)
–	Median lobes not yoked	4
4	Median lobes very small and pointed, occurring on the lower part of the leaf	*Unachionaspis tenuis* Maskell
–	Serrated plates present anterior to 2nd lobes	5
5	With less than 10 perivulvar pores on pygidium, occurring on the base of the leaf	*Kuwanaspis hikosani* Kuwana
–	With more than 20 perivulvar pores on pygidium, occurring on the base of the stem	6
6	Abdominal segment 1 with transverse row of macroducts	*Kuwanaspis howardi* (Cooley)
–	Abdominal segment 1 without transverse row of macroducts	*Kuwanaspis pseudoleucaspis* (Kuwana)

Discussion

Bamboo is an important resource with ecological and economic value due to its versatility as food, wood, landscape, conservation, and ornamental uses (Mera and Xu 2014).

Currently, ca. 150 species of armored scale insects have been known to feed on bamboo in Asian region (Ülgentürk et al. 2014). In South Korea, six species were reported as armored scale insects feeding on bamboo, and one species was newly added from this study: *Odonaspis secrata* (Cockerell, 1896), *Pinnaspis buxi* (Bouché, 1851), *Unachionaspis tenuis* Maskell, 1897, *Kuwanaspis hikosani* Kuwana, 1902, *Kuwanaspis howardi* (Cooley, 1898), *Kuwanaspis pseudoleucaspis* (Kuwana, 1923), and *Froggattiella penicillata* (Suh 2016).

In South Korea, *F. penicillata* was collected on *Sasa quelpaertensis*, and colonies of *F. penicillate* occurred beneath the base of the leaves. *Sasa quelpaertensis* is a new host plant and has been not reported in the previous studies (García Morales et al. 2016). The new host plant suggests that *F. penicillata* can survive in a variety of host plants and has a high possibility of spreading.

Until now, economic damage, distribution, and biology about the seven species have been not known in South Korea. As bamboo has unique ornamental and aesthetic values, the worldwide trade of bamboo has been continuously increased, and it can make opportunity of associated scale insects' invasions. Thus, intensive surveys of scale insects feeding bamboo are necessary to manage scale insects and detect potential invasive scale insects in South Korea.

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Author contributions

HSK (MS student), JK (MS student) and WL (Professor) performed the experiments. HSK (MS student) and JK (MS student) collected the data. WL (Professor) designed the experiment and guided thesis writing.

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Figure 1.

The habit of *Froggattiella penicillata*. **a** second-instar female; **b** adult female; **c** Body of adult female; **d** adult female and male scale cover on plant.

Figure 2.

Froggattiella penicillata. **a** adult female; **b** abdomen; **c** median lobe. Scale bars: a = 200 µm, b = 100 µm, c = 50 µm.