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Occurrence of an exotic whitefly,
Siphoninus phillyreae (Haliday) (Hemiptera: Aleyrodidae)
in South Korea and its potential pathway analysis

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Occurrence of an exotic whitefly, *Siphoninus phillyreae* (Haliday) (Hemiptera: Aleyrodidae) in South Korea and its potential pathway analysis

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Abstract. The ash whitefly, *Siphoninus phillyreae* (Haliday) (Hemiptera: Aleyrodidae), was first found in southern areas of South Korea during September 2019. During the survey of 2021, no additional specimens of the ash whitefly were found other than the previously reported regions. Attempts to trace a possible pathway for exotic ash whitefly suggested that this species probably followed pathways of illegal importation of infested plants from China or Japan and was unintentionally introduced into South Korea based on a survey-based study. This whitefly has not been intercepted at ports of entry to South Korea on imported plant material between 1999 and 2019 according to the PIS database (2021). Because of its wide host range and an ability to buildup massive populations, it will require continuous monitoring to prevent the spread to other areas of the country and to minimize potential losses of agriculturally and horticulturally important plants.

Key words. Ash whitefly, invasive, monitoring, spread.

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Introduction

South Korea has many exotic plant insect pests (Park 2010; PIS 2021). The reasons for this include the recent soaring increase in the amount of imported plant material into South Korea, the warmer climate that allows insects to become established, and high numbers of visitors who may bring plants and plant products into the country (PIS 2021). Quarantine of pests found on imported plant material is one of the nation's critical missions that safeguards natural and agricultural environments from the introduction of exotic injurious pests. One of the major focuses of the Animal and Plant Quarantine Agency (APQA) is to conduct the national surveillance program for pests of economic importance such as fruit flies, scale insects and whiteflies, to detect and identify exotic pests early enough to prevent their establishment in the country and potential spread to other areas of the country. Knowledge of possible pathways associated with intercepted pests can be used to design science-based regulations to prevent future establishment of exotic pests (Park 2010; Halbert et al. 2020).

Whiteflies (Hemiptera: Aleyrodidae) are among the main pests of ornamental plants in South Korea. Approximately 30 species of whiteflies have been recorded from South Korea (Suh 2014; Lee 2019). Some of these such as *Trialeurodes vaporariorum* (Westwood), *Trialeurodes packardii* (Morrill) and *Bemisia tabaci* (Genadius) have been introduced over the last half century or so (Park 2010; Suh 2014). The ash whitefly, *Siphoninus*

phillyreae (Haliday), which is thought to be native to Europe, the Mediterranean and northern Africa, has recently been detected in South Korea (Lee et al. 2020). The ash whitefly is a pest of numerous ornamental and fruit crops including citrus, pears and apples (Nguyen and Hamon 2020). Heavy infestations cause leaf wilt, early leaf drop and smaller fruit (Bellows et al. 1990). The ash whitefly was first discovered in the southern area of South Korea in September 2019 and is considered to have been already established locally in the exterior environment. Additionally, this species could spread throughout the nation since it has recently been introduced and has few natural enemies. Ash whiteflies in South Korea were mainly found on pomegranate trees (*Punica granatum* L.; Lythraceae), but were also found on other host including Chinese plum (*Prunus mume* (Siebold) Siebold and Zucc.), Chinese quince (*Pseudocydonia sinensis* C.K. Schneid.), Chinese hawthorn (*Crataegus pinnatifida* Bunge), loquat (*Eriobotrya japonica* (Thunb.) Lindl.), Japanese flowering crabapple (*Malus floribunda* Siebold ex Van Houtte), Japanese photinia (*Photinia glabra* (Thunb.) Franch. and Sav.), narrowleaf firethorn (*Pyracantha angustifolia* (Franch.) C.K. Schneid.), Asian pear (*Pyrus pyrifolia* (Burm.) Nakai; Rosaceae) and crape myrtle (*Lagerstroemia indica* L.; Lythraceae) trees (Lee et al. 2020). Further surveys will be required for preventing the expansion of *S. phillyreae* into other regions of South Korea, determining its host plants in the country and understanding its pestiferous nature due to a high adaptability of this polyphagous pest (CABI 2021); hence a field survey was carried out to determine the occurrence of the pest, focusing on the areas where outbreaks of the pest have occurred. The original source of the population of this exotic whitefly which was discovered in the southern areas of South Korea in 2019 is unknown. Here we provide information on the current status of the ash whitefly and its possible pathway based on a survey conducted from June to September of 2021.

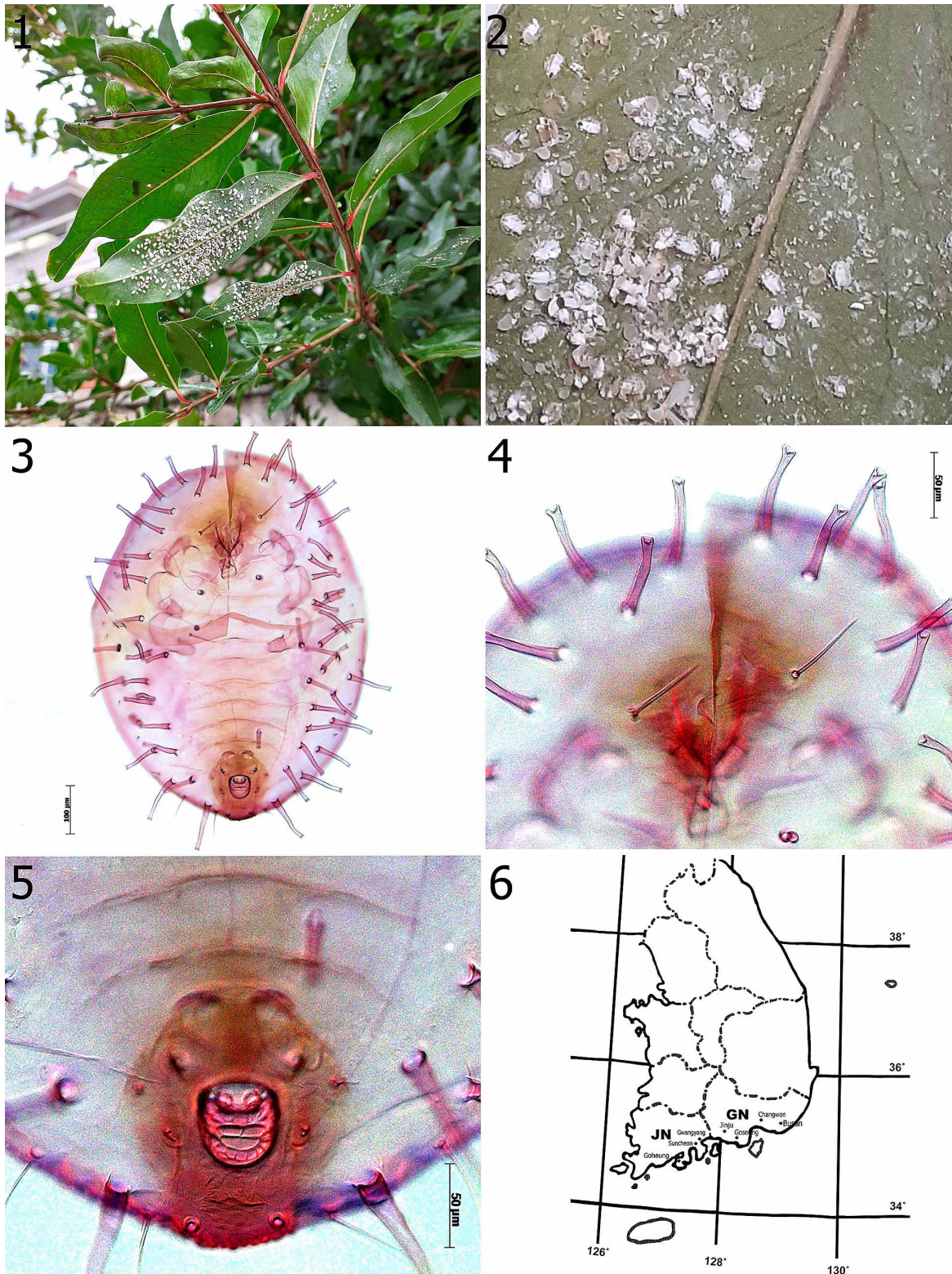
Materials and Methods

APQA plant inspectors routinely inspect businesses that sell imported plants for planting. Any live insects and infested plants found during these inspections are submitted to entomologists of APQA for identification. In addition, we conducted a survey of the ash whitefly from June to September 2021. Some of puparia (also known as the fourth instar nymphs) collected on leaves of its host plants were mounted on microscope slides in Canada balsam mounting medium for identification and the others were stored in alcohol. They are deposited in the Collection of Plant Quarantine Technology Center, Gimcheon, South Korea. Abbreviations of collecting regions are as follows (Fig. 6): Gyeongsangnamdo (GN) and Jeollanamdo (JN).

To understand the importance of the international trade of host plants associated with the ash whitefly as a pathway, data on imported plant materials and interception records were collected from the Pest Information System (PIS) database developed by the Animal Plant Quarantine Agency (PIS 2021). A total of 655 consignments of six of its known host plants, including pomegranate and pear trees imported from neighboring countries, Japan (545) and China (110) from 1999 to 2019 were recorded; this species was reported to occur in Japan and China in 1996 and 2010, respectively (Kanmiya and Sonobe 2002; Xian et al. 2015). Photographs were taken using an AxioCam MRc5 camera mounted on a ZEISS Axio Imager M2 microscope and a Leica M165C microscope with a Dhyana 400DC-Tucsen camera.

Results and Discussion

The first detection of *S. phillyreae* in South Korea was from Jinju (GN) located in the southern region of the country where colonies of the whitefly were noted in September 2019 on a potted pear tree in front of a store. It was additionally found in seven cities, Busan, Changwon, Jinju, Goseong (GN), Goheung, Gwangyang and Suncheon (JN) based on an occurrence survey conducted in 2019 (Lee et al. 2020). During the survey of 2021, no additional specimens of the ash whitefly were found other than those from the previously reported seven cities and was found only on the underside of leaves of pomegranate trees (Fig. 1–2). The puparium (pupal case) can be easily distinguished by having two longitudinal tufts of white wax down the midline of the dorsum, its pale body with black pigment at both ends, many siphons on marginal and submarginal areas of dorsum and polygonal reticulations on the cuticle of the operculum (Fig. 3–5). They were mostly found on uncontrolled or unsprayed trees



Figures 1–6. Ash whitefly (*Siphoninus phillyreae* (Haliday)) and regional map of South Korea. **1–2)** Several life stages of the ash whitefly on the underside of leaves of a pomegranate tree (GN: Jinju, 3-viii-2021 (S.J. Suh)). **3)** Pupa (slide-mounted). **4)** Siphons on marginal and submarginal areas of dorsum. **5)** Vasiform orifice. **6)** Distribution map of ash whitefly in South Korea.

planted in household gardens and urban landscapes, but were not found in commercial orchards. This whitefly sucks the plant sap and excretes the excess sugary liquid. This makes the plant leaves sticky and often black sooty mold fungi grow on the sticky surfaces. So far, it does not seem that the ash whitefly is causing a great deal of harm to the trees, but due to the copious amounts of sooty mold that grows on the sweet substrate, the trees can look unsightly and debilitated. Pomegranate trees planted in urban landscapes are especially more prone to attack by this pest due to higher temperature and relative humidity conditions, and the lack of biological agents such as parasitoids in these places. No native parasitoids associated with the ash whitefly were collected during this survey. Until now, they are considered to be restricted to Jeollanamdo and Gyeongsangnamdo of southern areas (Fig. 6).

There are many different types of pathways through which the ash whitefly may move from one place to another such as in the case of plants infested with nymphs or eggs brought in by travelers from overseas, moving infested plants globally by aircraft or mail. According to the PIS database (PIS 2021), the ash whitefly was not intercepted at ports of entry to South Korea on its imported host plants between 1999 and 2019. In addition, this whitefly is a regulated pest in South Korea and therefore, shipments of plants or parts of plants that can be a host for *Siphoninus phillyreae* have been regulated strictly. Although strong restrictions were put in place in the late 1990s, illegal importation of young plants of its host plants such as pomegranate, pear, Chinese quince, Chinese plum, hawthorn and loquat trees were found in hand luggage and international mail (155 cases from 1999 to 2019) and were destroyed accordingly (PIS 2021). These interceptions indicate that the whitefly was probably unintentionally introduced into South Korea by the illegal importation of infested young trees and subsequently spread to other areas of the country.

The ash whitefly is a polyphagous species, feeding on plants belonging to almost 10 families and tends to adapt very well to live on wild flora or on ornamental and fruit plants growing in urban areas, especially in newly colonized regions. Therefore, continuous monitoring is necessary for many species of agriculturally and horticulturally important plants for the occurrence of invasive whitefly species and their population that will enable the timely application of management practices to minimize potential losses of these plants. In addition, to prevent the spread to other areas of the country will be required.

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