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Alien Hitchhiker Insects Detected in Empty Containers Entering South Korea in 2024

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ABSTRACT

This study investigated the presence of alien hitchhiker insect species detected in empty international containers entering South Korea in 2024. A total of 12 species were identified, among which six species are not distributed in South Korea. Among them, *Erthesina fullo* (Pentatomidae, Hemiptera) and *Trochoideus desjardinsi* (Endomychida, Coleoptera) were identified as a stored product pests. If established in South Korea, these species could cause both agricultural and ecological disruptions, highligthing the importance of rigorous inspections. These findings emphasize the need for rigorous inspections and continuous monitoring of various entry pathways to mitigate and prevent the risks associated with hitchhiker insects.

Keywords: Empty containers, Hitchhiker insects, International trade, Invasive species, South Korea

Introduction

The growth and intensification of international trade and globalization have increased the risk of non-native organisms being introduced via sea, air, and land routes (Brasier, 2008; Hulme, 2009; Levine & D'Antonio, 2003; Seebens *et al*., 2017; Westphal *et al*., 2008). In this context, the hitchhiker organisms—which are temporarily associated with artificial structures or objects without forming biological host relationships (Toy & Newfield, 2010)—are transported via transportation equipment such as cars, ships, and aircrafts (Humble, 2009; Kang *et al.,* 2023b; Toy & Newfield, 2010). Additionally, the pathways facilitating their introduction include trade in live plants, wood packaging materials (such as pallets), logs, wooden products, international mail, and natural dispersal (Meurisse *et al.,* 2019).

These hitchhiker insects can affect native biodiversity in direct and indirect ways, for example a non-native herbivore consuming indigenous vegetation (Jenkins, 2003), a foreign predators or parasitoids preying on local species (Boettner *et al*., 2000; Snyder & Evans, 2006), hitchhiker insects interbreeding with native species (Jensen *et al*., 2005), cascading effects, spreading of diseases, competing for food or space or sharing natural enemies with native species (National Research Council, 2002).

According to the 2018 Ministry of Environment data, 2,653 non-native species have been reported in South Korea, with 211 species identified as insects (Lee *et al*., 2021). Notably, insect species such as *Lycorma delicatula* (Fulgoridae, Hemiptera), *Hyphantria cunea* (Erebidae, Lepidoptera), *Metcalfa pruinosa* (Flatidae, Hemiptera), and *Pochazia shantungensis* (Ricaniidae, Hemiptera) have adapted to the local climate, causing significant damage by feeding on various host plants (Lee, 2021). Additionally, social insects such as *Solenopsis invicta* (Formicidae, Hymenoptera) and *Linepithema humile* (Formicidae, Hy-

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menoptera), which are listed among the world's 100 worst invasive alien species by the International Union for Conservation of Nature (Lowe *et al.,* 2000), along with *Vespa velutina* (Vespidae, Hymenoptera), can easily invade urban areas, posing health risks to humans and causing additional damages.

Since the initiation of the survey of international vessels entering South Korea in 2018, Korea's surveillance efforts have detected over 100 species annually. The detection numbers have fluctuated, with notable peaks observed in 2019 (42 species) and 2022 (38 species), whereas in other years these ranged between 14 and 26 species (Kang *et al.*, 2020; 2021; 2023a; 2023b; 2024a; 2024b). These species, which span multiple families and insect orders, underscore the persistent risk of unintentional introduction despite the ongoing monitoring efforts.

Additional pathways for the introductions of non-native insects have been identified in South Korea. The discovery of *Stromatium longicorne* (Cerambycidae, Coleoptera) larvae and *Coptotermes formosanus* (Rhinotermtidae, Blattodea) in wood imports poses a potential risk to forest ecosystems and wood infrastructure (An *et al.*, 2024; Lee *et al.*, 2024).

Hitchhiker insects are commonly found in shipping containers, which account for approximately 90% of global trade and are the most widely used transportation method in international trade (Bernhofen *et al*., 2016; IMO, 2012). Therefore, surveying empty containers could be an effective approach to identify invasive hitchhiker insects. This study presents biological and hitchhiking data on non-native species detected in empty containers in 2024 with the aim of reporting these species and providing their taxonomic and biological information.

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Samples were collected by visually monitoring 33 empty containers shipped from May to November, at eight container terminals (Ulsan newport, Incheon Sun Kwang newport, Hangin Incheon, Incheon E1, Incheon, Busan port Sinseondae, Pusan newport international, Gwangyang west container terminals). Samples were obtained using tweezers and suction, whereafter they were stored in microtubes containing 70% ethanol. A total of 13 samples were collected. Species identification was initiated using DNA barcoding. DNA barcodes of the collected insects were compared using the NCBI BLAST search method. The identification results were checked against the National Species List of Korea and Biodiversity of the Korean Peninsula (National Institute of Biological Resources, Ministry of Environment, Incheon, Korea), to determine whether the species are distributed in South Korea. We cataloged the biological information, such as taxonomy, distribution, and collection data, for the species obtained in this study.

Discussion

Integrative analyses of the 13 individuals detected in the 33 empty containers revealed that 13 individuals belonged to 12 species across 11 families 6 orders. Of the 12 species identified, six species were confirmed as not being distributed in South Korea (Table 1; Bell, 1968; Berrazueta *et al*., 2024; Biondi, 2008; Bolshakov, 2021; Farooq & Freed, 2016; Hayashi *et al*., 2004; Hodkinson & Williams, 1980; Imamura *et al*., 2008; Kang *et al*., 2021; Kim *et al*., 2011; 2019; Kovats *et al*., 1996; Laciny, 2017; Lam *et al*., 2015; Lewandowski *et al*., 2007; Madsen *et al*., 2017; Paños *et al*., 2013; Pocklington, 2015; Princis, 1969; Qiu *et al*., 2017; Rösner *et al*., 2020; Santos *et al*., 2023; Shockley & Kovalenko, 2018; Suh & Tasen, 2024; Wetterer, 2010).

Hitchhiker insects that cause international issues are often introduced through ships traveling between countries. Recognizing this risk, both the International Plant Protection Convention (International Plant Protection Convention, 1997) and the Convention on Biological Diversity (Secretariat of the Convention on Biological Diversity, 2002) recommend conducting risk analyses to enhance biosecurity measures.

In this study, six species found in empty containers were confirmed not to be distributed in South Korea. Among them, two potentially invasive pests were detected. *Erthesina fullo* (Pentatomidae, Hemiptera), a polyphagous species native to Asia, poses a significant threat to crop security as it can attack 57 species from 29 botanical families (Mi *et al.*, 2020). This species was detected in Albania in 2017 and Brazil in 2021 (Brugnera *et al*., 2021; Lupoli *et al*., 2020) and is listed by the Animal and Plant Quarantine Agency of Korea. It was also detected in an international vessel in 2019 (Kang *et al.*, 2021). Another species of concern is *Trochoideus desjardinsi* (Endomychida, Coleoptera), whose adaptability as both a mold feeder and stored-grain pest raises significant concerns, particularly due to its association with ant and termite nests (Aitken, 1975; Drescher, 2011; Hinton, 1945). The establishment of these species in South Korea could lead to agricultural and ecological disruptions, highlighting the need for rigorous inspection. Notably, *Erthesina fullo* (Pentatomidae, Hemiptera) was repeatedly detected, highlighting the need for increased attention and a stronger focus on this species.

In this study, all specimens were confirmed dead. However, in other studies, hitchhiker insects were found to include both live and dead individuals. For example, a survey conducted in Australia on thousands of empty containers revealed that 39% were internally contaminated with live and dead insects, with 176 containers

Table 1. Summary data sheet of hitchhiker insect species detected in international empty containers in 2024

No.	Scientific name	Distribution	Remark
1	Blattodea Ectobiidae *Balta vilis**	Japan, China, Thailand, Malacca, Indonesia (Princis, 1969); Southeast Asia, East Asia (Qiu *et al*., 2017)	-
2	Coleoptera Endomychida *Trochoideus desjardinsi**	America (Berrazueta *et al*., 2024; Shockley & Kovalenko, 2018); Asia (Berrazueta *et al*., 2024), Africa (Berrazueta *et al*., 2024); Oceania (Berrazueta *et al*., 2024)	-
3	Tenebrionidae *Tribolium castaneum*	Worldwide (Rösner *et al.*, 2020)	-
4	Diptera Chironomidae *Chironomus plumosus*	England (Hodkinson & Williams, 1980); Germany (Lewandowski *et al*., 2007); South Korea (Kim *et al.*, 2019); Russia (Bolshakov, 2021)	-
5	Muscidae *Musca domestica*	Worldwide (Farooq & Freed, 2016)	-
6	Phoridae *Megaselia scalaris*	Worldwide (Pocklington, 2015)	-
7	Piophilidae *Piophila casei*	Worldwide (Paños *et al.*, 2013)	-
8	Hemiptera Pentatomidae *Erthesina fullo**,†	Europe, South America, Asia (Santos, 2023)	2019 (Kang *et al*., 2021)
9	Reduviidae *Vesbius purpureus**	Vietnam (Lam *et al.*, 2015); Thailand (Hayashi *et al.*, 2004; Imamura *et al*., 2008)	-
10	Hymenoptera Formicidae *Lasius niger*	Austria (Laciny, 2017); Europe, North America, Asia (Madsen *et al.*, 2017); South Korea (Kim *et al.*, 2011)	-
11	*Tetramorium lanuginosum**	East Asia, Australia, Oceania, Western Old World, Neotropics, USA (Wetterer, 2010)	2007, 2014 (Suh & Tasen, 2024)
12	Trichoptera Hydropsychidae *Cheumatopsyche campyla**	Canada (Kovats *et al.*, 1996); USA (Bell, 1968; Biondi, 2008)	-

-, not applicable.
*The not-distributed species in South Korea; †Regulated insect pest listed by the Animal and Plant Quarantine Agency of Korea.

(5.9%) containing live individuals (Stanaway *et al*., 2001). Similarly, a survey in New Zealand that examined 11,265 containers arriving at ports found live insects in 4.1% of loaded containers and 3.6% of empty containers (MAF, 2003). If live insects can survive in the domestic environment, they may become established in and potentially affect local ecosystem.

The continued detection of non-native insects in South Korea demonstrates the ongoing challenge of preventing their introduction and establishment. Given their diverse introduction pathways, ranging from shipping containers and wooden products to vehicles and international mail, multifaceted biosecurity strategy is essential. This could include enhanced inspection protocols for high-risk goods, particularly wood-based products and shipping containers; stronger preventative inspections and treatments at international ports (such as container treatment and fumigation); and long-term ecological monitoring to detect early signs of establishment and mitigate potential economic and ecological impacts. As global trade continues to expand, proactive monitoring is crucial to prevent the establishment of invasive hitchhiker insects and protect the ecosystems and economy in South Korea.

Author Contributions

ISB: project design, manuscript draft and editing; BJ: data analysis; MK: data analysis; MC: data analysis; YC: manuscript draft and editing; JA: project manager, project design, manuscript draft and editing.

Conflict of Interest

The authors declare that they have no competing interests.

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