

## Original Article

Two lepidopteran pests and damage on the cones of *Abies koreana* (Pinaceae) in Jeju Island, KoreaYoung-Min Shin<sup>a,b</sup>, Jong-Woo Nam<sup>c</sup>, Dong-Kap Kim<sup>a</sup>, Bong-Kyu Byun<sup>b</sup>, Il-Kwon Kim<sup>a,\*</sup><sup>a</sup>Division of Forest Biodiversity, Korea National Arboretum, Pocheon, Republic of Korea<sup>b</sup>Department of Biological Science and Biotechnology, Hannam University, Daejeon, South Korea<sup>c</sup>Human Resource Training Team, Bonghwa, Gyeongsangbuk-do, South Korea

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## ABSTRACT

In the present study, we report two lepidopteran pests and their damage on the cones of *Abies koreana* E. H. Wilson from Mt. Halla, Jeju, South Korea: *Cydia kamijoi* Oku and *Dioryctria abietella* (Denis & Schiffmüller). The former is new to Korea, and the latter is well known as an insect pest on cones of various coniferous trees. Larvae of these species bore into the immature cones of the host tree. Damaged cones can be easily distinguished by reddish brown frass piled around the holes that were made by the moths, and the cones that are severely damaged become crooked and eventually are folded in half. The average damage rate on the cones was  $75.3 \pm 2.34\%$  from the survey sites in 2014, but the insect damage could not be found again from the sites as the host did not bear any cones in 2015. Descriptions and images of *C. kamijoi* and *D. abietella* are provided along with a list of host species and distribution.

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## Introduction

*Abies koreana* E. H. Wilson, commonly known as Korean fir, is an endemic tree species in Korea and has been classified as an endangered species in the International Union for Conservation of Nature (IUCN) Red list of Threatened Species (Kim et al 2011). The species is distributed in the region having periglacial climate. In the beginning of the interglacial period, *A. koreana* disappeared from the warm low lands, and in the present time, it grows in the ridge over 500–1,950 m. Such an environmental condition makes the species vulnerable to global warming (Kong 2006). Distribution of the species is limited to Mt. Deogyu, Mt. Geumwon, Mt. Gaya, Mt. Jirisan, Mt. Baekun, and Mt. Halla in the southern region of South Korea (Kong 2006).

Disappearance and decline in *A. koreana* population goes on slowly but continuously for decades. Several studies were conducted to study the reasons of the vulnerable status of the species (e.g. Kim et al 1997; Koo et al 2001). In particular, Koo et al (2001) analyzed the relationships between the growth of the plant species and climatic factors of Mt. Halla, Jeju island, Korea, from 1912 to

1999. The result of their analyses showed that the growth of *A. koreana* was very poor and that the decline appeared to be related to the winter temperature rise since mid-1970s. However, insect pests of *A. koreana* have been poorly investigated and have never been considered as serious threats to the species. In Korea, only some species of *Zeiraphera* in Tortricidae (Lepidoptera) were recorded to feed on *Abies* spp. (Shin and Byun 2016), but there has been no report of any tortricid pest on *A. koreana* to date.

In July 2014, damaged cones of Korean fir were found from Mt. Halla, Jeju, Korea. The damage could often be seen from the survey sites and appeared to be caused by insect pests, judging by granulated excrements from punctures on scales of the cones. Many species of Tortricidae are known to harm the species of *Abies* worldwide, but none of them is recorded as a pest of Korean fir (Brown et al 2008). In Korea, one pyralid moth was known to harm Korean firs (Bae et al 2008).

In the present study, the identification of the insect pests, damage on the cones, and damage rate are presented and discussed.

## Materials and methods

Surveys were made at three sites on Mt. Halla, Jeju Island, South Korea, in August and October 2014 and at two sites on Mt. Halla and Mt. Deogyu in August 2015 (Figure 1, Table 1). Healthy and damaged cones (Figure 2) of *A. koreana* within five of  $5 \times 5$  m

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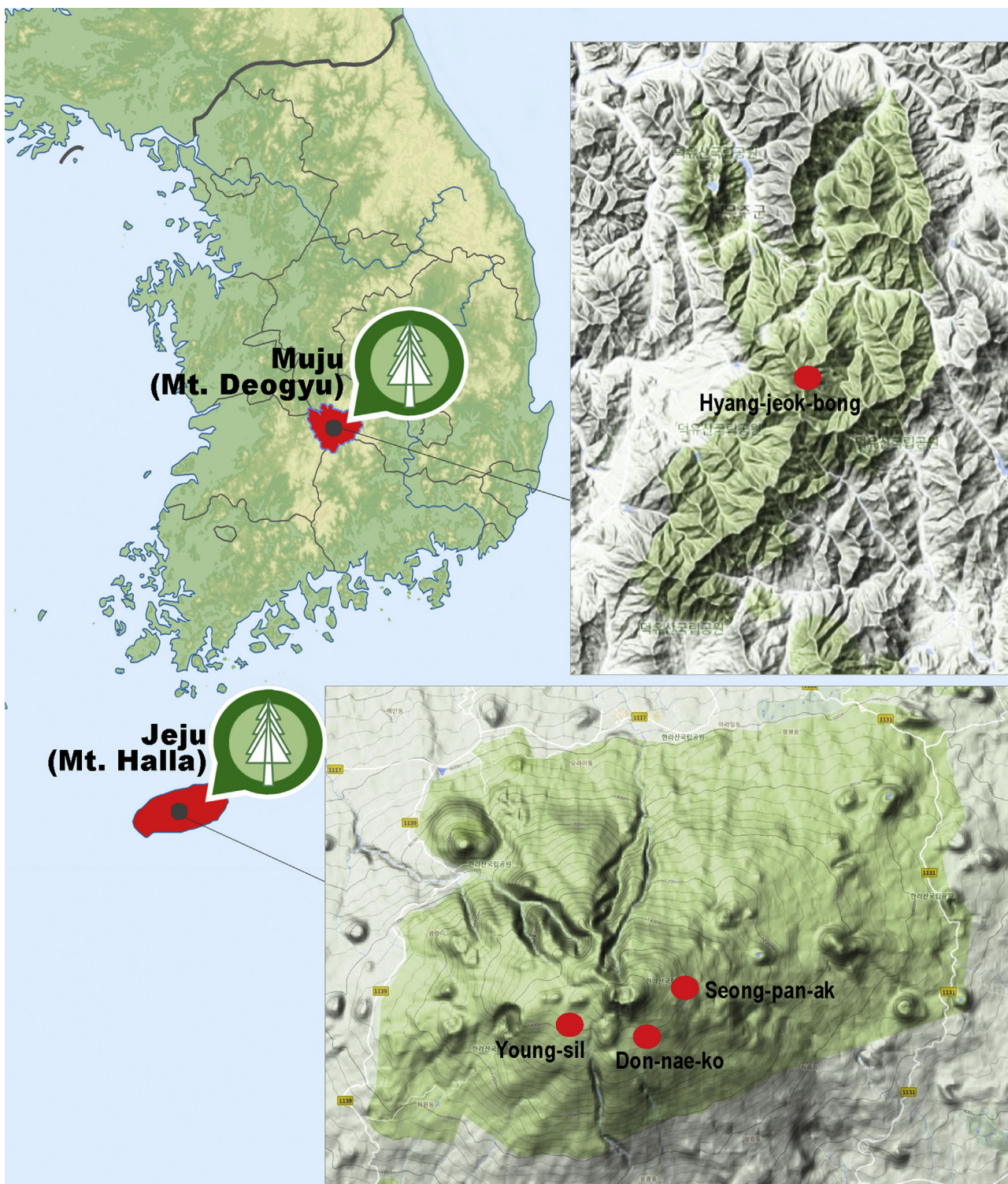


Figure 1. Survey sites on Mt. Halla, Jeju and Mt. Deogyu, Muju in South Korea.

quadrats were counted with binoculars to determine the damage rate from the survey sites. However, many cones fell completely or only cone axes remained after shedding seeds in October 2014. Therefore, we only managed to count damaged and crooked strobili (with damaged scales or puncture wounds) if cones were still intact with scales (Figure 3A) and crooked cone axes if only cone axes remained without scales (Figure 3B). In addition, we

evaluated the relation between *A. koreana* cones and environmental variables. These variables included elevation, tree height, and tree diameter at breast height. The evaluated relation was analyzed using correlation analysis by the program IBM SPSS Statistics, version 22 (SPSS, Inc., Chicago, IL, USA).

The damaged cones were collected in sealable plastic bags and kept in the laboratory at room temperature to rear the insect pests.

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