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Original article

Butterfly fauna in Mount Gariwang-san, Korea

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ABSTRACT

The aim of this study is to elucidate butterfly fauna in Mt. Gariwang-san, Korea. A field survey was conducted from 2010 to 2015 using the line transect method. A literature survey was also conducted. A total of 2,037 butterflies belonging to 105 species were recorded. In the estimation of species richness of butterfly, 116 species were estimated to live in Mt. Gariwang-san. In butterfly fauna in Mt. Gariwang-san, the percentage of northern species was very high and the percentage of grassland species was relatively higher than that of forest edge species and forest interior species. Sixteen red list species were found. In particular, *Mimathyma nycteis* was only recorded in Mt. Gariwang-san. When comparing the percentage of northern species and southern species including those recorded in previous studies, the percentage of northern species was found to have decreased significantly whereas that of southern species increased. We suggest that the butterfly community, which is distributed at relatively high altitudes on Mt. Gariwang-san, will gradually change in response to climate change.

Introduction

Mt. Gariwang-san is an alpine region located inland of Gangwon-do where natural broad-leaved forests are relatively widely developed, and the flora is diverse as soil conditions are favorable (Kim and Um 1997). In flora in Mt. Gariwang-san, *Quercus mongolica* is dominant, and coniferous forests including *Pinus densiflora*, *Abies nephrolepis*, *Abies holophylla*, and *Taxus cuspidata* are partially dominant (Paik et al 1998). In 2006 and 2008, some areas of Mt. Gariwang-san, covering a total of 2,462 ha, were designated as forest genetic resource reserves and are protected by the Korea Forest Service (Daejeon, Korea). The National Institute of Forest Science (NIFoS; Seoul, Korea) has been conducting various forest management practices such as reforestation, forest road development, thinning, and shelterwood forest (Lee et al 2014). A comprehensive study to evaluate the response of the forest ecosystem to the effect of these forest management practices is being carried out in Mt. Gariwang-san (NiFoS Project).

Biological indicators are widely used to assess biodiversity. These indicators can illustrate the effect of forest management on the function and structure of forest ecosystems (Pearce and Venier 2006; Maleque et al 2009). In particular, insects are often used to assess the biodiversity in forest ecosystems (Kwon et al 2013; Lee and Kwon 2014; Lee et al 2014). Among insects, butterflies are considered a good indicator because of their high diversity, short generation, good movement, host preference, and sensitivity to environment changes (Lee and Kwon 2012, 2014; Kwon et al 2014; Lee et al 2015). Moreover, butterflies can be reliably identified using the line transect method in the field (Pollard and Yates 1993).

In this study, literature (Kim 1988) and field (2010–2015) surveys were conducted to elucidate butterfly fauna in Mt. Gariwang-san. Species richness was evaluated, and distribution pattern, habitat type, and red list species were analyzed. In addition, the relationship between latitude and percentage of northern and southern species was analyzed including those reported in previous studies.

Materials and methods

Study site

The study was carried out in Mt. Gariwang-san (1,561 m, 37°27′ N, 128°33′ E) and Mt. Jungwang-san (1,371 m, 37°46′ N, 128°56′ E), which are located in Gangwon-do, Korea (Figure 1). Mt. Gariwang-san is located on the boundary of Jeongseon-eup in Jeongseon-gun

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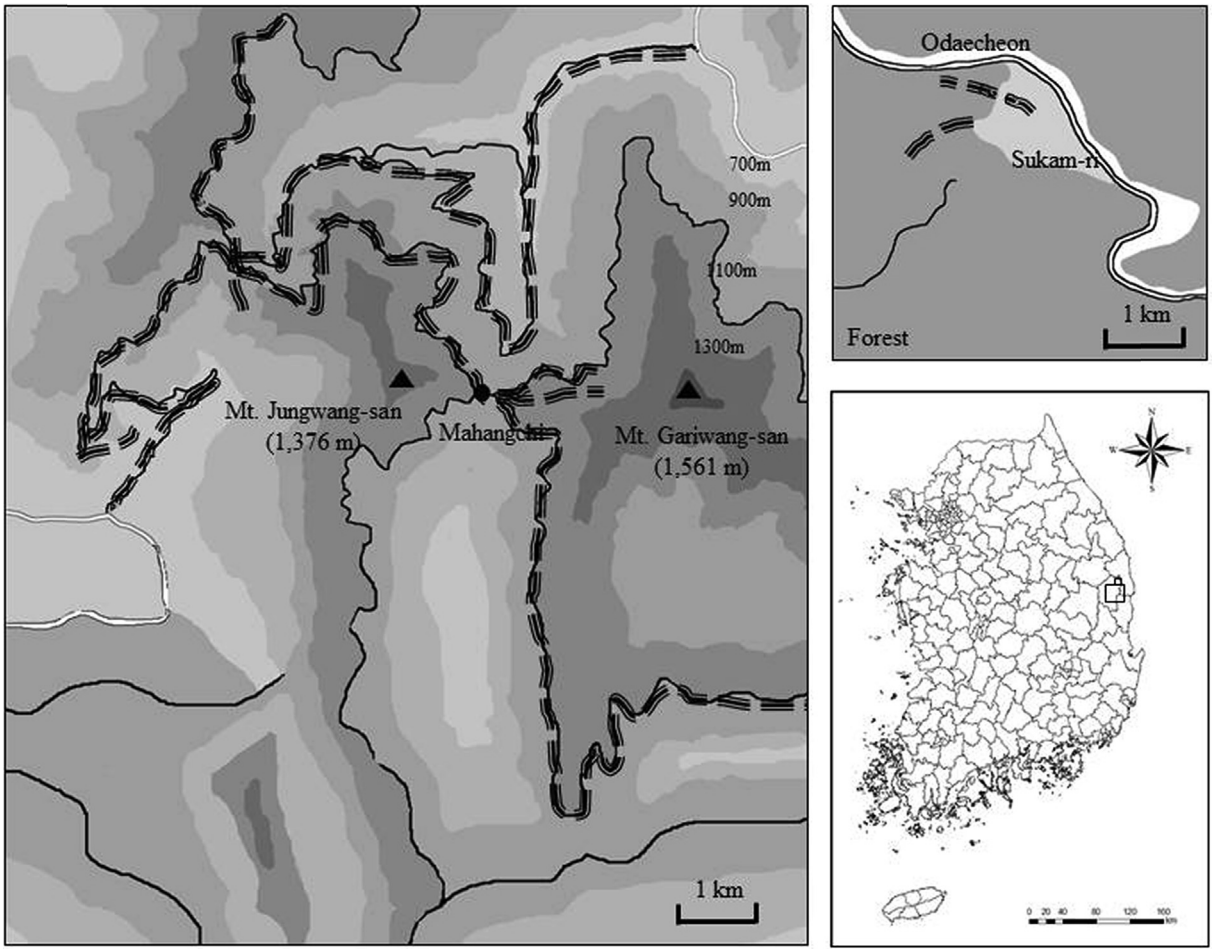

Figure 1. Map showing the location of the site. Black and dotted lines indicate forest road and line transect route, respectively.

and Jinbu-myeon in Pyeongchang-gun. Mt. Jungwang-san is in the west of Mt. Gariwang-san. In terms of vegetation, *Q. mongolica* is dominant and *Betula costata*, *Acer mono*, and *Ulmus laciniata* are partially dominant (Lee et al 2009). The average annual temperature and rainfall in Mt. Gariwang-san are 9.7° and 1,761.4 mm, respectively (Byeon et al 2012).

Survey method

In terms of survey methods, a literature survey (Kim 1988) and CM Lee's 2012–2013 field data and SS Kim's 2010–2015 field data were used. Kim (1988) collected butterflies, and Lee and Kim used the line transect method (Pollard and Yates 1993). The line transect method was carried out by steadily walking along the survey routes and recording the butterflies observed within a 10 m width along the routes. The butterflies that we could not identify by sight were caught using sweep nets and then released after identification. Kim's (1988) survey was conducted on July 24–26, 1987, whereas CM Lee's survey was conducted on June 4–6, 2012 (Haanmi-ri–log cabin on the ridge–Jangjeon Valley) and July 30–August 1, 2013 (Makdong Valley–log cabin on the ridge–Sukam-ri). SS Kim conducted a series of surveys at forest roads from May to August in 2010 and 2011 (once a month), and at forest roads and mountain roads from May to October in 2012–2015 (once a month). These surveys were conducted a total of 55 times.

Distribution pattern, habitat type, and red list species

The butterfly species were classified with their distribution pattern, habitat type, and red list species. The distribution pattern was determined based on the local distributions in Korea, Japan, and East Asia. Distribution pattern was classified into three types: northern species (hereafter N species), southern species (S species), and miscellaneous species (M species). Habitat type was classified based on the habitat of butterfly larva. The butterfly species were classified into three types: grassland (GL), forest edge (FE), and forest interior (FI) species. If a species occupied more than one habitat, the habitat recorded for it was the more frequently used habitat. Distribution pattern and habitat type based on all butterfly species in South Korea were reported by Kim et al (2012). The classification of red list species was based on the red data book of endangered insects in Korea I (National Institute of Biological Resources 2012). Red list species were classified as critically endangered (CR), endangered (EN), vulnerable (VU), or near-threatened species (NT).

Data analysis

The species richness of butterflies was estimated using Estimate S (Colwell 2005) based on four algorithms of ACE (Chao et al 1993; Chazdon et al 1998), Chao 1 (Chao 1984), Jack 1 (Burnham and