Quantitative data from six years (2013-2018) of light trap sampling of macromoths (Lepidoptera) in Mt. Hallasan National Park, South Korea

Sei-Woong Choi‡, Sang-Hyeon Na‡
‡ Mokpo National University, Muan, South Korea

Corresponding author: Sei-Woong Choi (choisw@mokpo.ac.kr)
Academic editor: Rodolphe Rougerie
Received: 26 Feb 2020 | Accepted: 06 Apr 2020 | Published: 07 Apr 2020
Citation: Choi S-W, Na S-H (2020) Quantitative data from six years (2013-2018) of light trap sampling of macromoths (Lepidoptera) in Mt. Hallasan National Park, South Korea. Biodiversity Data Journal 8: e51490. https://doi.org/10.3897/BDJ.8.e51490

Abstract

Background

This paper presents the results of long-term monitoring of macromoth communities in Mt. Hallasan National Park, South Korea. This mountain shows an altitudinal gradient of vegetation from evergreen deciduous to boreal trees, harbouring more than 550 species of vascular plants. The goal of this project was to investigate the changes in moth assemblages along the altitudinal gradient in this mountain ecosystem. We monitored macromoth communities at 11 sites in Mt. Hallasan National Park from 2013 to 2018, during which time moths were collected once a month from May to October, using an ultraviolet bucket trap. The generated dataset, which represented 587 species and 13,249 individuals from 14 families, can be adopted to establish a baseline for development of a network-orientated database to assess temporal and spatial changes of moths in temperate and tropical forests.
New information

This is the first long-term sampling-event dataset on macromoth assemblages in changing vegetation from evergreen deciduous to boreal tree zones, conducted in Mt. Hallasan National Park, the national park at the highest elevation and located on the largest volcanic island in South Korea. The aim of this study was to provide a description and a link to published data in the format of a peer-reviewed journal and to provide recognition of the effort in a scholarly article (based on data paper definition published at https://www.gbif.org/en/data-papers).

Introduction

Island ecosystems are self-maintaining entities with well-defined geographical limits and are the combined products of geography (area, latitude, altitude, isolation), ecology (geology, biotope availability, history, land use and management), biology (mobility, colonisation capability, presence of organisms) and time. Thus, island biota are considered ‘individuals’ carrying unique information regarding complex interactions amongst biological, geographical and historical factors (Vitousek et al. 1995, Lomolino et al. 2010Dapporto and Dennis 2008). However, a number of difficulties, inherent to examining biological diversity and ecosystem functioning on islands, exist due to the less diverse and disharmonious ecosystems and the varying degree of anthropogenic alteration (Vitousek et al. 1995). Montane species on islands are often endemic to a single mountain range and are vulnerable to climate change because they tend to occur in small populations, isolated from other source populations, climatically restricted and limited from moving to higher elevations upon reaching the summit of the mountain (Meyer et al. 2015).

Lepidoptera are one of the mega-diversity insect groups, comprised of more than 160,000 species that play important roles as herbivores and pollinators in terrestrial ecosystems. They also act as a food source for birds and bats and a vital linkage in the food chain between plants and higher trophic organisms. Due to their diversity, easy sampling with a light trap and known habitat associations, moths are considered one of the most suitable insect groups for assessing species diversity against changes in landscape change and management (Alison et al. 2017, Dirzo et al. 2014, Hallmann et al. 2019, Kamikura and Sakata 2019, Kitching et al. 2000, Macgregor et al. 2016, Summerville et al. 2004).

The aim of this study was to investigate the diversity and changes in macromoth communities at 11 sites in Mt. Hallasan National Park, South Korea, over a period of six years (2013-2018). We sampled macromoths to monitor their long-term changes in an island’s mountain ecosystem. The elevational gradient along Mt. Hallasan National Park has resulted in vertical stratification of vegetation zones from boreal to evergreen deciduous, producing a unique biodiversity pattern (Kang 2006, Kong 2007). Elevation gradients on mountains have the potential to enhance our understanding of the impact of climate change on biological communities. Thus, the diversity and distribution of montane
species will be a baseline for development of a network-orientated database to assess species responses to climate change in temperate and tropical forests.

**Project description**

**Title:** Long-term monitoring of macromoths in the southern mountains of South Korea

**Personnel:** Sei-Woong Choi and Sang-Hyeon Na

**Study area description:** Mt. Hallasan National Park (highest peak 1,950 m above sea level, total area 149 km²), one of South Korea’s 22 National Parks, is located on the nation’s largest volcanic island, Jeju-do (126°09’42”–126°56’57” E, 33°11’27”–33°33’50” N, 1,825 km², Fig. 1). The annual average temperature of Jeju-do Island is 5.3-10.9°C in areas more than 600 m above sea level and 15.2–16.2°C in coastal areas and the annual precipitation is 2,968-4,746 mm in areas more than 600 m above sea level and 1,095-1,851 mm in coastal areas (Kang 2006).

![Figure 1. Map of the survey sites in Mt. Hallasan, Jeju-do, South Korea.](image)

The vegetation on Mt. Hallasan is comprised of four zones: alpine zone (> 1,800 m a.s.l.), subalpine zone (1,500–1,800 m), temperate deciduous tree zone (400–1,500 m) and evergreen deciduous tree zone (600 m in the southern aspect and 400 m in the northern aspect) (Kong 2007). The alpine zone is characterised by dwarf trees (*Taxus cuspidata* Sieb. & Zucc., *Betula ermani* Chamisso) and shrubs (*Diapenis lapponica* var. *obovata* F. Schmidt, *Vaccinium uliginosum* L., *Emetrum nigrum* var. *japonicum* L. Koch., *Juniperus chinensis* var. *sargentii* Henry, *Rhododendron mucronulatum* var. *cliatum* Nakai). The subalpine zone is characterised by conifers (*Abies koreana* Wilson, *Taxus cuspidata* Sieb. & Zucc.) and deciduous trees (*Betula ermani* Chamisso). The temperate deciduous tree zone is covered with deciduous trees, such as *Quercus serrata* Thunb., *Q. acuta* Thunb., *Q. glauca* Thunb., *Carpinus laxiflora* (Sieb. & Zucc.) Blume, *C. tschonoskii* Maxim., *Acer palmatum* Thunb., *Daphniphyllum mucronatum* Miq. and *Castanopsis cuspidata* var. *siebildii* Nakai. Evergreen deciduous trees, such as *Cinnamomum camphora* Sieb., *Machilus thunbergii* Sieb. & Zucc., *Quercus myrsinaefolia* Bl. and *Camellia japonica* L., are
commonly observed at low altitudes. About 550 species of vascular plants are distributed on Mt. Hallasan amongst 1,800 plants found on Jeju-do Island (Kong 2007).

**Funding:** National Research Foundation of Korea (2018R1D1A1B07046637)

## Sampling methods

**Study extent:** Geographic coverage: Survey areas for collecting moths comprised evergreen deciduous and subalpine tree zones (Table 1)

### Table 1.

| Site Code | Local site name | Elevation | Latitude (N) | Longitude (E) | Vegetation          |
|-----------|-----------------|-----------|--------------|---------------|---------------------|
| JJ_1      | HRR (L)         | 278 m     | 33°18'57.0"  | 126°37'09.9"  | Evergreen           |
| JJ_2      | HRR (H)         | 525 m     | 33°19'56.7"  | 126°36'25.7"  | Evergreen           |
| JJ_3      | SPA (H)         | 752 m     | 33°22'14.0"  | 126°37'31.6"  | Temperate deciduous |
| JJ_4      | CWS             | 673 m     | 33°24'36.1"  | 126°29'43.3"  | Temperate deciduous |
| JJ_5      | SPA (L)         | 645 m     | 33°23'06.7"  | 126°37'16.0"  | Temperate deciduous |
| JJ_6      | YS (L)          | 963 m     | 33°19'57.6"  | 126°27'52.6"  | Temperate deciduous |
| JJ_7      | ERM             | 954 m     | 33°23'31.6"  | 126°29'13.0"  | Temperate deciduous |
| JJ_8      | 1100top         | 1109 m    | 33°21'32.1"  | 126°27'44.4"  | Temperate deciduous |
| JJ_9      | SJB             | 1410 m    | 33°22'32.2"  | 126°29'58.8"  | Subalpine           |
| JJ_10     | YS (H)          | 1630 m    | 33°21'31.3"  | 126°30'29.1"  | Subalpine           |
| JJ_11     | USOR            | 1699 m    | 33°21'43.5"  | 126°31'10.0"  | Subalpine           |

**Sampling description:** Sampling method: An ultraviolet light bucket trap, consisting of a 22 Watt ultraviolet circline light tube with a 12 V battery (BioQuip Co., USA), was employed to collect moths at each survey site. Moth sampling was conducted for five hours after dusk. To minimise sampling bias, we sampled moths simultaneously at all 11 sites. Traps were emptied the morning after collection and insects were brought to the lab for identification. Moths were identified at species level using taxonomic literature (Kim et al. 2001, Kononenko et al. 1998, Shin 2001, Kim et al. 2016). Vouchers of collected specimens were deposited in the collection of the Laboratory of Environmental Education, Mokpo National University, South Korea.

## Geographic coverage

**Description:** Survey areas for collecting moths comprised evergreen deciduous and subalpine tree zones
Coordinates: 33-18 and 33-24 Latitude; 126-37 and 126-27 Longitude.

Taxonomic coverage

Description: Macromoths targeted for this study comprised the moth families that traditionally fall under the category of macrolepidoptera (Kristensen and Skalski 1999), plus two easily identified microlepidoptera families: Bombycidae, Drepanidae, Erebidae, Geometridae, Noctuidae, Nolidae, Notodontidae, Limacodidae, Lasiocampidae, Sphingidae, Saturniidae, Thyrididae, Uraniidae and Zygaenidae.

Temporal coverage

Notes: We sampled moths once a month from May to October from 2013 to 2018.

Usage rights

Use license: Creative Commons Public Domain Waiver (CC-Zero)

Data resources

Data package title: Six years of data (2013-2018) of macromoths (Lepidoptera) in Mt. Hallasan National Park, Republic of Korea

Resource link: https://datadryad.org/stash/share/wdwhCjEWJ7yNQXzuwHcN48O45pG0taTvyyf4SbRnhY

Number of data sets: 3

Data set name: Data_Jejudo_taxaa

Character set: UTF-8

Data format: csv

| Column label     | Column description                                                                 |
|------------------|------------------------------------------------------------------------------------|
| ID               | ID number                                                                          |
| Taxon            | Species name used in data file (Data-Jejudodata.csv)                                |
| Family           | Family name for each species                                                       |
| Species in full name | Genus, species, author and publication year                                         |

Data set name: Data_Jejudodata.csv

Character set: UTF-8
Data format: csv

| Column label          | Column description                  |
|-----------------------|-------------------------------------|
| Site                  | Eleven survey site code             |
| Site code             | Site abbreviation                   |
| Date                  | Collection date (yyyy-mm-dd)        |
| Taxon                 | Species                             |
| Number of individuals | Number of individuals collected      |

Data set name: Data_Jejudo_site_information

Character set: UTF-8

Data format: csv

| Column label                          | Column description                                           |
|---------------------------------------|--------------------------------------------------------------|
| Site code                             | Eleven survey site code                                      |
| Site abbreviation in English          | Site abbreviation for site code                              |
| Elevation (m)                         | Elevation above sea level for each survey site               |
| Latitude (N)                          | Geographic latitude (WG84)                                   |
| Longitude (E)                         | Geographic longitude (WG84)                                  |
| Vegetation type                       | Dominant vegetation type for each survey site                |

Additional information

Suppl. material 1: The total number of moths collected at 11 sites on Mt. Hallasan represented 587 species and 13,249 individuals from 14 families. Amongst the sites surveyed, the total number of species was highest at site JJ_4 (293 species) and the total number of individuals was highest at site JJ_3 (2738 individuals) (Table 2, Table 3).

Table 2.

| Site   | Number of families | Number of species | Number of individuals |
|--------|--------------------|-------------------|----------------------|
| JJ_1   | 12                 | 221               | 814                  |
| JJ_2   | 12                 | 206               | 922                  |
| JJ_3   | 13                 | 248               | 2,738                |
Table 3.
Yearly summary of numbers of species and individuals collected from 2013 to 2018 in Mt. Hallasan National Park, South Korea.

| Year | Number of families | Number of species | Number of individuals |
|------|--------------------|-------------------|-----------------------|
| 2013 | 12                 | 243               | 1,526                 |
| 2014 | 11                 | 254               | 2,255                 |
| 2015 | 11                 | 236               | 2,037                 |
| 2016 | 13                 | 248               | 1,671                 |
| 2017 | 12                 | 315               | 2,996                 |
| 2018 | 13                 | 330               | 2,764                 |
| Total| 14                 | 587               | 13,249                |

Figure 2. Number of moth species in each family collected from 11 sites in Mt. Hallasan National Park from 2013 to 2018.
The family Geometridae was dominant in the total number of species (33%) and in the total number of individuals (42%) (Figs 2, 3). The three families, Geometridae, Erebidae, and Noctuidae, comprised most of the samples: 81.6% of the total species and 79.5% of the total individuals. On the other hand, moths of the Bombycidae and Zygaenidae families represented one and two species, respectively.

A geometrid species, *Alcis angulifera* was dominant with 1,618 individuals, occurring at all survey sites. In addition, five species *Hydrillodes morosa*, *Ghoria gigantean*, *Lomographa temerata*, *Idaea biselata* and *Diarsia pacifia* occurred at all survey sites.

**Acknowledgements**

We are grateful to all members of the Environmental Ecology Laboratory of Mokpo National University for their assistance in the field. We thank the editor and two anonymous reviewers for their constructive comments and suggestions. This study was supported by a grant from the National Research Foundation of Korea (2018R1D1A1B07046637).

**Author contributions**

Sei-Woong Choi conceived and designed the experiments, performed the field experiments, analysed the data, contributed reagents/materials/analysis tools, authored or reviewed drafts of the paper and approved the final draft.

Sang-Hyeon Na performed the field experiments, compiled the data, authored or reviewed drafts of the paper and approved the final draft.
References

- Alison J, Duffield S, Morecroft M, Marrs R, Hodgson J (2017) Successful restoration of moth abundance and species-richness in grassland created under agri-environment schemes. Biological Conservation 213: 51-58. https://doi.org/10.1016/j.biocon.2017.07.003
- Dapporto L, Dennis RH (2008) Species richness, rarity and endemcity on Italian offshore islands: complementary signals from island-focused and species-focused analyses. Journal of Biogeography 35 (4): 664-674. https://doi.org/10.1111/j.1365-2699.2007.01812.x
- Dirzo R, Young HS, Galetti M, Ceballos G, Isaac NJB, Collen B (2014) Defaunation in the Anthropocene. Science 345 (6195): 401-406. https://doi.org/10.1126/science.1251817
- Hallmann C, Zeegers T, Klink R, Vermeulen R, Wielink P, Spijkers H, Deijj J, Steenis W, Jongejans E (2019) Declining abundance of beetles, moths and caddisflies in the Netherlands. Insect Conservation and Diversity 13 (2): 127-139. https://doi.org/10.1111/icad.12377
- Kamikura M, Sakata Y (2019) Fauna of nocturnal moth species collected in a semi-natural grassland at Kanpu-zan in northern Japan. Biodiversity Data Journal 7: e37968. https://doi.org/10.3897/bdj.7.e37968
- Kang T (2006) Climate characteristics of Hallasan Natural Reserve. Report of survey and study of Hallasan Natural Reserve.
- Kim S, Beljaev E, Oh S (2001) Illustrated catalogue of Geometridae in Korea (Lepidoptera: Geometrinae, Ennominae). Korea Research Institute of Bioscience and Biotechnology & Center for Insect Systematics, Daejeon.
- Kim S, Choi S, Sohn J, Kim T, Lee B (2016) The Geometridae of Korea (Lepidoptera: Geometridae). Junghangsa, Seoul.
- Kitching RL, Orr AG, Thalib L, Mitchell H, Hopkins MS, Graham AW (2000) Moth assemblages as indicators of environmental quality in remnants of upland Australian rain forest. Journal of Applied Ecology 37 (2): 284-297. https://doi.org/10.1046/j.1365-2664.2000.00490.x
- Kong W (2007) Biogeography of Korean plants. Geobook, Seoul.
- Kononenko V, Ahn S, Ronkay L (1998) Illustrated catalogue of Noctuidae in Korea (Lepidoptera). KRIBB & CIS, Daejeo.
- Kristensen N, Skalski A (1999) Phylogeny and Palaeontology. In: Kristensen N (Ed.) Lepidoptera, Moths and Butterflies. Vol. 1. Evolution, systematic and biogeography. Walter de Gruyter, Berlin, 7-25 pp.
- Lomolino M, Brown J, Sax D (2010) Island biogeography theory. In: Losos J, Ricklefs R (Eds) The theory of island biogeography revisited. Princeton University Press, Princeton, 13-51 pp. https://doi.org/10.1515/9781400831920.13
- Macgregor C, Evans D, Fox R, Pocock MO (2016) The dark side of street lighting: impacts on moths and evidence for the disruption of nocturnal pollen transport. Global Change Biology 23 (2): 697-707. https://doi.org/10.1111/gcb.13371
- Meyer W, Eble J, Franklin K, McManus R, Brantley S, Henkel J, Marek P, Hall WE, Olson C, McInroy R, Bernal Loaiza E, Brusca R, Moore W (2015) Ground-dwelling arthropod communities of a Sky Island Mountain Range in Southeastern Arizona, USA:
Obtaining a baseline for assessing the effects of climate change. PLOS One 10 (9): e0135210. https://doi.org/10.1371/journal.pone.0135210

• Shin Y (2001) Coloured illustrations of the moths of Korea. Academybook, Seoul.
• Summerville KS, Ritter LM, Crist TO (2004) Forest moth taxa as indicators of lepidopteran richness and habitat disturbance: a preliminary assessment. Biological Conservation 116 (1): 9-18. https://doi.org/10.1016/s0006-3207(03)00168-x
• Vitousek P, Adsersen H, Loope L (1995) Introduction. In: Vitousek P, Loope L, Adsersen H (Eds) Islands: biological diversity and ecosystem function. Springer, Berlin, 1-6 pp. https://doi.org/10.1007/978-3-642-78963-2_1

Supplementary material

Suppl. material 1: Six years of data (2013-2018) of macromoths (Lepidoptera) in Mt. Hallasan National Park, Republic of Korea doi

Authors: Choi, SW, Na, SH
Data type: occurrences
Download file (41.57 kb)