BioOne COMPLETE

Seasonal Trends of Forest Moth Assemblages in Central Hokkaido, Northern Japan

Authors: Sayama, Katsuhiko, Ito, Masato, Tabuchi, Ken, Ueda, Akira, Ozaki, Kenichi, et al.

Source: The Journal of the Lepidopterists' Society, 66(1) : 11-26

Published By: The Lepidopterists' Society

URL: https://doi.org/10.18473/lepi.v66i1.a2

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Journal of the Lepidopterists' Society
66(1), 2012, 11–26

SEASONAL TRENDS OF FOREST MOTH ASSEMBLAGES IN CENTRAL HOKKAIDO, NORTHERN JAPAN

KATSUHIKO SAYAMA
Hokkaido Research Center, Forestry and Forest Products Research Institute, Sapporo 062-8516, Japan; email: sayama@ffpri.affrc.go.jp

MASATO ITO
Hokkaido Research Center, Forestry and Forest Products Research Institute, Sapporo 062-8516, Japan

KEN TABUCHI
Hokkaido Research Center, Forestry and Forest Products Research Institute, Sapporo 062-8516, Japan; current address: National Agricultural Research Center for Tohoku Region, Morioka 020-0198, Japan

AKIRA UEDA
Kyushu Research Center, Forestry and Forest Products Research Institute, Kurokami, Kumamoto 860-0862, Japan.

KENICHI OZAKI
Hokkaido Research Center, Forestry and Forest Products Research Institute, Sapporo 062-8516, Japan

AND

TERUHIKO HIRONAGA
The Hokkaido University Museum, Sapporo 060-0810, Japan; current address: Regional Environmental Planning Inc. Kyushu branch, Fukuoka 814-0006, Japan

ABSTRACT. Seasonal trends of adult moth assemblages were investigated using portable light traps in a cool-temperate region in central Hokkaido, northern Japan. Light traps were set at monthly intervals from April to December 2005 in five stands. Seasonal changes in the numbers of species and individuals in each stand were unimodal with a peak in summer (July or August). The value of a similarity index between samples from successive months in each stand was always low, indicating that species composition changed greatly between successive months. Based on the seasonal occurrence of 248 species, the mean occurrence period in each species was only 1.8 months. Among these species, 91.5% were estimated to be univoltine and only 8.5% were estimated to be multivoltine. Most species occurred in the summer (July and/or August), although some occurred only in the spring or autumn. Thus, in the present study the high species turnover of adult moths during the active season was due to the short occurrence period of each species, which may be associated at least in part with univoltinism, synchronized adult eclosion, and short life spans of adult moths.

Additional key words: black light trap, life history, night-flying moth, phenology, seasonal occurrence.

Moths comprise one of the most diverse insect groups in forest ecosystems. About 140,000 species have been identified throughout the world (New 2004) and more than 5000 species are listed in Japan (Sugi 2000). Such high diversity of moths may be maintained by plant diversity (e.g. Neuvonen & Niemelä 1981) and plant architecture (Lawton 1983). In addition to this impressive diversity, moths are easily collected with light traps that are widely recognized as the standard tool for sampling night-flying moths (Southwood & Henderson 2000).

In forest ecosystems, moths are mostly herbivores in their larval stage and are thus particularly sensitive to environmental changes that affect plant quality and quantity as their diets. On the other hand, moths are an important food resource for other animals and their abundance affects the population dynamics of animals in higher trophic levels. Because of their pivotal role in maintaining biodiversity in forest ecosystems, moths are generally regarded as useful indicator taxa for monitoring insect biodiversity and habitat disturbance caused naturally or artificially in tropical and temperate

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

forests (Hammond & Miller 1998; Usher & Keiller 1998; Kitching et al. 2000; Summerville et al. 2004).

Seasonal patterns of larval moth assemblages have been investigated in relation to foliage quality, weather conditions and natural enemies (Feeny 1970; Niemelä & Haukioja 1982; Yoshida 1985; Butler & Strazanac 2000; Summerville et al. 2003; Murakami et al. 2005). However, only a few studies have focused on seasonal patterns of adult moth assemblages (Yoshida 1980; Yela & Herrera 1993; Butler et al. 2001). For example, Yoshida (1980) investigated seasonal fluctuations of species richness, abundance and diversity index of adult moth communities at four forest stands in Hokkaido, northern Japan. Yela & Herrera (1993) studied seasonal patterns of species richness and abundance of noctuid moths in Mediterranean mixed forests. However, few studies have investigated seasonal occurrence in each species except for pest species.

In temperate regions, moth assemblages consist of seasonal progressions of the occurrences of different species. The timing and duration of flight periods of adult moths depend on the various life history traits of each species, such as overwintering stage, voltinism (the number of generations per year), adult life span, and immature growth rate (Wolda 1988). These traits may be further influenced by weather conditions (e.g. temperature, precipitation and day-length) and availability of host-plants (e.g. quantity and quality). For example, Hunter & McNeil (1997) revealed effects of host-plant quality on diapause induction and subsequent voltinism in a tortricid moth.

In the present study, we investigated seasonal trends of night-flying moth assemblages in a cool-temperate region to contribute information about the regional moth diversity of Hokkaido. For this purpose, we sampled adult moths using portable light traps because light traps are useful tools to quantify the moth communities (Southwood & Henderson 2000). Using data collected from these traps, we estimated flight duration and voltinism of major species.

MATERIALS AND METHODS

The study was conducted from April to December 2005, which covers almost the entire season of adult moth flight, in five stands of three different forest types located in Sapporo, central Hokkaido, northern Japan (42°53′–43°00′N, 141°22–26′E; 150–400 m a.s.l.). Study stands, which were always more than 10 ha in size and located more than 1 km apart, consisted of two deciduous broadleaved forests at Hitsujigaoka and Mizunenosawa, two larch (*Larix kaempferi* Carr.) plantations at Shimomitaki (42 years old) and Mt. Yagyu (47 years old), and a Todo-fir (*Abies sachalinensis* Masters) plantation at Mt. Yagyu (48 years old). We used these forest types because these are the most common forest types in the cool-temperate region in Hokkaido. The deciduous broadleaved forests were dominated by linden (*Tilia japonica* Simonkai), cucumber tree (*Magnolia obovata* Thunb.), oak (*Quercus crispula* Blume), and maple (*Acer mono* Maxim.). Forest floors in the study stands were more or less covered with bamboo grasses (*Sasa kurilensis* (Rupr.) Makino et Shibata).

We used portable light traps developed by Okochi (2002). This trap was equipped with a 6 W black (ultraviolet) light fluorescent tube powered by a 9 V alkaline battery made up of six 1.5 V cells. The light lasted about 12 h per night. Every month we set two light traps in each stand on a night around the new moon (nine nights in total). Trapping nights were chosen to avoid rain and snow. The two traps were hung at a height of approximately 1.5 m at fixed locations, which were located 100 m apart in the central part of each stand. Early the next morning, moths caught in the traps were killed with ethyl acetate, preserved in a refrigerator, and at a later date identified to species. We used scientific names of moths in Inoue et al. (1982) and changes after Inoue et al. (1982) followed Sugi (2000), Sugi & Jinbo (2004) and Jinbo (2004–2008). In the following analysis, individuals identified to species (67–85% of sampling individuals in each stand) were used. Unidentified individuals were those with either extensive wing wear or from microlepidopteran moths (e.g. Tortricidae). All voucher specimens in this study were deposited in the collection of Hokkaido Research Center, Forestry and Forest Products Research Institute.

For seasonal trends of moth assemblages, the number of species, the number of individuals, and the Pielou's index (J') for evenness were calculated for each trap and expressed as the averages of the two traps in each stand. Pielou's index (J') was calculated as follows:

$$J' = \frac{-\sum_i p_i \ln p_i}{\ln S}$$

where p_i is the proportion of individuals found in the ith species and S is the total number of species. Similarity indices (C_λ) between samples from successive months in each trap were also calculated and averaged in each stand to quantify the seasonal

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

changes in species composition. A similarity index (C_λ) was calculated as follows:

$$C_\lambda = \frac{2\sum_{i=1}^{S} n_{1i} \cdot n_{2i}}{(\lambda_1 + \lambda_2)N_1 \cdot N_2}$$

$$\lambda_1 = \frac{\sum_{i=1}^{S} n_{1i}(n_{1i} - 1)}{N_1(N_1 - 1)}, \quad \lambda_2 = \frac{\sum_{i=1}^{S} n_{2i}(n_{2i} - 1)}{N_2(N_2 - 1)}$$

where n_{1i} and n_{2i} are the numbers of individuals in the ith species and N_1 and N_2 are the total numbers of individuals in samples 1 and 2, which are collected from successive months, respectively. S is the total number of species. The value of C_λ is 0 when two samples have no common species and is nearly 1 when two samples are identical (Morisita 1959).

The seasonal occurrence of each moth species was examined for the species in which a total of at least 10 individuals were collected. The mean duration of occurrence in each species was calculated from the number of months in which each species was collected. This value indicates an occurrence of moths based on the assumption that the flight period of a moth species was one month for a moth species that was sampled in one trapping date since we conducted a monthly sampling. Voltinism (univoltine or multivoltine) of these species was estimated based on the following criteria. We assigned a species to multivoltine if the species was (1) collected in discontinuous sampling months, (2) collected in more than two sampling months and had two peaks in their occurrence or (3) collected in more than three sampling months. The other species were assigned to univoltine. The estimated voltinisms were compared with the voltinisms reported for the same species in eastern Hokkaido (Iijima 1990). Iijima (1990) assigned 12 species to partial bivoltine (basically univoltine with a partial second generation only in favorable seasons), but these species were excluded from the present analysis.

RESULTS

Seasonal changes in species diversity and species composition. A total of 14,591 adult moths, consisting of 693 species in 29 families, was collected and identified in the five study stands. No moths were collected in December. The number of species was greatest in Geometridae followed by Noctuidae (Table 1). Seasonal changes in the mean number of species in each stand were unimodal with a peak in July or August (Fig. 1). Seasonal changes in the mean number of individuals in each stand were also unimodal with a peak in August, except in the larch plantation at Mt. Yagyu where a peak occurred in July (Fig. 2). This peak was due to the high abundance of two dominant arctiids, *Ghoria collitoides* Butler and *Eilema cribrata* (Staudinger) in this month. On the other hand, mean evenness (J') showed a weak declining

TABLE 1. Numbers of species and individuals of forest moths collected in five stands in Sapporo in 2005.

Family	No. of species	No. of individuals
Incurvariidae	3	5
Tortricidae	46	638
Tineidae	3	15
Gracillariidae	1	1
Yponomeutidae	9	32
Argyresthiidae	1	1
Oecophoridae	4	14
Lecithoceridae	3	9
Gelechiidae	6	9
Carposinidae	1	3
Zygaenidae	1	3
Limacodidae	5	32
Pyralidae	67	969
Pterophoridae	1	1
Drepanidae	6	279
Thyatiridae	13	88
Geometridae	206	4684
Epiplemidae	2	8
Lasiocampidae	9	282
Bombycidae	2	20
Brahmaeidae	1	7
Saturniidae	6	224
Sphingidae	8	201
Notodontidae	51	899
Lymantriidae	11	644
Arctiidae	26	2763
Nolidae	7	55
Noctuidae	193	2703
Agaristidae	1	2
Total	693	14,591

Families were listed according to the taxonomic order adopted in Inoue et al. (1982)

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

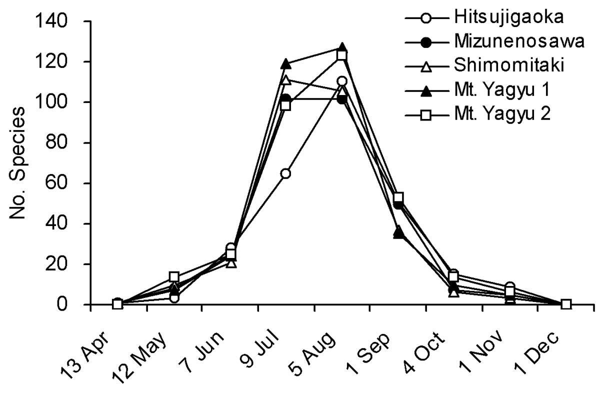

FIG. 1. Seasonal changes in the number of adult moth species in five stands in deciduous broadleaved forests (Hitsujigaoka, Mizunenosawa), larch plantations (Shimomitaki, Mt. Yagyu 1), and a Todo-fir plantation (Mt. Yagyu 2) in Sapporo, 2005. Values show the averages of two traps in each stand.

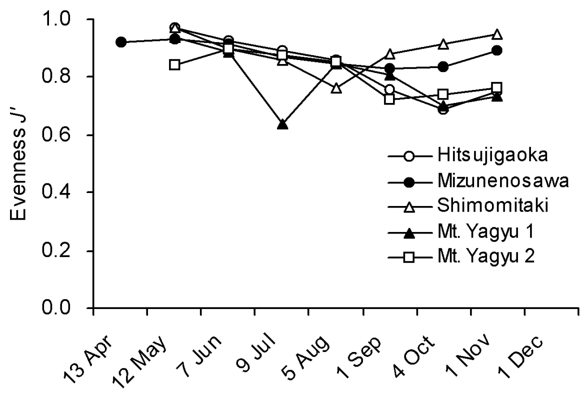

FIG. 3. Seasonal changes in evenness (Pielou's J') of adult moth assemblages in five stands in deciduous broadleaved forests (Hitsujigaoka, Mizunenosawa), larch plantations (Shimomitaki, Mt. Yagyu 1), and a Todo-fir plantation (Mt. Yagyu 2) in Sapporo, 2005. Values show the averages of two traps in each stand.

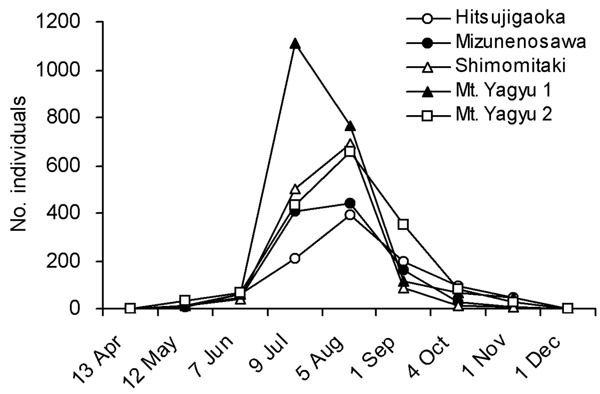

FIG. 2. Seasonal changes in the number of adult moth individuals in five stands in deciduous broadleaved forests (Hitsujigaoka, Mizunenosawa), larch plantations (Shimomitaki, Mt. Yagyu 1), and a Todo-fir plantation (Mt. Yagyu 2) in Sapporo, 2005. Values show the averages of two traps in each stand.

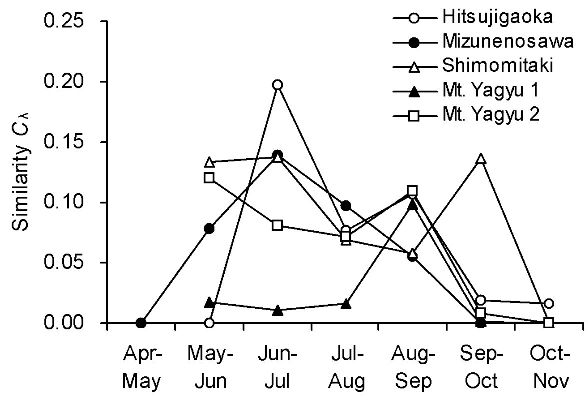

FIG. 4. Seasonal changes in the value of similarity index (C_λ) of adult moth assemblages between samples from successive months in five stands in deciduous broadleaved forests (Hitsujigaoka, Mizunenosawa), larch plantations (Shimomitaki, Mt. Yagyu 1), and a Todo-fir plantation (Mt. Yagyu 2) in Sapporo, 2005. Values show the averages of two traps in each stand.

trend as the season progressed, except in the larch plantation at Shimomitaki (Fig. 3). In the larch plantation at Mt. Yagyu, the lowest mean evenness was observed in July when two dominant noctuids, *Aventiola pusilla* (Butler) and *Mimachrostia fasciata* Sugi occupied 11.3% and 8.5% of the abundance, respectively. In the larch plantation at Shimomitaki, the lowest mean evenness was observed in August when two dominant arctiids, *Ghoria collitoides* and *Eilema cribrata* comprised 36.5% and 14.3% of the total abundance of moths, respectively.

Mean similarity indices (C_λ) between samples from successive months in each stand were always low (less than 0.2) (Fig. 4), although the indices fluctuated differently in each stand. The low similarity indices indicate that species composition changed greatly between successive months.

Seasonal occurrence of each moth species. At least 10 individuals were collected from 248 species in five stands (Appendix 1). These species were listed in order of the increasing mean occurrence period, which was calculated from the average of sampling months weighted by the number of individuals collected in each month. Each species was collected within a short period. The mean duration of occurrence in each species was 1.8 months (range 1–4 months), and 90 species (36.3%) were collected in only one month. Among the 248 species, 14 species (5.6%) were collected only in spring (from April to June; Appendix 1). On the other hand, 25 species

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

(10.0%) occurred only in autumn (from September to November; Appendix 1). Especially, some geometrid winter moths occurred only in November (Appendix 1).

Of the 248 species, 227 species (91.5%) were assigned to univoltine and only 21 species (8.5%) were assigned to multivoltine (Appendix 1). Eleven of the multivoltine species were geometrids. Voltinisms estimated for 156 species (90.2%) were similar to the voltinisms reported for the same species in Iijima (1990), in which 148 species were classified as univoltine and 25 species were classified as bivoltine. There were only a few differences in the two studies: 14 species estimated to be univoltine were bivoltine in Iijima (1990), and three species estimated to be multivoltine were univoltine in Iijima (1990).

Discussion

The present study shows that seasonal changes in the numbers of species and individuals of adult moths were markedly unimodal with a peak in summer (July or August) (Fig.1, 2). Yoshida (1980) also found that the numbers of species and individuals were greatest in July or August in a deciduous broadleaved natural forest and a larch plantation in the Tomakomai Experimental Forest of Hokkaido University, which is located about 60 km from Sapporo. However, Yoshida (1980) showed multimodal seasonal patterns with peaks in summer and autumn in the number of individuals in a deciduous broadleaved secondary forest and a Todo-fir plantation. The peak abundance in autumn is probably caused by some dominant species that were extremely abundant that autumn (Yoshida 1980). Hirao et al. (2006) collected adult moths in a deciduous broadleaved forest at the same locality as Yoshida (1980) and reported that July possessed the highest number of species and individuals. These studies suggest that a unimodal seasonal pattern with a peak in summer (July or August) is a general trend for species richness and abundance in adult moth assemblages in the cool-temperate region of central Hokkaido. This information is critical to determine efficient sampling periods in a future study and provides a useful basis for comparative studies with other regions.

In contrast to the unimodal seasonal pattern reported here, seasonal changes in the number of species of adult moths in a mixed deciduous forest in southern Korea were bimodal with peaks in June and August (Choi 2008). In mixed hardwood forests in North America, no clear peak was detected in the number of species, although the number of individuals was highest between March and June (Landau et al. 1999) or in July and early August (Butler et al. 2001). In Mediterranean mixed forests, abundance and diversity of adult noctuid moths were markedly bimodal with two distinct peaks, in early summer (mid-July) and in early autumn (late September to early October) (Yela & Herrera 1993). These studies demonstrate that seasonal trends of adult moth assemblages vary widely among regions. This difference may reflect different climate conditions among regions because climate variables are often important factors influencing moth abundance and diversity (Yela & Herrera 1993).

Seasonal changes of larval moth communities in forests have also been studied as an alternative measure of moth activity in forest ecosystems (Yoshida 1985; Yela & Herrera 1993; Butler & Strazanac 2000). Yoshida (1985) showed that the number of species and individuals of macrolepidopterous larvae on oak trees had two peaks, in June (spring) and August (summer). Butler & Strazanac (2000) sampled lepidopteran larvae at oak-dominated Appalachian forests from May to mid-August and showed that the numbers of species and individuals of larvae were higher in May and August. Yela & Herrera (1993) showed that the frequency of occurrence of noctuid larvae exhibited a distinct peak in the first half of June. Yela & Herrera (1993) also suggested that the duration of the pupal stage might affect the difference in the occurrence pattern between larvae and adults as a result of life history strategies adapted to the hot and dry summer season in Mediterranean habitats. This suggests that seasonal occurrence patterns of adults do not correspond to those of larvae.

The value of evenness (J') showed a decreasing trend as the season progressed except in the larch plantation at Shimomitaki (Fig. 3). In central Hokkaido, Yoshida (1980) also found that a relative diversity index, which is equivalent to evenness, decreased with season in deciduous broadleaved forests, a larch plantation, and a Todo-fir plantation, although the value of the index fluctuated considerably. These findings suggest either that dominant species occupy a relatively larger part of moth assemblages or that there are a large number of rare species in autumn.

Most (90.2%) of the voltinisms estimated in the present study were consistent with the voltinisms recorded in eastern Hokkaido (Appendix 1; Iijima 1990). In addition, more than 90% of the species were assigned to univoltine, suggesting that the univoltine life cycle is predominant for moths in Hokkaido. This may be caused by the relatively short growth period in the cool-temperate region in Hokkaido. For the species estimated to be univoltine in the present study but bivoltine by Iijima (1990), it is possible that we were simply unable to detect multivoltinism using our monthly sampling intervals. For the species estimated to be multivoltine in the present study but univoltine by Iijima (1990), these

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

species may be univoltine only in eastern Hokkaido where temperatures are relatively low in comparison to central Hokkaido. Further studies are needed to clarify the voltinism of these species.

Low values of the similarity index (C_λ) between samples from successive months (Fig. 4) show that species composition changed greatly between successive months. In a deciduous broadleaved forest in central Hokkaido, Hirao et al. (2006) also found that species composition of adult moth communities was distinctly partitioned into each month. These high species turnovers were due to the short occurrence period (1.8 months on average in the present study) of each species. For moth species to have short occurrence periods, species are likely to have a univoltine life history, synchronized adult eclosion, and short life spans for adult moths. In cool-temperate regions, relatively shorter growing season may result in one generation per year. General life expectancy of adult moths is assumed to be from one to three weeks (Zborowski & Edwards 2007), although we could not find any field studies that examined life span of adult moths. Similar life history traits seem to be common in moths because many moths have well-defined and characteristic periods of seasonal activity and, particularly in temperate regions, may fly for only short periods (New 2004).

ACKNOWLEDGEMENTS

We thank Mrs. Y. Korenaga for making light traps and Dr. R. Johns for critically reviewing the manuscript. We also thank Greenery Promotion Department, Environment Bureau of the City of Sapporo and National Agricultural Research Center for Hokkaido Region for permission to sample moths. This study was supported by a Grant-in-Aid for Scientific Research (No. 19380094).

LITERATURE CITED

BUTLER, L. & J. STRAZANAC. 2000. Occurrence of Lepidoptera on selected host trees in two central Appalachian national forests. Ann. Entomol. Soc. Am. 93: 500–511.

BUTLER, L., V. KONDO & J. STRAZANAC. 2001. Light trap catches of Lepidoptera in two central Appalachian forests. Proc. Entomol. Soc. Wash. 103: 879–902.

CHOI, S.-W. 2008. Effects of weather factors on the abundance and diversity of moths in a temperate deciduous mixed forest of Korea. Zool. Sci. 25: 53–58.

FEENY, P. 1970. Seasonal changes in oak leaf tannins and nutrients as a cause of spring feeding by winter moth caterpillars. Ecology 51: 565–581.

HAMMOND, P. C. & J. C. MILLER. 1998. Comparison of the biodiversity of Lepidoptera within three forested ecosystems. Ann. Entomol. Soc. Am. 91: 323–328.

HIRAO, T., M. MURAKAMI, H. KOGI, A. KASHIZAKI, Y. HIRAI, S. TANABE, N. INARI, H. YOROZUYA & M. J. TODA. 2006. International Biodiversity Observation Year in Western-Pacific and Asian regions (DIWPA-IBOY): a case report on species rarity and spatio-temporal variability of species composition in Lepidoptera and Coleoptera communities from a temperate forest of northern Japan. Ecol. Res. 21: 811–818.

HUNTER, M. D. & J. N. MCNEIL. 1997. Host-plant quality influences diapause and voltinism in a polyphagous insect herbivore. Ecology 78: 977–986.

IIJIMA, K. 1990. Moths in Shibecha-cho. Bull. Shibecha-cho Fork Mus. 5: 1–94. (In Japanese)

INOUE, H., S. SUGI, H. KUROKO, S. MORIUTI, A. KAWABE & M. OWADA. 1982. Moths of Japan. Kodansha, Tokyo. 968 pp. (Vol. 1), 556 pp. + 392 pls. (Vol. 2) (In Japanese)

JINBO, U. 2004–2008. List-MJ: A checklist of Japanese moths. [database on the Internet]. Available from URL: http://listmj.mothprog.com/.

KITCHING, R. L., A. G. ORR, L. THALIB, H. MITCHELL, M. S. HOPKINS & A. W. GRAHAM. 2000. Moth assemblages as indicators of environmental quality in remnants of upland Australian rain forest. J. Appl. Ecol. 37: 284–297.

LANDAU, D., D. PROWELL & C. E. CARLTON. 1999. Intensive versus long-term sampling to assess Lepidopteran diversity in a southern mixed mesophytic forest. Ann. Entomol. Soc. Am. 92: 435–441.

LAWTON, J. H. 1983. Plant architecture and the diversity of phytophagous insects. Ann. Rev. Entomol. 28: 23–39.

MORISITA, M. 1959. Measuring of interspecific association and similarity between communities. Mem. Fac. Sci. Kyushu Univ. Ser. E (Biol.) 3: 65–80.

MURAKAMI, M., K. YOSHIDA, H. HARA & M. J. TODA. 2005. Spatio-temporal variation in Lepidopteran larval assemblages associated with oak, *Quercus crispula*: the importance of leaf quality. Ecol. Entomol. 30: 521–531.

NEUVONEN, S. & P. NIEMELÄ. 1981. Species richness of Macrolepidoptera on Finnish deciduous trees and shrubs. Oecologia 51: 364–370.

NEW, T. R. 2004. Moths (Insecta: Lepidoptera) and conservation: background and perspective. J. Insect Conserv. 8: 79–94.

NIEMELÄ, P. & E. HAUKIOJA. 1982. Seasonal patterns in species richness of herbivores: Macrolepidopteran larvae on Finnish deciduous trees. Ecol. Entomol. 7: 169–175.

OKOCHI, I. 2002. A new portable light trap for moth collection. Bull. Forestry Forest Prod. Res. Inst. 1: 231–234. (In Japanese with English summary)

SOUTHWOOD, T. R. E. & P. A. HENDERSON. 2000. Ecological methods. 3rd ed. Blackwell Science Ltd, Oxford. xvi + 575 pp.

SUGI, S. 2000. Additions of species and changes in names of Japanese moths since the publication of 'Moths of Japan' by H. Inoue et al. (1982) Edition 2. The Japan Heterocerists' Society, Tokyo. xii + 171 pp. (In Japanese)

SUGI, S. & U. JINBO. 2004. Additions of species and changes in names of Japanese moths since the publication of 'Moths of Japan' by H. Inoue et al. (1982) Supplement 1 to Edition 2. The Japan Heterocerists' Society, Tokyo. ii + 60 pp. (In Japanese)

SUMMERVILLE, K. S., L. M. RITTER & T. O. CRIST. 2004. Forest moth taxa as indicators of lepidopteran richness and habitat disturbance: a preliminary assessment. Biol. Conserv. 116: 9–18.

SUMMERVILLE, K. S., T. O. CRIST, J. K. KAHN & J. C. GERING. 2003. Community structure of arboreal caterpillars within and among four tree species of the eastern deciduous forest. Ecol. Entomol. 28: 747–757.

USHER, M. B. & S. W. J. KEILLER. 1998. The macrolepidoptera of farm woodlands: determinants of diversity and community structure. Biodiv. Conserv. 7: 725–748.

WOLDA, H. 1988. Insect seasonality: why? Ann. Rev. Ecol. Syst. 19: 1–18.

YELA, J. L. & C. M. HERRERA. 1993. Seasonality and life cycles of woody plant-feeding noctuid moths (Lepidoptera: Noctuidae) in Mediterranean habitats. Ecol. Entomol. 18: 259–269.

YOSHIDA, K. 1980. Seasonal fluctuation of moth community in Tomakomai Experimental Forest of Hokkaido University. Res. Bull. Coll. Exptl. For. Coll. Agric. Hokkaido Univ. 37: 675–685.

———. 1985. Seasonal population trends of Macrolepidopterous larvae on oak trees in Hokkaido, northern Japan. Kontyû 53: 125–133.

ZBOROWSKI, P. & T. EDWARDS. 2007. A guide to Australian moths. CSIRO Publishing, Collingwood. x + 214 pp.

Received for publication 14 April 2010; revised and accepted 5 March 2011.

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Seasonal occurrence of adult moth species in which at least 10 individuals were collected in Sapporo in 2005.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
1	*Lithophane plumbealis* (Matsumura)	Noctuidae	1	16							17	U
2	*Odontosia sieversii japonibia* Matsumura	Notodontidae		15							15	U
3	*Perigrapha hoenei* Püngeler	Noctuidae		37	2						39	U
4	*Orthosia gothica jezoensis* (Matsumura)	Noctuidae		13	6						19	U
5	*Cerastis pallescens* (Butler)	Noctuidae		5	7						12	U
6	*Eupithecia clavifera* Inoue	Geometridae		6	19						25	U
7	*Pseuderannis lomozemia* (Prout)	Geometridae		1	16						17	U
8	*Eupithecia daemionata* Dietze	Geometridae		1	18						19	U
9	*Ellida arcuata* (Alphéraky)	Notodontidae			20						20	U
10	*Lassaba nikkonis* (Butler)	Geometridae			20						20	U
11	*Phyllodesma japonicus japonicus* (Leech)	Lasiocampidae			14						14	U
12	*Nola confusalis* (Herrich-Schäffer)	Nolidae			13						13	U
13	*Cusiala stipitaria stipitaria* (Oberthür)	Geometridae			10						10	U
14	*Trichopteryx hemana* (Butler)	Geometridae			10						10	U
15	*Paradarisa consonaria* (Hübner)	Geometridae			56	4					60	U
16	*Chlorissa inornata* (Matsumura)	Geometridae			11	4					15	U
17	*Cleora insolita* (Butler)	Geometridae			9	4					13	U
18	*Plagodis dolabraria* (Linnaeus)	Geometridae			10		2				12	M
19	*Togepteryx velutina* (Oberthür)	Notodontidae			12	8					20	U
20	*Marumba jankowskii* Oberthür	Sphingidae			22	41					63	U
21	*Spilosoma punctarium* (Stoll)	Arctiidae			4	27					31	U
22	*Hydrillodes morosus* (Butler)	Noctuidae			18	127					145	U
23	*Ptilodon jezoensis* (Matsumura)	Notodontidae			1	9					10	U
24	*Aethalura ignobilis* (Butler)	Geometridae			5	53					58	U
25	*Xerodes rufescentaria* (Motschulsky)	Geometridae			19	187	2				208	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
26	*Stauropus fagi persimilis* Butler	Notodontidae			2	12	1				15	U
27	*Chytonix subalbonotata* Sugi	Noctuidae			1	35					36	U
28	*Calliteara pseudabietis* Butler	Lymantriidae			2	36	1				39	U
29	*Hypomecis punctinalis conferenda* (Butler)	Geometridae			1	70					71	U
30	*Parectropis similaria japonica* Sato	Geometridae				95					95	U
31	*Archips nigricaudana* (Walsingham)	Tortricidae				95					95	U
32	*Paracolax albinotata* (Butler)	Noctuidae				75					75	U
33	*Pheosiopsis cinerea* (Butler)	Notodontidae			4	55	4				63	U
34	*Ellida viridimixta* (Bremer)	Notodontidae			10	39	10				59	U
35	*Heterarmia costipunctaria* (Leech)	Geometridae				56					56	U
36	*Leptostegna tenerata* Christoph	Geometridae				54					54	U
37	*Lomaspilis marginata amurensis* (Hedemann)	Geometridae				51					51	U
38	*Apamea hampsoni* Sugi	Noctuidae				49					49	U
39	*Tortrix sinapina* (Butler)	Tortricidae				48					48	U
40	*Phthonosema tendinosarium* (Bremer)	Geometridae				43					43	U
41	*Hyperstrotia flavipuncta* (Leech)	Noctuidae				31					31	U
42	*Lomographa bimaculata subnotata* (Warren)	Geometridae				30					30	U
43	*Parapsestis argenteopicta* (Oberthür)	Thyatiridae				29					29	U
44	*Protoboarmia faustinata* (Warren)	Geometridae				28					28	U
45	*Idaea invalida invalida* (Butler)	Geometridae				26					26	U
46	*Scopula duplinupta* Inoue	Geometridae				24					24	U
47	*Electrophaes corylata granitalis* (Butler)	Geometridae				19					19	U
48	*Menophra senilis* (Butler)	Geometridae				18					18	U
49	*Cabera purus* (Butler)	Geometridae				18					18	U
50	*Gandaritis maculata* (Swinhoe)	Geometridae				18					18	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
51	*Olethreutes moderatus* (Falkovitsh)	Tortricidae				18					18	U
52	*Protoboarmia simpliciaria* (Leech)	Geometridae				17					17	U
53	*Eana argentana* (Clerck)	Tortricidae				16					16	U
54	*Archips audax* Razowski	Tortricidae				16					16	U
55	*Prometopus flavicollis* (Leech)	Noctuidae				12					12	U
56	*Chytonix albonotata* (Staudinger)	Noctuidae				11					11	U
57	*Rabtala cristata* (Butler)	Notodontidae				11					11	U
58	*Euplexia koreaeplexia* Bryk	Noctuidae				10					10	U
59	*Eustroma aerosum* (Butler)	Geometridae				10					10	U
60	*Ghoria collitoides* Butler	Arctiidae				920	1				921	U
61	*Eilema cribrata* (Staudinger)	Arctiidae				347	3				350	U
62	*Actias aliena sjoeqvisti* Bryk	Saturniidae				106	1				107	U
63	*Idaea imbecilla* (Inoue)	Geometridae				136		1			137	M
64	*Callambulyx tatarinovii gabyae* Bryk	Sphingidae				33	1				34	U
65	*Taeniophora unio* (Oberthür)	Geometridae				32	1				33	U
66	*Ghoria gigantea gigantea* (Oberthür)	Arctiidae				83	3				86	U
67	*Torigea straminea* (Moore)	Notodontidae				23	1				24	U
68	*Scopula floslactata claudata* (Prout)	Geometridae				43	2				45	U
69	*Zanclognatha helva* (Butler)	Noctuidae				17	1				18	U
70	*Microcalicha sordida* (Butler)	Geometridae				17	1				18	U
71	*Marumba gaschkewitschii echephron* (Boisduval)	Sphingidae				82	5				87	U
72	*Leucodonta bicoloria* (Denis et Schiffermüller)	Notodontidae			1	14	2				17	U
73	*Spilarctia seriatopunctata seriatopunctata* (Motschulsky)	Arctiidae				115	8				123	U
74	*Hypomecis roboraria displicens* (Butler)	Geometridae				39	3				42	U
75	*Shaka atrovittatus* (Bremer)	Notodontidae				26	2				28	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
76	*Perinephela lancealis pryeri* Munroe et Mutuura	Pyralidae				24	2				26	U
77	*Mimopydna pallida* (Butler)	Notodontidae				12	1				13	U
78	*Moma alpium* (Osbeck)	Noctuidae				23	2				25	U
79	*Agathia carissima carissima* Butler	Geometridae				30	3				33	U
80	*Cabera exanthemata insulata* Inoue	Geometridae				28	3				31	U
81	*Lomographa temerata* (Denis et Schiffermüller)	Geometridae			1	34	5				40	U
82	*Tethea ampliata ampliata* (Butler)	Thyatiridae				9	1				10	U
83	*Herminia tarsicrinalis* (Knoch)	Noctuidae				16		1			17	M
84	*Panthea coenobita idea* Bryk	Noctuidae				20	3				23	U
85	*Spilonota eremitana* Moriuti	Tortricidae				60	10				70	U
86	*Hexafrenum leucodera* (Staudinger)	Notodontidae				30	5				35	U
87	*Hydrelia sylvata* (Denis et Schiffermüller)	Geometridae				15	3				18	U
88	*Ptycholomoides aeriferana* (Herrich-Schäffer)	Tortricidae				64	7	3			74	U
89	*Anacronicta nitida* (Butler)	Noctuidae				84	20				104	U
90	*Gandaritis whitelyi whitelyi* (Butler)	Geometridae				8	2				10	U
91	*Eilema okanoi* Inoue	Arctiidae				35	10				45	U
92	*Syntypistis cyanea cyanea* (Leech)	Notodontidae			18	16	33				67	U
93	*Koyaga falsa* (Butler)	Noctuidae				15	8				23	U
94	*Abraxas sylvata microtate* Wehrli	Geometridae				12	8				20	U
95	*Archips ingentana* (Christoph)	Tortricidae				7	5				12	U
96	*Phthonosema invenustarium* (Leech)	Geometridae				22	16				38	U
97	*Semidonta biloba* (Oberthür)	Notodontidae				16	12				28	U
98	*Euproctis piperita* Oberthür	Lymantriidae				25	19				44	U
99	*Ectropis crepuscularia* (Denis et Schiffermüller)	Geometridae			26	1	68				95	M
100	*Geometra dieckmanni* Graeser	Geometridae				15	7	2			24	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
101	*Habrosyne dieckmanni roseola* Matsumura	Thyatiridae				7	6				13	U
102	*Belciades niveola* (Motschulsky)	Noctuidae				14	13				27	U
103	*Zaranga permagna* (Butler)	Notodontidae			2	6	13				21	U
104	*Fusapteryx ladislai* (Oberthür)	Notodontidae				5	6				11	U
105	*Nomis albopedalis* Motschulsky	Pyralidae				73	88				161	U
106	*Barsine pulchera* (Butler)	Arctiidae				15	19				34	U
107	*Herminia grisealis* (Denis et Schiffermüller)	Noctuidae				24	2	9			35	M
108	*Paracolax fascialis* (Leech)	Noctuidae				29	39				68	U
109	*Sphrageidus similis* (Fuessly)	Lymantriidae				46	69	3			118	U
110	*Crambus perlellus* (Scopoli)	Pyralidae				4	8				12	U
111	*Laciniodes denigratus ussuriensis* Prout	Geometridae				5	7	1			13	U
112	*Chrysoteuchia diplogramma* (Zeller)	Pyralidae				3	7				10	U
113	*Euthrix potatoria bergmani* (Bryk)	Lasiocampidae				44	90	3			137	U
114	*Jodis lactearia* (Linnaeus)	Geometridae				4	10				14	U
115	*Miltochrista miniata rosaria* Butler	Arctiidae				87	220				307	U
116	*Tyloptera bella bella* (Butler)	Geometridae				9	23				32	U
117	*Epodonta lineata* (Oberthür)	Notodontidae			3	2	19	1			25	M
118	*Holocryptis nymphula* (Rebel)	Noctuidae				20	4	11			35	M
119	*Nerice davidi* Oberthür	Notodontidae				3	9				12	U
120	*Dendrolimus superans* (Butler)	Lasiocampidae				7	24				31	U
121	*Hemithea aestivaria* (Hübner)	Geometridae				5	19				24	U
122	*Microphalera grisea* Butler	Notodontidae			7	2	14	10			33	M
123	*Hadennia incongruens* (Butler)	Noctuidae				2	10				12	U
124	*Endropiodes abjectus abjectus* (Butler)	Geometridae			6		70				76	M
125	*Olethreutes pryeranus* (Walsingham)	Tortricidae				6	35				41	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
						Sampling Date						
126	*Nerice bipartita* Butler	Notodontidae				3	18				21	U
127	*Hagapteryx admirabilis* (Staudinger)	Notodontidae				5	32				37	U
128	*Selenia tetralunaria* (Hufnagel)	Geometridae			8		112				120	M
129	*Zanclognatha griselda* (Butler)	Noctuidae				3	23				26	U
130	*Notodonta albicosta* (Matsumura)	Notodontidae				1	9				10	U
131	*Scopula takao* Inoue	Geometridae				1	10				11	U
132	*Auzata superba superba* (Butler)	Drepanidae				2	8	1			11	U
133	*Brabira artemidora artemidora* (Oberthür)	Geometridae			3		41		1		45	M
134	*Meganola fumosa* (Butler)	Nolidae				3	34				37	U
135	*Gonoclostera timoniorum* (Bremer)	Notodontidae				3	37				40	U
136	*Chrysoteuchia distinctella* (Leech)	Pyralidae				20	77	12			109	U
137	*Hydrelia shioyana* (Matsumura)	Geometridae				1	13				14	U
138	*Peridea gigantea* Butler	Notodontidae				4	60				64	U
139	*Zanclognatha subgriselda* Sugi	Noctuidae				1	15				16	U
140	*Cnethodonta grisescens grisescens* Staudinger	Notodontidae				2	31				33	U
141	*Talanga quadrimaculalis* (Bremer et Grey)	Pyralidae				1	16				17	U
142	*Parasa sinica* Moore	Limacodidae				1	17				18	U
143	*Barsine aberrans askoldensis* (Oberthür)	Arctiidae				1	18				19	U
144	*Abraxas niphonibia* Wehrli	Geometridae				4	13	3			20	U
145	*Eilema japonica ainonis* (Matsumura)	Arctiidae				5	122				127	U
146	*Idiochlora ussuriaria* (Bremer)	Geometridae				1	30				31	U
147	*Sophta subrosea* (Butler)	Noctuidae				2	69				71	U
148	*Idaea effusaria* (Christoph)	Geometridae					246				246	U
149	*Lithosia quadra* (Linnaeus)	Arctiidae					223				223	U
150	*Mimachrostia fasciata* Sugi	Noctuidae					209				209	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
151	*Aventiola pusilla* (Butler)	Noctuidae					165				165	U
152	*Gynaephila maculifera* Staudinger	Noctuidae					127				127	U
153	*Eilema nankingica* (Daniel)	Arctiidae					115				115	U
154	*Omiodes tristrialis* (Bremer)	Pyralidae					67				67	U
155	*Hypomecis lunifera* (Butler)	Geometridae					60				60	U
156	*Idaea auricruda* (Butler)	Geometridae					59				59	U
157	*Cosmia pyralina* (Denis et Schiffermüller)	Noctuidae					56				56	U
158	*Pelosia angusta* (Staudinger)	Arctiidae					36				36	U
159	*Idaea foedata* (Butler)	Geometridae					32				32	U
160	*Cyana hamata hamata* (Walker)	Arctiidae					29				29	U
161	*Gandaritis agnes festinaria* (Christoph)	Geometridae					29				29	U
162	*Trachycera hollandella* (Ragonot)	Pyralidae					27				27	U
163	*Sypnoides hercules* (Butler)	Noctuidae					23				23	U
164	*Peridea graeseri* (Staudinger)	Notodontidae					23				23	U
165	*Asthena sachalinensis* (Matsumura)	Geometridae					22				22	U
166	*Oncocera semirubella* (Scopoli)	Pyralidae				1	20	1			22	U
167	*Sinibotys obliquilinealis* Inoue	Pyralidae					22				22	U
168	*Cosmia moderata* (Staudinger)	Noctuidae					21				21	U
169	*Pelosia noctis* (Butler)	Arctiidae					19				19	U
170	*Phlogophora aureopuncta* (Hampson)	Noctuidae					18				18	U
171	*Phthonandria atrilineata atrilineata* (Butler)	Geometridae					17				17	U
172	*Dimorphicosmia variegata* (Oberthür)	Noctuidae					16				16	U
173	*Melanaema venata venata* Butler	Arctiidae					16				16	U
174	*Malacosoma neustrium testaceum* (Motschulsky)	Lasiocampidae					16				16	U
175	*Archips fuscocupreanus* Walsingham	Tortricidae					16				16	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
176	*Cosmia camptostigma* (Ménétriès)	Noctuidae					15				15	U
177	*Arctornis l-nigrum ussuricum* Bytinski-Salz	Lymantriidae					15				15	U
178	*Sypnoides picta* (Butler)	Noctuidae					14				14	U
179	*Ivela ochropoda* (Eversmann)	Lymantriidae					13				13	U
180	*Rhyparioides nebulosa* Butler	Arctiidae					12				12	U
181	*Eupithecia gigantea* Staudinger	Geometridae					11				11	U
182	*Plemyria rubiginata japonica* Inoue	Geometridae					11				11	U
183	*Ancylolomia japonica* Zeller	Pyralidae					11				11	U
184	*Schrankia separatalis* (Herz)	Noctuidae					10				10	U
185	*Ceroprepes ophthalmicella* (Christoph)	Pyralidae					87	1			88	U
186	*Eilema griseola submontana* Inoue	Arctiidae					205	3			208	U
187	*Zanclognatha fumosa* (Butler)	Noctuidae				6	30	7			43	U
188	*Metabraxas clerica clerica* Butler	Geometridae					40	1			41	U
189	*Eulithis convergenata* (Bremer)	Geometridae					137	4			141	U
190	*Hupodonta lignea* Matsumura	Notodontidae					63	2			65	U
191	*Prodasycnemis inornata* (Butler)	Pyralidae					60	2			62	U
192	*Lobogonodes erectaria* (Leech)	Geometridae			4	9	18	19			50	M
193	*Paratalanta ussurialis* (Bremer)	Pyralidae					34	2			36	U
194	*Deileptenia ribeata* (Clerck)	Geometridae				26	236	43			305	U
195	*Pachista superans* (Butler)	Geometridae					15	1			16	U
196	*Eilema deplana pavescens* (Butler)	Arctiidae					38	3			41	U
197	*Chasminodes albonitens* (Bremer)	Noctuidae					19	3			22	U
198	*Lymantria monacha* (Linnaeus)	Lymantriidae					311	50			361	U
199	*Diarsia canescens* (Butler)	Noctuidae			8		1	10	5		24	M
200	*Oreta pulchripes* Butler	Drepanidae				28		42			70	M

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
201	*Palpita nigropunctalis* (Bremer)	Pyralidae				45	20	3	33		101	M
202	*Eulithis ledereri* (Bremer)	Geometridae				1	20	8			29	U
203	*Idaea biselata* (Hufnagel)	Geometridae				1	123	45			169	U
204	*Callidrepana palleola* (Motschulsky)	Drepanidae			9	1	106	73			189	M
205	*Hupodonta corticalis* Butler	Notodontidae					7	3			10	U
206	*Martania saxea* (Wileman)	Geometridae				16	4	35			55	M
207	*Eustroma melancholicum melancholicum* (Butler)	Geometridae				3	1	7			11	M
208	*Udea lugubralis* (Leech)	Pyralidae					13	9			22	U
209	*Gandaritis placida* (Butler)	Geometridae					21	16			37	U
210	*Geometra papilionaria subrigua* (Prout)	Geometridae					10	11			21	U
211	*Amphipyra schrenckii* Ménétriès	Noctuidae					11	16			27	U
212	*Asthena amurensis* (Staudinger)	Geometridae				2		8			10	M
213	*Morophaga bucephala* (Snellen)	Tineidae				2		8			10	M
214	*Hermonassa arenosa* (Butler)	Noctuidae					7	11			18	U
215	*Catocala dissimilis* Bremer	Noctuidae					6	14			20	U
216	*Cosmia unicolor* (Staudinger)	Noctuidae					4	11			15	U
217	*Sineugraphe bipartita* (Graeser)	Noctuidae					8	25			33	U
218	*Martania fulvida* (Butler)	Geometridae				2		25			27	M
219	*Chasminodes sugii* Kononenko	Noctuidae					37	220			257	U
220	*Garaeus specularis mactans* (Butler)	Geometridae					1	11			12	U
221	*Gandaritis fixseni* (Bremer)	Geometridae					1	26			27	U
222	*Triphaenopsis jezoensis* Sugi	Noctuidae					1	31			32	U
223	*Alcis medialbifera* Inoue	Geometridae						321			321	U
224	*Acleris dentata* (Razowski)	Tortricidae						126			126	U
225	*Chasminodes aino* Sugi	Noctuidae						92			92	U

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use

Appendix 1. Continued.

			Sampling Date									
	Species	Family	13 Apr	12 May	7 Jun	9 Jul	5 Aug	1 Sep	4 Oct	1 Nov	Total	Voltinism
226	*Patagoniodes nipponellus* (Ragonot)	Pyralidae						48			48	U
227	*Ilema eurydice* (Butler)	Lymantriidae						34			34	U
228	*Myrteta angelica* Butler	Geometridae						32			32	U
229	*Saturnia japonica japonica* (Moore)	Saturniidae						13			13	U
230	*Xestia efflorescens* (Butler)	Noctuidae						12			12	U
231	*Timandra recompta ovidius* (Bryk)	Geometridae						11			11	U
232	*Rhopobota naevana* (Hübner)	Tortricidae						11			11	U
233	*Gypsonoma dealbana* (Frölich)	Tortricidae						11			11	U
234	*Ypsolopha albistriatus* (Issiki)	Yponomeuti-dae					2	6	5		13	U
235	*Bombyx mandarina* (Moore)	Bombycidae						9	10		19	U
236	*Ramobia basifuscaria* (Leech)	Geometridae						5	86		91	U
237	*Daseochaeta viridis* (Leech)	Noctuidae						2	50		52	U
238	*Saturnia jonasii fallax* Jordan	Saturniidae							95		95	U
239	*Telorta edentata* (Leech)	Noctuidae							21		21	U
240	*Ramobia mediodivisa* Inoue	Geometridae							46	1	47	U
241	*Venusia phasma* (Butler)	Geometridae							159	4	163	U
242	*Epinotia rasdolnyana* (Christoph)	Tortricidae							12	1	13	U
243	*Erannis golda* Djakonov	Geometridae								70	70	U
244	*Poecilocampa tamanukii* Matsumura	Lasiocampi-dae								64	64	U
245	*Operophtera brumata* (Linnaeus)	Geometridae								51	51	U
246	*Erannis defoliaria gigantea* Inoue	Geometridae								26	26	U
247	*Larerannis orthogrammaria* (Wehrli)	Geometridae								16	16	U
248	*Operophtera relegata* Prout	Geometridae								11	11	U
	Total		1	94	438	4,922	5,475	1,604	523	244	13,301	

The number of individuals collected in five stands in each month is expressed. Species were listed in order of increasing mean occurrence period. To estimate voltinism (univoltine or multivoltine), we assigned a species to multivoltine if it was collected in discontinuous months, collected in more than two months and had two peaks in their occurrence pattern, or collected in more than three months. Voltinism: U, univoltine; M, multivoltine.

Downloaded From: https://bioone.org/journals/The-Journal-of-the-Lepidopterists'-Society on 18 Sep 2024
Terms of Use: https://bioone.org/terms-of-use