Fauna of nocturnal moth species collected in a semi-natural grassland at Kanpu-zan in northern Japan

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Abstract

Semi-natural grasslands, which house species-rich ecosystems, have rapidly declined since the twentieth century due to land-use practices, such as agricultural intensification and abandonment. Owing to their diversity and known habitat associations, nocturnal moths are considered as one of the most suitable organisms to be studied for assessing the dynamics of species composition as a result of changes in landscape management of semi-natural grasslands. The present study provides the foremost description of nocturnal moth fauna of the semi-natural grassland at Kanpu-zan, northern Japan. Moth population data from 1987 were compared to the data collected in 2018 to evaluate the impact of decline in grasslands on species-richness. During the field sampling in 2018, a total of 226 nocturnal moth species were detected, which was nearly two-thirds of the number of species recorded in 1987, i.e. 396 species. The values obtained in 2018 were found to be nearly constant for different sites. For both periods, it was evident that moth fauna in Kanpu-zan mainly consisted of species that relied on woody plants. Amongst the species which were only recorded in 1987, 107 species were generalists that fed on plants that are commonly distributed in Kanpu-zan. No moth species were recorded that depended upon endangered or extinct plant food sources. Thus, it is unlikely that the decline in the number of moth species in Kanpu-zan was due to the loss in plant food sources. Our results
suggest that environmental factors other than food plants may have caused decline and changes in nocturnal moth fauna. More studies on various organism fauna are needed for understanding the conservation of semi-natural grassland, considering that the loss of semi-natural grasslands is one of the major threats to biodiversity.

**Keywords**

arthropods, northern Japan, nocturnal moth, semi-natural grassland, species occurrences

**Introduction**

Semi-natural grasslands house species-rich ecosystems including regional meta-communities by specialists of open habitats (Emanuelsson 2008, Pykälä et al. 2005, Alison et al. 2017). The persistence of semi-natural grassland depends on anthropogenic activities, such as mowing, grazing and burning (Suka et al. 2012, Dengler et al. 2014, Ushimaru et al. 2018). Recent studies have shown that the grasslands may have persisted during the Holocene in a natural state due to natural disturbances and severe environmental conditions (Nakahama et al. 2018, Ohwaki 2018). However, these semi-natural grasslands have shown a continuous and rapid decline since the twentieth century due to changes in land-use practices such as agricultural intensification and abandonment (Donald et al. 2001, Eriksson et al. 2002, Koyanagi and Furukawa 2013). As a result, many grassland species, including insects feeding on grassland plants and those inhabiting grassland habitat, are presently endangered due to the scarcity of natural grasslands in these regions (Maes and Van Dyck 2001, Habel et al. 2013). There is an urgent need to understand the changes in grassland fauna due to human activities.

Nocturnal moths are an ecologically important group of insects that play a key role in herbivory and pollination. They act as a food source for birds as well as potential indicators of ecosystem change across a wide variety of landscapes (Kitching et al. 2000, Summerville and Crist 2004, Macgregor et al. 2016). Declines in moth populations have been linked to habitat loss and agricultural intensification (Wenzel et al. 2006, Merckx et al. 2012). Owing to their diversity and known habitat associations, nocturnal moths are considered as one of the most suitable study taxa for assessing species richness against the changes in landscape management of semi-natural grasslands (Erhardt and Thomas 1991, Wenzel et al. 2006; Alison et al. 2017).

Kanpu-zan, which is located in northern Japan, consists of semi-natural grasslands partly maintained by mowing and burning and accommodates many endangered grassland species (Akita Prefecture 2016). The region was a rich source of grassland resources as a livestock feed for farmers until the 1960s. However, the utilisation of the grassland, such as the grass harvest, gradually declined leading to succession by dense shrubs and trees from the 1970s as lifestyles changed. A study indicates that the grassland area, which was 319 ha in 1975, had decreased to 138 ha by 2014 (Masui et al. 2017). The prevalent plant
community varied depending on the management frequency and plant richness was lower in abandoned sites with reduced or diminished grassland species (Masui et al. 2017). Documentation of moth species in the region was conducted in 1987 before the grassland had severely declined (Takahashi 1993). However, the present status of moth fauna is largely unknown. This study presents the first account of nocturnal moths in Kanpu-zan after the decline in grasslands and presents a model for understanding the changes in moth fauna related to altered vegetation in grassland areas caused by changes in human activity. Uchida and Ushimaru (2014) compared plant richness and butterfly and orthopteran richness and diversity amongst three different land use types in semi-natural grasslands: abandoned, traditional and intensified terraces and suggested that the number of individuals of most herbivorous species decreased randomly with respect to life-history traits, following a decline in plant richness reflecting disturbance frequency. Due to the present plant flora being revealed in Kanpu-zan, this site provides a promising opportunity to understand the relationship between moth fauna and the land use of the grassland vegetation.

Materials and Methods

Study site

Surveys of nocturnal moths were carried out at Kanpu-zan during May to October in 2018, twice a month (12 nights in total), on clear nights from sunset to midnight. Three sites that differ in vegetation were selected: 1) grassland maintained by mowing once or twice a year (grassland site), 2) site where grassland management had been abandoned leading to overgrowth of shrubs and trees (forest site) and 3) mixed vegetation with both grassland and woody plants (mixed site) (Fig. 1). In 1987, the moths were collected during May to September, once or twice a month (6 nights in total) at one site in a grassland dominated by tall grass such as *Miscanthus sinensis*, where shrubs and hedgerow trees were interspersed (Takahashi 1993).

Sampling methods

Moths were collected using UV light traps, equipped with a 20 W black (ultraviolet) light fluorescent tube. One light trap was set at each site. The same method was used in 1987 (Takahashi 1993). All collected specimens were dried at room temperature and mounted for morphological examination. All moths were identified to species level by M. Kamikura and K. Umetsu using descriptions and photos in the book "Standard of Moths in Japan" (Hirowatari et al. 2013, Kishida 2011a, Kishida 2011b, Nasu et al. 2013). Some of the family names (i.e. Arctiidae, Lymantriidae, Micronoctuidae) were updated to current taxonomy. All the specimens were preserved as a personal collection of M. Kamikura.
Data analyses

Owing to the annual variations in abundance of moth species (Highland et al. 2013), data analyses were based on presence-absence data of moths sampled at each site in each month (Table 1, Suppl. material 1). Species composition was compared between years and amongst sites. In addition, because micro-moths belonging to the families of Chrysopeleiidae, Cosmopterigidae, Oecophoridae and Depressariidae were not identified in the study in 1987 (Takahashi 1993), those specimens were excluded from the data in 2018, as well as from the following analysis. In order to test whether the community composition of moth species differed between 1987 and 2018, permutational multivariate analyses of variance (PERMANOVA) were performed. We included the year of the survey as an explanatory variable. Additionally, PERMANOVA was also performed to test whether the community composition of moth species differed amongst the three sites in 2018. Here each site was included as an explanatory variable. For these analyses, the ADONIS function in library VEGAN (Oksanen et al. 2016) in R. ver. 3.3.2 (R Development Core Team 2016) was used. Non-metric multidimensional scaling analysis (NMDS) on the Jaccard index was used to visually summarise the plant community compositions of each site at each month.

Figure 1. Studied area and habitat vegetation: a. Geographic location of Kanpu-zan; b. grassland (GL); c. forest (FR); d. mixed vegetation (MIX).
Table 1.
Species list (presence (1) or absence (0)) of the three sites in 2018 and one site in 1987.

| family         | species name                                      | food     | specialist/generalist | 1987 | forest | grassland | mixed |
|----------------|--------------------------------------------------|----------|-----------------------|------|--------|-----------|-------|
| Bombycidae     | Bombyx mandarina (Moore, 1872)                   | woody    | specialist            | 0    | 1      | 1         | 0     |
| Chrysopелеidae | Aсscalenia sp. (Japanese name: Zugurokobukanariba) | unknown  | unknown               | 0    | 0      | 0         | 1     |
| Cosmopterigidae| Pyroderces sarcogypsa (Meyrick, 1932)            | unknown  | unknown               | 0    | 0      | 0         | 1     |
| Cosmopterigidae| Ressia quercidentella Sinev, 1988                | unknown  | unknown               | 0    | 1      | 0         | 1     |
| Cossidae       | Pharagmataecia castaneae (Hübner, 1790)          | herb     | specialist            | 1    | 0      | 0         | 0     |
| Cossidae       | Zeuzera multistrigata Moore, 1881                | woody    | generalist            | 0    | 1      | 1         | 1     |
| Crambidae      | Agrotera posticalis Wileman, 1911                | woody    | specialist            | 0    | 0      | 0         | 1     |
| Crambidae      | Anania alboverbasalis Yamanaka, 1966             | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae      | Anania verbascalis [(Denis & Schiffermüller], 1775) | herb     | specialist            | 1    | 0      | 0         | 0     |
| Crambidae      |Ancylolomia japonica Zeller, 1877                 | herb     | specialist            | 0    | 0      | 0         | 1     |
| Crambidae      | Bradina angustalis Yamanaka, 1984                | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae      | Bradina atopalis (Walker, 1859)                  | unknown  | unknown               | 0    | 1      | 1         | 1     |
| Crambidae      | Calamotropa okanoi Bleszynski, 1961              | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae      | Camptomastix hisbonalis (Walker, 1859)           | unknown  | unknown               | 0    | 1      | 0         | 0     |
| Crambidae      | Chilo luteellus (Motschulsky, 1866)              | herb     | generalist            | 0    | 0      | 0         | 1     |
| Crambidae      | Chilo suppressalis (Walker, 1863)                | herb     | specialist            | 1    | 0      | 0         | 0     |
| Crambidae      | Chrysoteuchia diplogramma (Zeller, 1863)         | herb     | specialist            | 0    | 1      | 0         | 0     |
| Crambidae      | Circothytis nycterina Butler, 1879               | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae      | Cnaphalocrocis medinalis (Gueneé, 1854)          | herb     | specialist            | 1    | 0      | 0         | 0     |
| Crambidae      | Cnaphalocrocis stereogona (Meyrick, 1886)        | herb     | specialist            | 1    | 1      | 0         | 0     |
| Crambidae      | Crambus argyrophorus Butler, 1878                | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae      | Crambus perlellus (Scopoli, 1763)                | herb     | specialist            | 1    | 0      | 0         | 0     |
| Crambidae      | Daulia afralis Walker, 1859                      | herb     | specialist            | 1    | 0      | 0         | 0     |
| Crambidae      | Diasemia reticularis (Linnaeus, 1761)            | herb     | generalist            | 1    | 0      | 0         | 0     |
| family    | species name                                      | food             | specialist/generalist | 1987 | forest | grassland | mixed |
|-----------|--------------------------------------------------|------------------|-----------------------|------|--------|-----------|-------|
| Crambidae | Dolicharthria brugueralis (Duponchel, 1833)      | herb             | generalist            | 1    | 0      | 0         | 0     |
| Crambidae | Flavocrambus striatellus (Leech, 1889)           | unknown          | unknown               | 1    | 0      | 0         | 0     |
| Crambidae | Glaucocaris exsectella (Christoph, 1881)         | lichen/moss      | specialist            | 1    | 0      | 0         | 1     |
| Crambidae | Glyphodes pyleri Butler, 1879                   | woody            | specialist            | 1    | 0      | 0         | 0     |
| Crambidae | Haritalodes derogatus (Fabricius, 1775)          | woody            | specialist            | 0    | 0      | 0         | 1     |
| Crambidae | Herpetogramma luctuosale (Guenee, 1854)          | woody            | specialist            | 1    | 1      | 1         | 1     |
| Crambidae | Herpetogramma magnum (Butler, 1879)              | herb/woody       | generalist            | 0    | 0      | 0         | 1     |
| Crambidae | Herpetogramma moderatale (Christoph, 1881)       | herb             | generalist            | 1    | 0      | 0         | 0     |
| Crambidae | Herpetogramma stultale (Walker, 1859)            | herb             | generalist            | 1    | 0      | 0         | 0     |
| Crambidae | Mabra charonialis (Walker, 1859)                 | dead leaves      | generalist            | 1    | 0      | 0         | 0     |
| Crambidae | Maruca vitrata (Fabricius, 1787)                 | herb             | specialist            | 1    | 0      | 0         | 0     |
| Crambidae | Microchilo inouei Okano, 1962                    | unknown          | unknown               | 1    | 0      | 0         | 0     |
| Crambidae | Nacoleia commixta (Butler, 1879)                 | woody            | generalist            | 1    | 1      | 0         | 0     |
| Crambidae | Nacoleia sibirialis (Milliere, 1879)             | unknown          | unknown               | 1    | 0      | 0         | 0     |
| Crambidae | Nacoleia tampiusalis (Walker, 1859)              | unknown          | unknown               | 0    | 0      | 1         | 1     |
| Crambidae | Nomis albopedalis Motschulsky, 1861              | unknown          | unknown               | 1    | 1      | 1         | 1     |
| Crambidae | Nomophila noctuella (Denis & Schiffermuller, 1775)| herb/woody      | generalist            | 1    | 0      | 0         | 0     |
| Crambidae | Omiodes tristrials (Bremer, 1864)                | unknown          | unknown               | 1    | 0      | 0         | 1     |
| Crambidae | Ostrinia latipennis (Warren, 1892)               | herb             | specialist            | 1    | 0      | 0         | 0     |
| Crambidae | Palpita nigropunctalis (Bremer, 1864)            | woody            | generalist            | 0    | 1      | 1         | 1     |
| Crambidae | Patissa fulvosparsa (Butler, 1881)               | unknown          | unknown               | 0    | 0      | 0         | 1     |
| Crambidae | Piletoca sodalis (Leech, 1889)                   | unknown          | unknown               | 1    | 0      | 0         | 0     |
| Crambidae | Platyes ornatella (Leech, 1889)                  | unknown          | unknown               | 1    | 0      | 0         | 0     |
| Crambidae | Pleuroptya chlorophanta (Butler, 1878)           | woody            | generalist            | 1    | 0      | 0         | 0     |
| Crambidae | Pleuroptya harutai (Inoue, 1955)                 | woody            | specialist            | 0    | 0      | 1         | 0     |
| Crambidae | Pleuroptya inferior (Hampson, 1898)              | herb             | specialist            | 1    | 0      | 0         | 0     |
| family       | species name                                                                 | food     | specialist/generalist | 1987 | forest | grassland | mixed |
|--------------|------------------------------------------------------------------------------|----------|-----------------------|------|--------|-----------|-------|
| Crambidae    | Prodasycnemis inornata (Butler, 1879)                                        | herb     | specialist            | 1    | 0      | 0         | 0     |
| Crambidae    | Pyrausta unipunctata Butler, 1881                                            | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae    | Scirpophaga virginia Schultze, 1908                                          | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae    | Sitochroa palealis (Denis & Schiffermüller, 1775)                           | herb     | specialist            | 0    | 0      | 1         | 0     |
| Crambidae    | Sitochroa umbrosalis (Warren, 1892)                                          | herb     | specialist            | 1    | 1      | 1         | 1     |
| Crambidae    | Sitochroa verticalis (Linnaeus, 1758)                                        | herb     | generalist            | 0    | 0      | 1         | 1     |
| Crambidae    | Spoladea recurvaris (Fabricius, 1775)                                        | herb     | generalist            | 1    | 1      | 1         | 0     |
| Crambidae    | Sylete pallidonotalis (Hampson, 1912)                                        | woody    | generalist            | 1    | 0      | 0         | 0     |
| Crambidae    | Sylete segnalis (Leech, 1889)                                                | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae    | Toruliquama obliquilinealis Inoue, 1982                                      | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae    | Tyspanodes striatus (Butler, 1879)                                           | woody    | generalist            | 1    | 0      | 0         | 0     |
| Crambidae    | Udea lugubralis (Leech, 1889)                                                | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae    | Uresiphta gracilis (Butler, 1879)                                            | unknown  | unknown               | 1    | 0      | 0         | 0     |
| Crambidae    | Xanthocrambus lucellus (Herrich-Schäffer, 1848)                              | unknown  | unknown               | 0    | 1      | 1         | 0     |
| Depressaridae| Agonopterix mutuurai Saito, 1980                                            | herb     | specialist            | 0    | 0      | 0         | 1     |
| Depressaridae| Agonopterix sumizome Fujisawa, 1985                                          | herb     | specialist            | 0    | 0      | 0         | 1     |
| Depressaridae| Agonopterix yomogiella Saito, 1980                                          | herb     | specialist            | 0    | 0      | 0         | 1     |
| Drepanidae   | Habrosyne pyrinioides (Butler, 1766)                                         | woody    | specialist            | 1    | 0      | 0         | 0     |
| Drepanidae   | Tethea ampliata (Butler, 1878)                                               | woody    | specialist            | 1    | 0      | 0         | 0     |
| Drepanidae   | Thyatira batis (Linnaeus, 1758)                                              | woody    | specialist            | 1    | 0      | 0         | 0     |
| Erebidae     | Arctomis l-nigrum (Müller, 1764)                                            | woody    | generalist            | 0    | 1      | 0         | 0     |
| Erebidae     | Artaxa subflava (Bremer, 1864)                                               | herb/woody| generalist          | 1    | 1      | 1         | 1     |
| Erebidae     | Barsine aberrans (Butler, 1877)                                              | lichen/moss| generalist          | 0    | 1      | 0         | 0     |
| Erebidae     | Barsine pulchra (Butler, 1877)                                               | unknown  | unknown               | 1    | 0      | 1         | 0     |
| Erebidae     | Barsine striata (Bremer & Grey, 1853)                                        | dead leaves| generalist          | 1    | 0      | 0         | 1     |
| family       | species name                          | food               | specialist/ generalist | 1987 | forest | grassland | mixed |
|--------------|---------------------------------------|--------------------|------------------------|------|--------|-----------|-------|
| Erebidae     | Chinoarctia nivea (Ménétriés, 1859)   | herb               | generalist             | 1    | 1      | 1         | 1     |
| Erebidae     | Cituna locuples Walker, 1855          | herb/woody         | generalist             | 1    | 0      | 0         | 0     |
| Erebidae     | Cyana hamata (Walker, 1854)           | lichen/moss        | generalist             | 1    | 0      | 0         | 1     |
| Erebidae     | Eilema affineola (Bremer, 1864)       | unknown            | unknown                | 1    | 1      | 1         | 1     |
| Erebidae     | Eilema deplea (Esper, 1787)           | lichen/moss        | generalist             | 1    | 1      | 0         | 0     |
| Erebidae     | Eilema japonica (Leech, 1889)         | lichen/moss        | generalist             | 0    | 1      | 0         | 0     |
| Erebidae     | Eilema nankingica (Daniel, 1954)      | unknown            | unknown                | 1    | 0      | 0         | 0     |
| Erebidae     | Eilema vetusta (Walker, 1854)         | lichen/moss        | generalist             | 1    | 1      | 0         | 1     |
| Erebidae     | Epatolmis caesarea (Goeze, 1781)      | herb/woody         | generalist             | 1    | 1      | 1         | 0     |
| Erebidae     | Ghoria collitoides Butler, 1885       | unknown            | unknown                | 1    | 1      | 1         | 1     |
| Erebidae     | Ghoria gigantea (Oberthür, 1879)      | woody              | generalist             | 0    | 1      | 0         | 1     |
| Erebidae     | Ilema eurydice (Butler, 1885)         | woody              | generalist             | 1    | 0      | 1         | 0     |
| Erebidae     | Kidokuga piperita (Oberthür, 1880)    | woody              | generalist             | 1    | 0      | 0         | 1     |
| Erebidae     | Lemyra imparilis (Butler, 1877)       | woody              | generalist             | 1    | 0      | 0         | 0     |
| Erebidae     | Lemyra inaequalis (Butler, 1879)      | woody              | generalist             | 1    | 0      | 0         | 0     |
| Erebidae     | Lithosia quadra (Linnaeus, 1758)      | lichen/moss        | generalist             | 1    | 0      | 0         | 0     |
| Erebidae     | Lymantria mathura (Moore, 1865)       | woody              | generalist             | 1    | 1      | 0         | 0     |
| Erebidae     | Mitochrista calamina Butler, 1877     | woody              | generalist             | 1    | 1      | 1         | 1     |
| Erebidae     | Mitochrista miniata (Forster, 1771)   | lichen/moss        | generalist             | 1    | 1      | 0         | 1     |
| Erebidae     | Mimachrostia fasciata Sugi, 1982      | unknown            | unknown                | 1    | 1      | 0         | 0     |
| Erebidae     | Orgia thyellina Butler, 1881          | herb/woody         | generalist             | 0    | 1      | 0         | 0     |
| Erebidae     | Pelosia muscerda (Hufnagel, 1766)     | lichen/moss        | generalist             | 1    | 0      | 0         | 1     |
| Erebidae     | Pelosia noctis (Butler, 1881)         | lichen/moss        | generalist             | 1    | 0      | 0         | 0     |
| Erebidae     | Pelosia obtusa (Herrich-Schäffer, 1852) | unknown         | unknown                | 1    | 0      | 0         | 0     |
| Erebidae     | Phragmatobia amurensis Seitz, 1910    | herb               | generalist             | 1    | 0      | 0         | 0     |
| Erebidae     | Rhyparioides amurensis (Bremer, 1861) | herb               | specialist             | 1    | 1      | 1         | 1     |
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| family         | species name                  | food          | specialist/generalist | 1987 | forest | grassland | mixed |
|----------------|-------------------------------|---------------|-----------------------|------|--------|-----------|-------|
| Erebidae       | *Rhyparioides metelkana* (Lederer, 1861) | herb          | generalist            | 1    | 0      | 1         | 0     |
| Erebidae       | *Rhyparioides nebulosa* Butler, 1877 | herb          | generalist            | 1    | 1      | 0         | 1     |
| Erebidae       | *Sphrageidus similis* (Fuessly, 1775) | woody         | generalist            | 1    | 1      | 0         | 0     |
| Erebidae       | *Spilarctia lutea* (Huflnagel, 1766) | unknown       | unknown               | 1    | 0      | 0         | 0     |
| Erebidae       | *Spilarctia obliquizonata* (Miyake, 1910) | woody         | specialist            | 0    | 1      | 1         | 1     |
| Erebidae       | *Spilarctia seriopunctata* (Motschulsky, 1861) | woody         | generalist            | 1    | 0      | 1         | 0     |
| Erebidae       | *Spilosoma lubricipedium* (Linnaeus, 1758) | woody         | generalist            | 1    | 0      | 0         | 0     |
| Erebidae       | *Spilosoma punctarium* (Stoll, 1782) | woody         | generalist            | 1    | 1      | 1         | 0     |
| Erebidae       | *Stigmatophora rhodophila* (Walker, 1865) | lichen/moss   | generalist            | 1    | 0      | 0         | 0     |
| Erebidae       | *Thumatha ochracea* (Bremer, 1861) | unknown       | unknown               | 1    | 0      | 0         | 0     |
| Eupterotidae   | *Apha aequalis* (Felder, 1874) | herb/woody    | generalist            | 1    | 1      | 1         | 1     |
| Geometridae    | *Abraxas fulvobasalis* Warren, 1894 | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae    | *Abraxas miranda* Butler, 1878 | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae    | *Abraxas niphonia* Wehrli, 1935 | woody         | specialist            | 1    | 0      | 1         | 0     |
| Geometridae    | *Acrodontis fumosa* (Prout, 1930) | woody         | specialist            | 0    | 0      | 0         | 1     |
| Geometridae    | *Amraica superans* (Butler, 1878) | woody         | specialist            | 1    | 1      | 1         | 0     |
| Geometridae    | *Arichanna melanaria* (Linnaeus, 1758) | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae    | *Ascotis selenaria* (Denis & Schiffermüller, 1775) | herb/woody    | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | *Astygisa chlororhphnodes* (Wehrli, 1936) | woody         | specialist            | 1    | 1      | 0         | 0     |
| Geometridae    | *Chiasmia defixaria* (Walker, 1861) | woody         | specialist            | 0    | 0      | 1         | 0     |
| Geometridae    | *Chiasmia hebesata* (Walker, 1861) | herb/woody    | generalist            | 1    | 0      | 1         | 1     |
| Geometridae    | *Chlorissa amphitritaria* (Oberthür, 1879) | woody         | generalist            | 1    | 0      | 0         | 1     |
| Geometridae    | *Chlorissa anadema* (Prout, 1930) | herb/woody    | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | *Chlorissa obliterata* (Walker, 1863) | herb          | generalist            | 1    | 0      | 0         | 0     |
| family    | species name                                      | food         | specialist/generalist | 1987 | forest | grassland | mixed |
|-----------|--------------------------------------------------|--------------|-----------------------|------|--------|-----------|-------|
| Geometridae | *Chloroclystis v-ata* (Haworth, 1809)             | herb/woody   | generalist            | 1    | 1      | 0         | 0     |
| Geometridae | *Cleora insolita* (Butler, 1878)                 | woody        | generalist            | 1    | 0      | 0         | 0     |
| Geometridae | *Cornibaena delicatior* (Warren, 1897)           | woody        | generalist            | 1    | 0      | 0         | 1     |
| Geometridae | *Costaconvexa caespitaria* (Christoph, 1881)     | unknown      | unknown               | 0    | 0      | 0         | 1     |
| Geometridae | *Culpinia diffusa* (Walker, 1861)                | herb/woody   | generalist            | 1    | 0      | 0         | 0     |
| Geometridae | *Cusiala stipitaria* (Oberthür, 1880)           | woody        | generalist            | 1    | 0      | 0         | 0     |
| Geometridae | *Descoreba simplex* Butler, 1878                 | woody        | generalist            | 1    | 0      | 0         | 0     |
| Geometridae | *Dindica virescens* (Butler, 1878)               | woody        | specialist            | 1    | 1      | 0         | 0     |
| Geometridae | *Ecliptopera capitata* (Herrich-Schäffer, 1840) | woody        | specialist            | 1    | 0      | 0         | 0     |
| Geometridae | *Ecliptopera umbrosaria* (Motschulsky, 1861)    | woody        | specialist            | 1    | 0      | 0         | 0     |
| Geometridae | *Ecpetelia albifrontaria* (Leech, 1891)         | woody        | specialist            | 1    | 0      | 0         | 0     |
| Geometridae | *Ectropis excellens* (Butler, 1884)              | herb/woody   | generalist            | 1    | 0      | 0         | 0     |
| Geometridae | *Ectropis obliqua* (Prout, 1915)                 | herb/woody   | generalist            | 1    | 0      | 0         | 0     |
| Geometridae | *Epirrhoe supergressa* (Butler, 1878)           | herb         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae | *Euphyia cineraria* (Butler, 1878)               | unknown      | unknown               | 1    | 0      | 0         | 0     |
| Geometridae | *Eupithecia interpunctaria* Inoue, 1979          | herb         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae | *Eupithecia mandschurica* Staudinger, 1897       | unknown      | unknown               | 1    | 0      | 0         | 0     |
| Geometridae | *Eupithecia neosatyra* Inoue, 1979               | woody        | specialist            | 1    | 0      | 0         | 0     |
| Geometridae | *Evecliptopera illitata* (Wileman, 1911)        | woody        | specialist            | 1    | 0      | 1         | 1     |
| Geometridae | *Gandaritis fixseni* (Bremer, 1864)             | woody        | generalist            | 0    | 0      | 0         | 1     |
| Geometridae | *Geometra dieckmanni* Graeser, 1889             | woody        | specialist            | 0    | 0      | 0         | 1     |
| Geometridae | *Heterophoneus fusca* (Butler, 1878)             | unknown      | unknown               | 0    | 1      | 0         | 0     |
| Geometridae | *Heterothera postalbida* (Wileman, 1911)         | woody        | specialist            | 1    | 0      | 0         | 0     |
| Geometridae | *Hypomecis punctinalis* (Scopoli, 1763)         | woody        | generalist            | 1    | 0      | 0         | 0     |
| family     | species name                             | food          | specialist/generalist | 1987 | forest | grassland | mixed |
|------------|------------------------------------------|---------------|-----------------------|------|--------|-----------|-------|
| Geometridae| *Idaea auricruda* (Butler, 1879)          | unknown       | unknown               | 1    | 1      | 0         | 1     |
| Geometridae| *Idaea denudaria* (Prout, 1913)          | unknown       | unknown               | 1    | 0      | 0         | 0     |
| Geometridae| *Idaea invalida* (Butler, 1879)          | unknown       | unknown               | 1    | 0      | 0         | 0     |
| Geometridae| *Idaea jakima* (Butler, 1878)            | unknown       | unknown               | 1    | 0      | 0         | 0     |
| Geometridae| *Idaea muricata* (Hufnagel, 1767)        | unknown       | unknown               | 1    | 1      | 0         | 1     |
| Geometridae| *Idaea nielseni* (Hedemann, 1879)        | unknown       | unknown               | 0    | 0      | 1         | 0     |
| Geometridae| *Idaea trisetata* (Prout, 1922)          | unknown       | unknown               | 1    | 0      | 0         | 0     |
| Geometridae| *Jankowskia pseudathleta* Sato, 1980     | woody         | generalist            | 1    | 0      | 0         | 0     |
| Geometridae| *Lamprocabera candidaria* (Leech, 1897)  | woody         | specialist            | 0    | 1      | 0         | 1     |
| Geometridae| *Lassaba nikkonis* (Butler, 1881)        | woody         | generalist            | 1    | 0      | 0         | 0     |
| Geometridae| *Lomographa bimaculata* (Fabricius, 1775)| woody         | specialist            | 0    | 0      | 1         | 0     |
| Geometridae| *Lomographa temerata* (Denis & Schiffermüller, 1775) | woody | specialist | 1 | 1 | 1 | 1 |
| Geometridae| *Macaria liturata* (Clerck, 1759)        | woody         | specialist            | 0    | 0      | 0         | 1     |
| Geometridae| *Macaria shanghaisaria* Walker, 1861     | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae| *Menophra senilis* (Butler, 1878)        | herb/woody    | generalist            | 1    | 1      | 0         | 0     |
| Geometridae| *Metabraxas clerica* Butler, 1881        | unknown       | unknown               | 1    | 1      | 0         | 0     |
| Geometridae| *Microcalicha sordida* (Butler, 1878)    | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae| *Ninodes splendens* (Butler, 1878)       | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae| *Orthonama obstipata* (Fabricius, 1794)  | herb/woody    | generalist            | 1    | 0      | 0         | 0     |
| Geometridae| *Otoplecta frigida* (Butler, 1878)       | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae| *Ourapteryx maculicuadaria* (Motschulsky, 1866) | woody | generalist | 1 | 0 | 0 | 0 |
| Geometridae| *Oxymacaria normata* (Alphéraky, 1892)   | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae| *Pachista superans* (Butler, 1878)       | woody         | specialist            | 0    | 1      | 1         | 1     |
| Geometridae| *Pasiphila excisa* (Butler, 1878)        | woody         | generalist            | 0    | 1      | 0         | 1     |
| Geometridae| *Peratophyga hyalinata* (Kollar, 1844)   | herb          | specialist            | 1    | 0      | 0         | 0     |
| Geometridae| *Petelia rivulosa* (Butler, 1881)        | woody         | specialist            | 1    | 0      | 0         | 0     |
| Geometridae| *Petrophora chlorosata* (Scopoli, 1763)  | herb          | specialist            | 1    | 1      | 1         | 1     |
| Geometridae| *Phthonosema tendinosaria* (Bremer, 1864) | herb/woody    | generalist            | 1    | 1      | 1         | 1     |
| family         | species name                                                                 | food            | specialist/generalist | 1987 | forest | grassland | mixed |
|----------------|-------------------------------------------------------------------------------|-----------------|-----------------------|------|--------|-----------|-------|
| Geometridae    | Pingasa alba Swinhoe, 1891                                                   | woody           | specialist            | 0    | 1      | 0         | 0     |
| Geometridae    | Pingasa pseudoterpınaria (Guenée, 1857)                                      | woody           | specialist            | 1    | 0      | 0         | 0     |
| Geometridae    | Protoboarmia faustinata (Warren, 1897)                                       | woody           | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | Protoboarmia simpliciaria (Leech, 1897)                                      | woody           | generalist            | 0    | 1      | 0         | 0     |
| Geometridae    | Pseuderannis lomozemia (Prout, 1930)                                         | woody           | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | Pylargosceles steganioides (Butler, 1878)                                    | herb/woody      | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | Racotis petrosa (Butler, 1879)                                               | woody           | specialist            | 1    | 0      | 0         | 0     |
| Geometridae    | Scopula floslactata (Haworth, 1809)                                          | herb            | generalist            | 0    | 1      | 0         | 0     |
| Geometridae    | Scopula ignobilis (Warren, 1901)                                             | herb/woody      | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | Scopula impersonata (Walker, 1861)                                           | herb            | specialist            | 1    | 0      | 0         | 0     |
| Geometridae    | Scopula nigropunctata (Hufnagel, 1767)                                       | herb/woody      | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | Scopula nudipta (Butler, 1878)                                               | unknown         | unknown               | 1    | 0      | 0         | 0     |
| Geometridae    | Scopula pudicaria (Motschulsky, 1861)                                        | herb            | specialist            | 0    | 0      | 0         | 1     |
| Geometridae    | Scopula semignobilis Inoue, 1942                                             | herb            | specialist            | 1    | 0      | 0         | 0     |
| Geometridae    | Spilopera debilis (Butler, 1878)                                             | woody           | specialist            | 1    | 1      | 1         | 1     |
| Geometridae    | Trichopteryx ussurica (Wehrli, 1927)                                         | unknown         | unknown               | 0    | 1      | 0         | 0     |
| Geometridae    | Tyloptera bella (Butler, 1878)                                               | woody           | specialist            | 1    | 1      | 0         | 0     |
| Geometridae    | Xanthorhoe birivata (Borkhausen, 1794)                                       | herb            | specialist            | 1    | 1      | 0         | 0     |
| Geometridae    | Xerodes albonotaria (Bremer, 1864)                                           | herb/woody      | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | Xerodes rufescerenta (Motschulsky, 1861)                                     | woody           | generalist            | 1    | 0      | 0         | 0     |
| Geometridae    | Xerodes semilutata (Lederer, 1853)                                           | woody           | specialist            | 1    | 1      | 1         | 1     |
| Lasiocampidae  | Dendrolimus spectabilis (Butler, 1877)                                        | woody           | specialist            | 1    | 0      | 0         | 0     |
| Lasiocampidae  | Euthrix albomaculata (Bremer, 1861)                                          | herb            | specialist            | 1    | 0      | 0         | 0     |
| Lasiocampidae  | Euthrix potatoria (Linnaeus, 1758)                                           | herb/woody      | generalist            | 1    | 1      | 1         | 0     |
| family          | species name                                      | food                  | specialist/generalist | 1987 | forest | grassland | mixed |
|-----------------|--------------------------------------------------|-----------------------|-----------------------|------|--------|-----------|-------|
| Lasiocampidae   | Kunugia undans (Walker, 1859)                    | woody                 | generalist            | 0    | 1      | 1         | 1     |
| Lasiocampidae   | Malacosoma neustria (Linnaeus, 1758)             | woody                 | generalist            | 1    | 0      | 0         | 0     |
| Limacodidae     | Narsoideus flavidosalis (Staudinger, 1887)       | woody                 | generalist            | 1    | 1      | 0         | 1     |
| Limacodidae     | Parasa consocia Walker, 1863                     | woody                 | generalist            | 1    | 0      | 0         | 0     |
| Limacodidae     | Parasa hilarula (Staudinger, 1887)              | woody                 | generalist            | 1    | 1      | 0         | 1     |
| Limacodidae     | Phlosa conjuncta (Walker, 1855)                  | unknown               | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae       | Abrostola ussuriensis Dufay, 1958               | unknown               | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae       | Acanthoplusia agnata (Staudinger, 1892)         | herb                  | generalist            | 0    | 0      | 1         | 0     |
| Noctuidae       | Acronicta hercules (Felder & Rogenhofer, 1874)  | woody                 | specialist            | 0    | 0      | 1         | 0     |
| Noctuidae       | Acronicta rumicis (Linnaeus, 1758)              | herb/woody            | generalist            | 1    | 1      | 0         | 0     |
| Noctuidae       | Actinotia intermediata (Bremer, 1861)           | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae       | Adrapsa simplex (Butler, 1879)                  | dead leaves           | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae       | Agrotis exclamationis (Linnaeus, 1758)          | herb                  | generalist            | 1    | 0      | 1         | 1     |
| Noctuidae       | Agrotis ipsilon (Hufnagel, 1766)                | herb/woody            | generalist            | 0    | 0      | 1         | 0     |
| Noctuidae       | Agrotis segetum (Denis & Schiffmüller, 1775)    | herb                  | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae       | Amphipoea ussuriensis (Petersen, 1914)          | unknown               | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae       | Amphipyra pyramidea (Linnaeus, 1758)            | woody                 | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae       | Anachrothis nigripunctalis (Wileman, 1911)      | woody                 | specialist            | 1    | 1      | 0         | 0     |
| Noctuidae       | Anacronea caliginosa (Butler, 1881)             | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae       | Anacronea nitida (Butler, 1878)                 | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae       | Anapamea incerta (Staudinger, 1892)             | unknown               | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae       | Anaplectoides vires (Butler, 1878)              | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae       | Anarta (Calocestra) trifolii (Hufnagel, 1766)   | herb                  | generalist            | 0    | 0      | 0         | 1     |
| Noctuidae       | Anorthoa angustipennis (Matsumura, 1926)        | woody                 | generalist            | 1    | 0      | 0         | 0     |
| family  | species name                        | food       | specialist/generalist | 1987 forest | grassland | mixed |
|---------|------------------------------------|------------|-----------------------|--------------|-----------|--------|
| Noctuidae | Apamea aquila (Donzel, 1837)       | unknown    | unknown               | 1            | 0         | 0      |
| Noctuidae | Apamea hamponsi Sugi, 1963         | unknown    | unknown               | 1            | 1         | 0      |
| Noctuidae | Apamea sordens (Hufnagel, 1766)    | herb       | specialist            | 0            | 0         | 0      |
| Noctuidae | Archanara resoluta Hampson, 1910    | herb       | specialist            | 1            | 0         | 0      |
| Noctuidae | Athetis albisignata (Oberthür, 1879) | herb      | generalist            | 1            | 0         | 0      |
| Noctuidae | Athetis cinerascens (Motschulsky, 1861) | unknown    | unknown               | 1            | 0         | 0      |
| Noctuidae | Athetis dissimilis (Hampson, 1909) | herb       | generalist            | 1            | 0         | 0      |
| Noctuidae | Athetis lapidea Wileman, 1911      | unknown    | unknown               | 1            | 1         | 1      |
| Noctuidae | Athetis lineosa (Moore, 1881)      | herb       | generalist            | 1            | 0         | 0      |
| Noctuidae | Athetis stellata (Moore, 1882)     | herb       | generalist            | 1            | 1         | 1      |
| Noctuidae | Aventiola pusilla (Butler, 1879)   | lichen/moss| generalist            | 1            | 0         | 0      |
| Noctuidae | Asyly putris (Linnaeus, 1761)      | herb       | generalist            | 1            | 0         | 1      |
| Noctuidae | Bambusiphila vulgaris (Butler, 1886) | herb       | specialist            | 1            | 0         | 0      |
| Noctuidae | Blasticorhinus ussuriensis (Bremer, 1861) | herb/woody | generalist            | 1            | 1         | 1      |
| Noctuidae | Bomolocha melanica Sugi, 1959      | unknown    | unknown               | 1            | 0         | 0      |
| Noctuidae | Bomolocha stygiana (Butler, 1878)  | woody      | specialist            | 1            | 0         | 1      |
| Noctuidae | Bomolocha zilla (Butler, 1879)     | unknown    | unknown               | 1            | 0         | 0      |
| Noctuidae | Callispistria juventina (Stoll, 1782) | herb     | generalist            | 1            | 1         | 1      |
| Noctuidae | Callopistria placoides (Guenée, 1852) | herb    | generalist            | 1            | 0         | 1      |
| Noctuidae | Callopistria repleta Walker, 1858  | herb       | generalist            | 0            | 1         | 0      |
| Noctuidae | Calytra thalictri (Borkhausen, 1790) | herb    | specialist            | 1            | 0         | 1      |
| Noctuidae | Catocala duplicata Butler, 1885    | woody      | specialist            | 1            | 0         | 0      |
| Noctuidae | Catocala nagioides Wileman, 1924   | woody      | specialist            | 1            | 0         | 0      |
| Noctuidae | Catocala nubila Butler, 1881       | woody      | specialist            | 1            | 0         | 0      |
| Noctuidae | Chandata bella (Butler, 1881)      | herb       | specialist            | 0            | 0         | 0      |
| Noctuidae | Chasminodes sugii Kononenko, 1981   | woody      | specialist            | 1            | 0         | 0      |
| Noctuidae | Chorsia japonica (Warren, 1912)    | woody      | specialist            | 0            | 0         | 0      |
| Noctuidae | Chrysodeixis acuta (Walker, 1857)  | herb/woody | generalist            | 1            | 0         | 0      |
| family   | species name                                      | food                      | specialist/generalist | 1987 | forest | grassland | mixed |
|----------|--------------------------------------------------|---------------------------|-----------------------|------|--------|-----------|-------|
| Noctuidae | Chrysorithrum amatum (Bremer & Grey, 1853)       | woody                     | specialist            | 1    | 0      | 0         | 1     |
| Noctuidae | Chytonix suballonotata Sugi, 1959                | unknown                   | unknown               | 0    | 0      | 1         | 0     |
| Noctuidae | Cidarippla gladiata Butler, 1879                 | unknown                   | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae | Clavipalpula aurariae (Oberthür, 1880)           | woody                     | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Conistra grisescens Draudt, 1950                 | woody                     | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Corgatha nitens (Butler, 1879)                   | lichen/moss               | generalist            | 0    | 1      | 0         | 0     |
| Noctuidae | Cosmia trapezina (Linnaeus, 1758)                | woody                     | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Cryphia mitsuhashi (Marumo, 1917)                | lichen/moss               | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Cucullia perforata Bremer, 1861                  | herb                      | specialist            | 0    | 1      | 0         | 0     |
| Noctuidae | Diarsia canescens (Butler, 1878)                 | herb                      | generalist            | 1    | 1      | 1         | 1     |
| Noctuidae | Diarsia depaca (Butler, 1879)                    | herb                      | generalist            | 0    | 0      | 0         | 1     |
| Noctuidae | Diarsia pacifica Boursin, 1943                   | herb                      | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Diarsia ruficauda (Warren, 1909)                 | herb                      | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Diomea cremata (Butler, 1878)                    | lichen/moss               | generalist            | 0    | 0      | 0         | 1     |
| Noctuidae | Dipterygina cupreotincta Sugi, 1954              | herb                      | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae | Dypterygia andreji Kardakoff, 1928               | herb                      | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae | Ercheia niveostrigata Warren, 1913               | herb                      | specialist            | 1    | 0      | 1         | 0     |
| Noctuidae | Ercheia umbrosa Butler, 1881                     | woody                     | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae | Ericea pertendens (Walker, 1858)                 | woody                     | specialist            | 0    | 1      | 0         | 0     |
| Noctuidae | Erygia apicalis Guenée, 1852                    | herb/woody                | specialist            | 0    | 0      | 1         | 0     |
| Noctuidae | Euplexia lucipara (Linnaeus, 1758)               | herb                      | generalist            | 0    | 1      | 1         | 0     |
| Noctuidae | Eutelia geyeri (Felder & Rogenhofer, 1874)       | woody                     | generalist            | 0    | 0      | 1         | 0     |
| Noctuidae | Euxoa karschi (Graeser, 1889)                    | herb                      | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae | Euxoa sibirica (Boisduval, 1832)                 | herb                      | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Gonitis mesogona (Walker, 1858)                  | woody                     | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Gortyna basalipunctata Graeser, 1889             | unknown                   | unknown               | 0    | 1      | 1         | 0     |
| Noctuidae | Gortyna foris (Butler, 1878)                     | herb                      | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Gynaephila maculifera Staudinger, 1892          | lichen/moss               | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Harita belinda (Butler, 1879)                    | woody                     | specialist            | 1    | 0      | 0         | 0     |
| family     | species name                                         | food           | specialist/generalist | 1987 | forest | grassland | mixed |
|------------|------------------------------------------------------|----------------|-----------------------|------|--------|-----------|-------|
| Noctuidae  | *Heliothis maritima* Graslin, 1855                   | herb           | generalist            | 0    | 0      | 1         | 0     |
| Noctuidae  | *Herminia arenosa* Butler, 1878                      | dead leaves    | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Herminia grisealis* (Denis & Schiffermüller, 1775) | dead leaves    | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Herminia tarsicrinalis* (Knoch, 1782)               | dead leaves    | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Holocryptis ussuriensis* (Rebel, 1901)              | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae  | *Honeyania ragusana* (Freyer, 1844)                  | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae  | *Hydraecia petasitis* Doubleday, 1847                | herb           | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Hydrioides morosa* (Butler, 1879)                   | dead leaves    | generalist            | 1    | 1      | 1         | 1     |
| Noctuidae  | *Hyperstrotia flavipuncta* Leech, 1889               | dead leaves    | generalist            | 1    | 1      | 1         | 1     |
| Noctuidae  | *Iambia japonica* Sugi, 1958                         | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae  | *Idia curvipalpis* (Butler, 1879)                    | dead leaves    | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Koyaga falsa* (Butler, 1885)                        | herb           | specialist            | 0    | 0      | 1         | 1     |
| Noctuidae  | *Koyaga numisma* (Staudinger, 1888)                  | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae  | *Leucapamea kawadai* (Sugi, 1955)                    | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae  | *Lygephila maxima* (Bremer, 1861)                    | herb           | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Mamestra brassicae* (Linnaeus, 1758)                | herb           | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Melapia electaria* (Bremer, 1864)                   | herb           | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Metopta rectifasciata* (Ménétriès, 1863)           | herb           | specialist            | 1    | 1      | 0         | 1     |
| Noctuidae  | *Micardia argentata* Butler, 1878                    | herb           | specialist            | 0    | 1      | 0         | 0     |
| Noctuidae  | *Micreremites pyraloides* Sugi, 1982                 | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae  | *Microxyta confusa* (Wileman, 1911)                  | herb           | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae  | *Mocis ancilla* (Warren, 1913)                       | herb           | specialist            | 1    | 0      | 0         | 0     |
| family         | species name                  | food           | specialist/generalist | 1987 | forest | grassland | mixed |
|----------------|-------------------------------|----------------|-----------------------|------|--------|-----------|-------|
| Noctuidae      | *Mocis annetta* (Butler, 1878) | herb/woody     | specialist             | 1    | 0      | 1         | 0     |
| Noctuidae      | *Mosopia sordidum* (Butler, 1879) | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna chosenicola* (Bryk, 1949) | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna flavostigma* (Bremer, 1861) | unknown        | unknown               | 1    | 0      | 1         | 1     |
| Noctuidae      | *Mythimna inanis* (Oberthür, 1880) | unknown        | unknown               | 1    | 1      | 0         | 1     |
| Noctuidae      | *Mythimna matsumuriana* (Bryk, 1949) | herb          | specialist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna obsoleta* (Hübner, 1803) | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna pallens* (Linnaeus, 1758) | herb          | generalist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna postica* (Hampson, 1905) | herb          | specialist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna pudorina* (Denis & Schiffermüller, 1775) | herb          | generalist             | 0    | 1      | 0         | 0     |
| Noctuidae      | *Mythimna radiata* (Bremer, 1861) | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna rufipennis* Butler, 1878 | unknown        | unknown               | 1    | 0      | 1         | 1     |
| Noctuidae      | *Mythimna separata* (Walker, 1865) | herb          | generalist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Mythimna turca* (Linnaeus, 1761) | herb          | generalist             | 1    | 1      | 1         | 1     |
| Noctuidae      | *Naranga aeneascens* Moore, 1881 | herb          | specialist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Niphonyx segregata* (Butler, 1878) | herb          | specialist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Nycteola asiatica* (Krulikowski, 1904) | woody         | generalist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Ochropleura plecta* (Linnaeus, 1761) | herb          | generalist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Orthogonia sera* Felder & Felder, 1862 | herb          | specialist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Orthosia ella* (Butler, 1878) | herb          | generalist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Orthosia gothica* (Linnaeus, 1758) | woody         | generalist             | 0    | 1      | 0         | 0     |
| Noctuidae      | *Orthosia lizetta* Butler, 1878 | woody         | specialist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Oruza mira* (Butler, 1879) | dead leaves   | generalist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Pangraptula lunulata* (Sterz, 1915) | woody         | specialist             | 0    | 1      | 0         | 0     |
| Noctuidae      | *Pangraptula obscurata* (Butler, 1879) | woody         | generalist             | 1    | 1      | 0         | 0     |
| Noctuidae      | *Pangraptula umbrosa* (Leech, 1900) | woody         | specialist             | 1    | 0      | 1         | 0     |
| Noctuidae      | *Panolis japonica* Draudt, 1935 | woody         | specialist             | 1    | 0      | 0         | 0     |
| Noctuidae      | *Paracolax trilinealis* (Bremer, 1864) | unknown        | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae      | *Paracolax tristalis* (Fabricius, 1794) | dead leaves   | generalist             | 0    | 1      | 0         | 1     |
| family     | species name                          | food       | specialist/generalist | 1987 | forest | grassland | mixed |
|-----------|---------------------------------------|------------|-----------------------|------|--------|-----------|-------|
| Noctuidae | Paragabara flavomacul (Oberthür, 1880)| unknown    | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae | Perigraphe hoenei Püngeler, 1914      | woody      | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae | Phyllina obliterata (Rambur, 1833)    | herb       | specialist            | 1    | 1      | 1         | 1     |
| Noctuidae | Plusiodonta casta (Butler, 1878)      | woody      | specialist            | 1    | 1      | 1         | 0     |
| Noctuidae | Prospalta cyclica (Hampson, 1908)     | unknown    | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae | Protodeltote distinguenda (Staudinger, 1888) | herb   | specialist            | 1    | 1      | 0         | 0     |
| Noctuidae | Protodeltote pygarga (Hufnagel, 1766) | unknown    | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae | Pryntha umbra (Hufnagel, 1766)        | herb       | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Rhizedra lutosa (Hübner, 1803)        | herb       | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae | Rivula sericealis (Scopoli, 1763)     | herb       | specialist            | 0    | 0      | 0         | 1     |
| Noctuidae | Ruscada privata (Walker, 1865)        | woody      | specialist            | 0    | 0      | 1         | 0     |
| Noctuidae | Sarcopilia illoba (Butler, 1878)      | herb/woody | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Sphragifera sigillata (Ménétriès, 1859) | woody  | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Sphragifera sigillata (Ménétriès, 1859) | woody  | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Sphragifera oceanica (Kardakoff, 1928) | herb     | specialist            | 1    | 1      | 1         | 1     |
| Noctuidae | Sphragifera oceanica (Kardakoff, 1928) | herb     | specialist            | 1    | 1      | 1         | 1     |
| Noctuidae | Sophta subrosea (Butler, 1881)        | unknown    | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae | Sphragifera sigillata (Ménétriès, 1859) | woody  | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Spodoptera depravata (Butler, 1879)   | herb       | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae | Stenhylena nigrpuncta (Wileman, 1911) | lichen/moss| generalist            | 1    | 0      | 0         | 0     |
| Noctuidae | Stenoloba clara (Leech, 1889)         | unknown    | unknown               | 0    | 0      | 1         | 0     |
| Noctuidae | Stenoloba jankowskii (Oberthür, 1885) | unknown    | unknown               | 0    | 0      | 0         | 1     |
| Noctuidae | Sugia erastoides (Draudt, 1950)       | unknown    | unknown               | 1    | 0      | 0         | 0     |
| Noctuidae | Sugia idiostygia (Sugi, 1958)         | unknown    | unknown               | 0    | 1      | 0         | 0     |
| family       | species name                                      | food                  | specialist/generalist | 1987 | forest | grassland | mixed |
|--------------|--------------------------------------------------|-----------------------|-----------------------|------|--------|-----------|-------|
| Noctuidae    | *Sugia stygia* (Butler, 1878)                    | unknown               | unknown               | 0    | 1      | 0         | 0     |
| Noctuidae    | *Sypnoides picta* (Butler, 1877)                 | woody                 | generalist            | 0    | 1      | 0         | 0     |
| Noctuidae    | *Telorta edentata* (Leech, 1889)                | woody                 | generalist            | 0    | 0      | 1         | 0     |
| Noctuidae    | *Thyas junio* (Dalman, 1823)                    | woody                 | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae    | *Trachea punkikonis* Matsumura, 1927            | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae    | *Trachea tokiensis* (Butler, 1884)              | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Noctuidae    | *Treitschkendia tarsipennalis* (Treitschke, 1835)| dead leaves           | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae    | *Virgo datanidia* (Butler, 1885)                | unknown               | unknown               | 0    | 1      | 1         | 0     |
| Noctuidae    | *Xestia c-nigrum* (Linnaeus, 1758)              | herb                  | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae    | *Xestia ditrapezium* (Denis & Schiffermüller, 1775) | herb                  | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae    | *Xestia efforescens* (Butler, 1879)             | unknown               | unknown               | 1    | 1      | 1         | 1     |
| Noctuidae    | *Xestia stupenda* (Butler, 1878)                | herb                  | generalist            | 1    | 1      | 1         | 1     |
| Noctuidae    | *Zanclognatha lunalis* (Scopoli, 1763)          | dead leaves           | generalist            | 1    | 0      | 0         | 0     |
| Noctuidae    | *Zekelita plusioides* (Butler, 1879)            | lichen/moss           | generalist            | 1    | 0      | 0         | 0     |
| Nolidae      | *Earias pudicana* Staudinger, 1887               | woody                 | generalist            | 1    | 1      | 0         | 0     |
| Nolidae      | *Gelastocera exusta* Butler, 1877               | woody                 | generalist            | 1    | 0      | 0         | 0     |
| Nolidae      | *Gelastocera kotschubeji* Obraztsov, 1943       | woody                 | generalist            | 1    | 0      | 0         | 0     |
| Nolidae      | *Nola taniata* Snellen, 1874                    | unknown               | unknown               | 0    | 1      | 0         | 0     |
| Nolidae      | *Nola trilinea* Marumo, 1923                    | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Nolidae      | *Pseudoips prasinanus* (Linnaeus, 1758)         | woody                 | specialist            | 1    | 0      | 1         | 0     |
| Notodontidae | *Clostera anachoreta* Denis & Schiffermüller, 1775| woody                 | specialist            | 1    | 0      | 0         | 0     |
| Notodontidae | *Cutuja straminea* (Walker, 1865)               | herb                  | specialist            | 1    | 0      | 0         | 0     |
| Notodontidae | *Epodonta lineata* (Oberthür, 1880)             | woody                 | specialist            | 1    | 1      | 0         | 0     |
| Notodontidae | *Fentonia ocypete* (Bremer, 1861)               | woody                 | specialist            | 1    | 0      | 0         | 1     |
| Notodontidae | *Furcula furcula* (Clerck, 1759)                | woody                 | specialist            | 1    | 0      | 0         | 0     |
| Notodontidae | *Gonoclostera timoniorum* (Bremer, 1861)        | woody                 | specialist            | 1    | 0      | 0         | 0     |
| Notodontidae | *Hexafrenum leucodera* (Staudinger, 1892)       | woody                 | generalist            | 1    | 0      | 0         | 0     |
| Notodontidae | *Hupodonta corticalis* Butler, 1877              | woody                 | specialist            | 1    | 0      | 0         | 0     |
| Notodontidae | *Mimopydna pallida* (Butler, 1877)              | herb                  | specialist            | 1    | 0      | 0         | 0     |
| family   | species name                                          | food       | specialist/  | 1987 | forest | grassland | mixed |
|----------|-------------------------------------------------------|------------|--------------|------|--------|-----------|-------|
| Notodontidae | Nerice bipartita Butler, 1885                        | woody      | specialist   | 0    | 1      | 0         | 0     |
| Notodontidae | Peridea gigantea Butler, 1877                       | woody      | specialist   | 1    | 0      | 0         | 0     |
| Notodontidae | Phalera flavescens (Bremer & Grey, 1853)            | woody      | specialist   | 1    | 0      | 0         | 0     |
| Notodontidae | Phalerodonta manleyi (Leech, 1889)                  | woody      | specialist   | 0    | 1      | 0         | 0     |
| Notodontidae | Rheosiopsis cinerea (Butler, 1879)                  | woody      | specialist   | 1    | 0      | 0         | 0     |
| Notodontidae | Pterostoma gigantinum Staudinger, 1892             | woody      | specialist   | 1    | 0      | 0         | 0     |
| Notodontidae | Shaka atrovittatus (Bremer, 1861)                  | woody      | specialist   | 0    | 1      | 1         | 0     |
| Notodontidae | Stauropus basalis (Moore, 1877)                    | woody      | generalist   | 1    | 0      | 0         | 1     |
| Notodontidae | Stauropus fagi (Linnaeus, 1758)                    | woody      | generalist   | 1    | 0      | 0         | 0     |
| Notodontidae | Syntypistis cyanea (Leech, 1889)                  | woody      | specialist   | 1    | 0      | 0         | 0     |
| Oecophoridae | Acyptolechia malacobyrsa (Meyrick, 1921)             | dead leaves| generalist   | 0    | 0      | 0         | 1     |
| Oecophoridae | Acyptolechia sp. 1                                  | unknown    | unknown      | 0    | 1      | 1         | 0     |
| Oecophoridae | Periacma delegata Meyrick, 1914                     | unknown    | unknown      | 0    | 1      | 1         | 0     |
| Oecophoridae | Tyrolimnas anthraconesa Meyrick, 1934              | dead leaves| generalist   | 0    | 1      | 0         | 0     |
| Pyralidae | Acrobasis bellulella (Ragonot, 1893)               | woody      | generalist   | 1    | 0      | 0         | 0     |
| Pyralidae | Acrobasis birgitella (Roesler, 1975)               | woody      | specialist   | 1    | 0      | 0         | 0     |
| Pyralidae | Acrobasis ferruginella Wileman, 1911              | woody      | specialist   | 1    | 0      | 0         | 0     |
| Pyralidae | Acrobasis squalidella Christoph, 1881              | woody      | specialist   | 0    | 1      | 0         | 1     |
| Pyralidae | Addyme confusalis Yamanaka, 2006                   | herb/woody | generalist   | 1    | 1      | 0         | 1     |
| Pyralidae | Assara funerella (Ragonot, 1901)                   | woody      | specialist   | 1    | 0      | 0         | 0     |
| Pyralidae | Ceroprepes ophthalmicella (Christoph, 1881)     | woody      | specialist   | 1    | 0      | 0         | 0     |
| Pyralidae | Ceroprepes patriciella Zeller, 1867               | unknown    | unknown      | 1    | 0      | 0         | 0     |
| Pyralidae | Ectomyelois pyrivorella (Matsumura, 1899)         | woody      | specialist   | 1    | 0      | 0         | 0     |
| Pyralidae | Emmalocera venosella (Wileman, 1911)              | unknown    | unknown      | 1    | 1      | 0         | 1     |
| Pyralidae | Endotricha consocia (Butler, 1879)                | unknown    | unknown      | 0    | 1      | 0         | 1     |
| Pyralidae | Endotricha kuznetzovi Whalley, 1963               | dead leaves| generalist   | 1    | 1      | 1         | 0     |
Fauna of nocturnal moth species collected in a semi-natural grassland at ...

| family      | species name                                                                 | food         | specialist/generalist | 1987 | forest | grassland | mixed |
|-------------|------------------------------------------------------------------------------|--------------|------------------------|------|--------|-----------|-------|
| Pyralidae   | *Endotricha olivacealis* (Bremer, 1864)                                      | dead leaves  | generalist             | 1    | 1      | 0         | 1     |
| Pyralidae   | *Etielloides bipartitellus* (Leech, 1889)                                    | unknown      | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Euzophera batangensis* Caradja, 1939                                        | woody        | generalist             | 1    | 0      | 0         | 0     |
| Pyralidae   | *Furcata dichromella* (Ragonot, 1993)                                        | woody        | specialist             | 1    | 0      | 0         | 0     |
| Pyralidae   | *Furcata hollandella* (Ragonot, 1893)                                        | woody        | specialist             | 1    | 0      | 0         | 0     |
| Pyralidae   | *Furcata pseudodichromella* (Yamanaka, 1980)                                 | woody        | specialist             | 1    | 0      | 0         | 0     |
| Pyralidae   | *Hypsopygia regina* (Butler, 1879)                                           | woody        | generalist             | 0    | 1      | 0         | 1     |
| Pyralidae   | *Lepidogma melanobasis* Hampson, 1906                                        | unknown      | unknown                | 0    | 1      | 0         | 1     |
| Pyralidae   | *Locastra muscosalis* (Walker, 1866)                                         | woody        | generalist             | 1    | 0      | 0         | 0     |
| Pyralidae   | *Maliarpha borealis* Sasaki, 2012                                            | unknown      | unknown                | 0    | 1      | 0         | 0     |
| Pyralidae   | *Nyctegretis trigangulella* (Hampson, 1901)                                  | unknown      | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Oncocera bitinctella* (Wileman, 1911)                                       | unknown      | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Oncocera semirubella* (Scopoli, 1763)                                       | herb         | specialist             | 1    | 1      | 1         | 1     |
| Pyralidae   | *Orthaga achatina* (Butler, 1878)                                            | woody        | generalist             | 0    | 0      | 0         | 1     |
| Pyralidae   | *Orthaga euadrusalis* Walker, 1859                                           | woody        | specialist             | 0    | 0      | 0         | 1     |
| Pyralidae   | *Ortholepis infausta* (Ragonot, 1893)                                        | unknown      | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Orthopygia placens* (Butler, 1879)                                          | unknown      | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Paraemmalocera gensanalis* (South, 1901)                                   | unknown      | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Patagoniodes nipponellus* (Ragonot, 1901)                                  | unknown      | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Phycitodes matsumurellus* (Shibuya, 1927)                                  | unknown      | unknown                | 0    | 1      | 0         | 0     |
| Pyralidae   | *Pseudacrobasis nankingella* Roesler, 1975                                  | unknown      | unknown                | 0    | 1      | 0         | 0     |
| Pyralidae   | *Quasipuer colon* (Christoph, 1881)                                          | unknown      | unknown                | 1    | 0      | 0         | 1     |
| Pyralidae   | *Sacada fasciata* (Butler, 1878)                                            | woody        | generalist             | 1    | 0      | 0         | 1     |
| Pyralidae   | *Salma amica* (Butler, 1879)                                                 | unknown      | unknown                | 1    | 0      | 0         | 0     |
| family      | species name                               | food                  | specialist/ generalist | 1987 | forest | grassland | mixed |
|-------------|-------------------------------------------|-----------------------|------------------------|------|--------|-----------|-------|
| Pyralidae   | *Salma elegans* (Butler, 1881)            | herb/ woody           | generalist             | 1    | 1      | 0         | 0     |
| Pyralidae   | *Scirpophaga virginia* Schultz, 1908      | unknown               | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Scirpophaga xanthopygata* Schawerda, 1922| unknown               | unknown                | 1    | 0      | 0         | 0     |
| Pyralidae   | *Selagia spadicella* (Hübner, 1796)       | unknown               | unknown                | 0    | 0      | 0         | 1     |
| Pyralidae   | *Tegulifera bicoloralis* (Leech, 1889)    | dead leaves           | generalist             | 1    | 0      | 0         | 0     |
| Pyralidae   | *Termioptycha margarita* (Butler, 1879)   | unknown               | unknown                | 1    | 0      | 0         | 1     |
| Pyralidae   | *Trebania flavifrontalis* (Leech, 1889)   | unknown               | unknown                | 0    | 1      | 0         | 0     |
| Saturniidae | *Actias aliena* (Butler, 1879)            | woody                 | generalist             | 1    | 0      | 0         | 0     |
| Saturniidae | *Saturnia japonica* (Moore, 1872)         | woody                 | generalist             | 1    | 0      | 0         | 0     |
| Saturniidae | *Saturnia jonasii* (Butler, 1877)         | woody                 | generalist             | 0    | 1      | 1         | 1     |
| Sphingidae  | *Acosmeryx naga* (Moore, 1858)            | woody                 | specialist             | 1    | 1      | 0         | 1     |
| Sphingidae  | *Agrius convolvuli* (Linnaeus, 1758)      | herb                  | generalist             | 0    | 0      | 1         | 0     |
| Sphingidae  | *Ambulyx ochracea* Butler, 1885           | woody                 | specialist             | 1    | 0      | 0         | 0     |
| Sphingidae  | *Ampelophaga rubiginosa* Bremer & Grey, 1853| woody                 | specialist             | 1    | 1      | 0         | 1     |
| Sphingidae  | *Callambulyx tatarinovii* (Bremer & Grey, 1852) | woody                 | specialist             | 1    | 0      | 0         | 0     |
| Sphingidae  | *Clanis bilineata* (Walker, 1866)         | herb/ woody           | generalist             | 1    | 1      | 0         | 0     |
| Sphingidae  | *Deilephila askoldensis* (Oberthür, 1879) | herb                  | specialist             | 1    | 1      | 1         | 0     |
| Sphingidae  | *Deilephila elpenor* (Linnaeus, 1758)     | herb                  | generalist             | 1    | 0      | 0         | 0     |
| Sphingidae  | *Marumba gaschkewitschii* (Bremer & Grey, 1853) | herb/ woody           | specialist             | 1    | 0      | 1         | 1     |
| Sphingidae  | *Marumba sperchius* (Ménétriès, 1857)     | woody                 | specialist             | 1    | 0      | 0         | 0     |
| Sphingidae  | *Smerinthus planus* Walker, 1856          | woody                 | generalist             | 1    | 0      | 0         | 0     |
| Sphingidae  | *Theretra japonica* (Boisduval, 1869)     | herb/ woody           | generalist             | 1    | 0      | 1         | 1     |
| Thyrididae  | *Strigilina cancellata* (Christoph, 1881) | woody                 | specialist             | 1    | 1      | 0         | 0     |
| Tortricidae | *Aethes cnicana* (Westwood, 1854)         | unknown               | unknown                | 1    | 0      | 0         | 0     |
| Tortricidae | *Aethes rectilinea* (Caradja, 1939)       | unknown               | unknown                | 1    | 0      | 0         | 0     |
| family   | species name                        | food                  | specialist/generalist | 1987 | forest | grassland | mixed |
|----------|-------------------------------------|-----------------------|-----------------------|------|--------|-----------|-------|
| Tortricidae | Ancylis mandarinana Walsingham, 1900 | woody                | specialist            | 1    | 0      | 0         | 0     |
| Tortricidae | Apotomis basipunctana (Walsingham, 1900) | woody                | specialist            | 0    | 0      | 0         | 1     |
| Tortricidae | Apotomis capreana (Hübner, 1817) | woody                | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Apotomis geminata (Walsingham, 1900) | woody                | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Archips audax Razowski, 1977 | herb/woody           | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Archips fuscocupreana Walsingham, 1900 | herb/woody           | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Archips ingentana (Christoph, 1881) | herb/woody           | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Archips oporana (Linnaeus, 1758) | woody                | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Archips semistructa (Meyrick, 1937) | herb/woody           | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Choristoneura longicellana (Walsingham, 1900) | woody                | generalist            | 1    | 0      | 0         | 0     |
| Tortricidae | Cochylidia subroseana (Haworth, 1811) | herb                 | specialist            | 1    | 0      | 0         | 0     |
| Tortricidae | Cydia danilevskyi (Kuznetzov, 1973) | woody                | specialist            | 1    | 0      | 0         | 0     |
| Tortricidae | Diplocalyptis congruentana (Kennel, 1901) | herb                 | specialist            | 0    | 0      | 0         | 1     |
| Tortricidae | Epiblema autolitha (Meyrick, 1931) | unknown              | unknown               | 1    | 0      | 0         | 0     |
| Tortricidae | Epiblema foenella (Linnaeus, 1758) | herb                 | specialist            | 1    | 1      | 1         | 1     |
| Tortricidae | Epinotia bicolor (Walsingham, 1900) | woody                | specialist            | 1    | 0      | 0         | 0     |
| Tortricidae | Epinotia majorana (Caradja, 1916) | herb                 | specialist            | 1    | 0      | 0         | 0     |
| Tortricidae | Eucosma catharaspis (Meyrick, 1922) | unknown              | unknown               | 1    | 0      | 0         | 0     |
| Tortricidae | Eucosma denigratana (Kennel, 1901) | unknown              | unknown               | 1    | 0      | 0         | 0     |
| Tortricidae | Eucosma metzneriana (Treitschke, 1830) | herb                 | specialist            | 1    | 0      | 0         | 0     |
| Tortricidae | Eucosma striatiradix Kuznetzov, 1964 | unknown              | unknown               | 1    | 0      | 0         | 0     |
| Tortricidae | Eucosma tundrana (Kennel, 1900) | unknown              | unknown               | 0    | 1      | 0         | 0     |
| Tortricidae | Eudemis porphyra (Hübner, 1799) | woody                | specialist            | 0    | 1      | 0         | 0     |
| Tortricidae | Eugnosta dives (Butler, 1878) | herb                 | specialist            | 0    | 0      | 1         | 0     |
In order to explore the food habits of moth species at each site in both years, the moth species were classified into six feeding groups: 1) species that primarily feed on herbs, 2) species that primarily feed on shrubs and/or trees, 3) species that feed on both herbs and trees, 4) species that primarily feed on lichens, 5) species that primarily feed on dead leaves and 6) species whose food habit is unknown, referring to the guide “The Standard of Moths in Japan I-IV” (Kishida 2011a, Kishida 2011b, Hirowatari et al. 2013, Nasu et al. 2013). The collected moths were also classified into two groups based on the range of host plants: 1) specialist, defined as species that feed on only one plant family and 2) generalists, defined as species that feed on more than two plant families. We calculated the proportions of each feeding groups for each site in both years.
Results and Discussion

The number of taxa of moths recorded in 2018 at each site (excluding the 4 families and 10 species of micro-moths) was 14 families, 79 genera and 95 species for the grassland site; 16 families, 115 genera and 137 species for the forest site and 14 families, 103 genera and 123 species for the mixed site (Fig. 2). In total, 17 families, 181 genera and 226 species were recorded in 2018. This was nearly two-thirds of the species recorded in 1987, which comprised of 16 families, 291 genera and 396 species. Amongst all the moth species documented, only 118 species were observed in both periods. The 278 species that were recorded in 1987 were not recorded in 2018, while 115 species were newly recorded in 2018.

Species composition of moths between years and amongst sites

The results of the PERMANOVA showed that the species composition of the moths significantly differed between years (Fig. 3a; $R^2 = 0.06$, $P = 0.02$). This suggests that species composition at the three sites in 2018 differed from that in 1987. On the other hand, when the data of 1987 was excluded from the analysis, it did not differ amongst sites in 2018 (Fig. 3b; $R^2 = 0.08$, $P = 0.99$). This may be because the three sites in 2018 were located in a geographically adjacent area (an average of 400 m between sites). Studies that detected differences in moth species composition amongst different vegetation and management were sites that were geographically separated by more than 1 km (Öckinger and Smith 2006, Pöyry et al. 2009). As some moth species are known to show high mobility (i.e. a flight range larger than 500 m in radius) (van der Meulen and Groenendijk 2005, Merckx and Macdonald 2015), species composition of moths may not differ in a small spatial scale. Furthermore, because the present data included only one replicate for each type of vegetation, more replicates from multiple sites would be useful in confirming
that the difference in vegetation reflecting the management did not affect the moth species composition in the semi-natural grassland in Kanpu-zan.

**Food habits**

The number of species that may rely on woody plants comprised more than half of the total number of species at all sites in both years (Fig. 4a). This includes species that feed only on woody plants; species that feed on both herbs and woody plants; species that feed on lichens and mosses; and species that feed on dead leaves. These species were known to consume woody plants that belong to the families of Fagaceae, Rosaceae, Fabaceae and Caprifoliaceae. Trees and shrubs that belong to Fagaceae and Rosaceae were dominant in the forest site and Fabaceae shrubs and vines were scattered across the grassland site, while the mixed site had a mixture of vegetation of both sites. Moreover, trees and shrubs such as *Cerasus jamasakura* H.Ohba and *Quercus serrata* Murray were present in grasslands in 1987 (Takahashi 1993, K. Umetsu, personal observation). These suggest that, in both years, moth fauna in Kanpu-zan was mainly comprised of species that may feed on woody plants.

![Figure 3](https://example.com/figure3.png)

**Figure 3.** Non-metric multidimensional scaling (NMDS) ordination graphs of monthly aggregated moth communities showing (a) for both years and (b) for 2018.

**Figure 4.**

Proportion of each food habits for moth species (a) of each site in both years, (b) those unique to each year and common in both years.

![Figure 4](https://example.com/figure4.png)
For the 118 species that were recorded in both in 1987 and 2018, the composition rate of species that may use both herbs and woody plants was 19%, which was higher compared to that for the species that were only recorded in either 1987 or 2018, at 10.1% and 11.2%, respectively (Fig. 4b). This may be because the species that can feed on both herbs and woody species are adapted to habitats with various vegetations and were tolerant to the environmental change between 1987 and 2018 caused by decline in grasslands. Species that primarily feed on herbs such as Deilephila askoldensis, which is known to inhabit volcanic grasslands (Yano 2011), consisted of 15-20% in all three sites in 2018. The semi-natural grasslands in Kanpu-zan may be a valuable habitat for the larvae of these moths. On the other hand, the composition rate of species that feed on lichens was relatively low in all sites and especially low at the grassland site in 2018 (Fig. 4a). This is consistent with the result in 1987, which identified that it is one of the characteristics in grasslands that lichen feeding moths are scarce (Takahashi 1993).

The composition rate of specialist and generalist moths was stable across sites including the year 1987. Generalists consisted of 43.8±1.5% (mean±SE) of the total number of moth species in both years (Fig. 5). Out of the 280 species of moths that were only recorded in 1987, 107 species were generalists that feed on plants that are commonly distributed in Kanpu-zan (Masui et al. 2017).

**Conclusion**

The present study suggests the species composition changed between 1987 and 2018 and the number of moth species largely declined in the last 30 years. Wenzel et al. (2006) also showed that the number of butterflies and burnet moths had declined between 1972 and 2001 in calcareous grassland remnants in south-western Germany. They suggested that species which require structured habitats, species with low mobility, species which require more than 16 ha of habitat and specialist feeders were especially affected by the decline. As we did not find any moths that depend on endangered plants or whose food plant had
become extinct, it is unlikely that the decline in the moths in Kanpu-zan was due to the loss in food plants. Other factors such as plant height, flowering species richness and habitat connectivity (Pöry et al. 2009) may have caused the decline. Continuing landscape management such as mowing and burning may be important, not only for endangered species, but also for common moth species and to maintain the nocturnal moth community in semi-natural grasslands.

A previous study in Japan covering 31 agricultural areas, including semi-natural grasslands, demonstrated that declines in herbivorous insects in both abandoned and intensified use of agricultural landscapes are also explained by multiple factors (Uchida and Ushimaru 2014). It has been reported that there are large differences with respect to the preferred management intensity amongst species groups in the grassland habitats (Pöry et al. 2006). More studies on other organism fauna are needed for understanding the conservation of semi-natural grassland, considering that the loss of semi-natural grasslands is one of the major threats to biodiversity.

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Supplementary material

Suppl. material 1: monthly species occurrences doi

Authors: Masaru Kamikura, Yuzu Sakata
Data type: occurrences
Brief description: monthly species occurrences of nocturnal moths
Download file (61.39 kb)