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Macrolepidopterous Moth Fauna on a Volcano Mt. Usu Six Years after the 1977–78 Eruptions[1)]

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Abstract

In total 4,747 samples of 329 macrolepidopterous moth species were obtained in the surveys conducted at Yosomi Hill and the crater basin of Mt. Usu in 1984. As in Nopporo (Sakamoto *et al.*, 1977; Sato, 1985) and Tomakomai (Yoshida, 1976, 1981), Noctuidae, Geometridae and Notodontidae exceeded the other families in number of species. Dominant species were *Perizoma saxeum*, *Thera variata* (Geometridae) and *Hypena tristalis* (Noctuidae) in the late spring; *Chasminodes nervosa*, *Chasminodes* spp., *Cosmia unicolor* (Noctuidae) in the summer; *Amphipoea ussuriensis*, *Hydraecia amurensis* (Noctuidae), *Perizoma saxeum* (Geometridae) in the autumn; *Ptilophora nohirae* (Notodontidae), *Erannis golda* (Geometridae) in the early winter. Since the species feeding on broad-leaved trees and conifers were rich in the crater basin deforested by the last eruptions, many moth species seemed to have immigrated from the base to the top of the mountain. The level of species diversity was almost same between Yosomi Hill and the crater basin throughout all seasons, though the evenness was lower in the crater basin from spring to autumn due to a predominance of *Chasiminodes nervosa*, *Chasminodes* spp. and *Cosmia unicolor*.

Key Words: Mt. Usu, Macrolepidopterous moth fauna, Immigration, Species diversity

1. Introduction

Since the 1977–78 eruptions caused serious damages on the vegetation and the fauna, an active volcano, Mt. Usu, provided opportunities for study of the ecological recovery or succession after the complete destruction of a bioecosystem (Oota and Ito, 1980; Ito and Haruki, 1984). An entomological census was also conducted by Sakagami *et al.* (1980) in 1977 and 1978, which reported the serious defaunation of insects due to deforestation and thick accumulation of volcanic ash. As a second census of insects, in 1984 six years after the last eruptions we made a comprehensive survey of ants, bees, springtails, ground beetles and moths. The present paper represents the results of the moth survey, which is the first report of the comprehensive study.

1) Entomological and ecological surveys on Mt. Usu in 1984. I.

Fortunately, the taxonomy of Japanese moths is advanced today and their host plants have been identified (Inoue *et al.* 1982), which has contributed to a great amount of research on moth communities in central Hokkaido. This paper will discuss the faunal makeup, the species diversity, and the immigration of macrolepidopterous moths, by comparing the moth communities in Nopporo (Sakamoto *et al.* 1977; Sato, 1985) and Tomakomai (Yoshida, 1976, 1981), and by estimating the habitat preference of each moth species from their host plants.

2. Localities and Sampling Method

Mt. Usu consists of two peaks, O-usu (729 m in alt.) and Ko-usu (609 m), which are enclosed with a crater basin and a somma (Figure 1). The 1977–78 eruptions caused complete deforestation of the top areas and slopes above 350 m (Iwaki, 1978). At present, according to Ito and Haruki (1984) and our observation, an exposed ground of volcanic ash extends in these areas with occasional occurrence of artificial lawns (*Festuca rubra* var. *rubra*, *F. elatior*, *Artemisia montana*, *Trifolium repens*) and natural herbs (*Petasites japonicus* var. *giganteus*, *Polygonum sachalinense*, *Polygonum longisetum*, *Rumex obtusifolius*) sparsely containing broad-leaved saplings (*Populus maximowiczii*, *Acer mono*, *Betula ermanii*, *Alnus hirsuta*). The area below 350 m is covered with coniferous plantations (*Abies sachalinensis*,

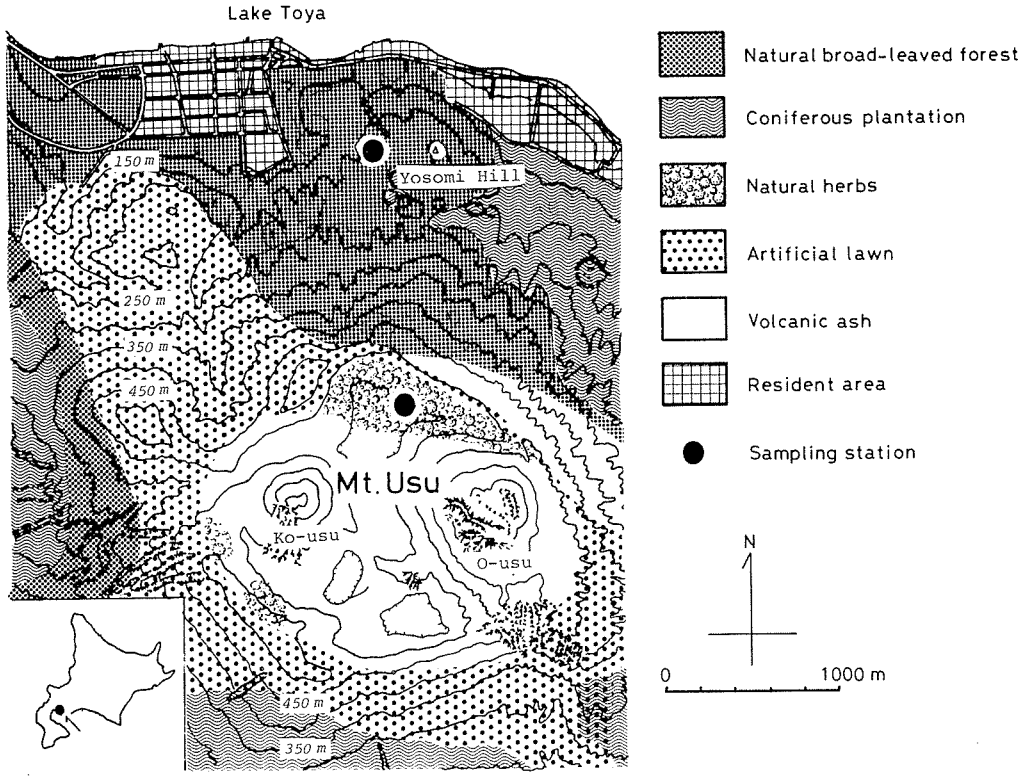

Figure 1. Topography and vegetation of area studied (after Iwaki, 1978).

Larix leptolepis), natural broad-leaved forests (*Populus maximowiczii, Alnus hirsuta, Betula ermanii, Ulmus davidiana* var. *japonica, Acer mono, Tilia japonica, Kalopanax pictus, Quercus mongolica* var. *grosseserrata, Cercidiphyllum japonicum*), and resident areas (Figure 1).

The moth sampling was conducted in the crater basin from sunset to sunrise on June 16/17 (late spring), July 31/August 1 (summer), September 8/9 (autumn) and October 30/31 (early winter). Moreover, because Yosomi Hill did not suffer the serious damages vegetationally during the last eruptions control sampling was made in a natural broad-leaved forest on June 15/16, July 31/August 1, September 8/9 and October 29/30. During each sampling a 20-watt mercury light and two 40-watt fluorescent black lamps screened with a white 110×220 cm cloth were fixed at a height of 120 cm. Moths lured to the lights were captured with an insect net and poison bottles.

3. Results and Discussion

The list of moth species obtained in the present survey is given below, with the following items presented: scientific name, total number of individuals (total=males+females), and in parentheses sampling site (A: Yosomi Hill, B: the crater basin), and monthly number* (total=males+females).

Family **LIMACODIDAE**

1. *Austrapoda dentata* (Oberthür). 2=2+0. (A: VII 1=1+0, B: VII 1=1+0)
2. *Latoia sinica* (Moore). 2=2+0. (A: VI 1=1+0, B: VI 1=1+0)

Family **DREPANIDAE**

3. *Nordstromia grisearia* (Staudinger). 2=2+0. (A: VI 2=2+0)
4. *Drepana curvatula* (Borkhausen). 23=12+11. (A: VI 1=0+1, VII 3=1+2, B: VI 2=2+0, VII 17=9+8)
5. *Callidrepana palleola* (Motschulsky). 21=20+1. (A: VI 7=7+0, VII 7=6+1, IX 3=3+0, B: VIII 4=4+0)
6. *Auzata superba* (Butler). 2=2+0. (A: VII 1=1+0, B: 1=1+0)
7. *Oreta pulchripes* Butler. 4=4+0. (A: VI 1=1+0, IX 3=3+0)

Family **THYATIRIDAE**

8. *Thyatira batis* (Linnaeus). 7=3+4. (A: VII 1=1+0, B: VI 4=2+2, VII 2=0+2)
9. *Tethea albicostata* (Bremer). 1=0+1. (B: VII 1=0+1)
10. *T. consimilis* (Warren). 3=3+0. (A: VI 1=1+0, B: VI 2=2+0)
11. *Tetheella fluctuosa* (Hübner). 3=3+0. (B: VI 3=3+0)
12. *Parapsestis argenteopicta* (Oberthür). 2=2+0. (A: VI 1=1+0, B: VI 1=1+0)

Family **GEOMETRIDAE**

Subfamily GEOMETRINAE

13. *Pachyodes superans* (Butler). 8=7+1. (A: VII 5=5+0, B: VII 3=2+1)

* Roman numerals indicate particular month.

14. *Agathia carissima* Butler. 1=0+1. (B: VIII 1=0+1)
15. *Geometra papilionaria* (Linnaeus). 27=22+5. (A: VII 6=5+1, B: VII 21=17+4)
16. *G. dieckmanni* Graeser. 6=3+3. (A: VII 1=1+0, B: VII 5=2+3)
17. *Culpinia diffusa* (Walker). 2=1+1. (A: VI 1=1+0, B: VII 1=0+1)

Subfamily STERRHINAE

18. *Timandra* spp.. 12=12+0. (A: VI 7=7+0, VII 1=1+0, IX 1=1+0, B: IX 3=3+0)
19. *Problepsis plagiata* (Butler) 1=0+1. (B: VII 1=0+1)
20. *Scopula nigropunctata* (Hufnagel). 1=1+0. (B: IX 1=1+0)
21. *S. umbelaria* (Hübner). 2=1+1. (A: VII 1=0+1, B: VII 1=1+0)
22. *S. pudicaria* (Motschulsky). 6=6+0. (A: VI 6=6+0)
23. *S. floslactata* (Haworth). 1=1+0. (A: VI 1=1+0)
24. *S. tenuisocius* Inoue. 6=6+0. (A: VI 6=6+0)
25. *S. ignobilis* (Warren). 2=2+0. (A: VI 1=1+0, B: VI 1=1+0)
26. *Idaea foedata* (Butler). 1=1+0. (A: VII 1=1+0)

Subfamily LARENTIINAE

27. *Leptostegna tenerata* Christoph. 1=1+0. (A: VI 1=1+0)
28. *Tyloptera bella* (Butler). 12=9+3. (A: VI 7=5+2, VII 1=1+0, B: VI 1=1+0, VII 3=2+1)
29. *Brabira artemidora* (Oberthür). 32=21+11. (A: VI 7=5+2, VII 12=10+2, B: VI 6=3+3, VII 7=3+4)
30. *Xanthorhoe quadrifasciata* (Clerck). 1=1+0. (B: VII 1=1+0)
31. *Glaucorhoe unduliferaria* (Motschulsky). 1=1+0. (A: IX 1=1+0)
32. *Euphyia cineraria* (Butler). 1=1+0. (A: VI 1=1+0)
33. *Electrophaes corylata* (Thunberg). 4=3+1. (A: VI 2=1+1, B: VI 2=2+0)
34. *Mesoleuca albicillata* (Linnaeus). 2=2+0. (A: VI 2=2+0)
35. *Epirrhoe supergressa* (Butler). 9=8+1. (A: VI 6=5+1, VII 1=1+0, IX 2=2+0)
36. *Hydriomena furcata* (Thunberg). 2=2+0. (A: VI 2=2+0)
37. *H. impluviata* (Denis & Schiffermüller). 1=1+0. (A: VI 1=1+0)
38. *Calleulype whitelyi* (Butler). 1=1+0. (A: VII 1=1+0)
39. *Eucosmabraxas placida* (Butler). 7=6+1. (A: VII 5=5+0, B: VII 2=1+1)
40. *E. evanescens* (Butler). 6=5+1. (B: VII 6=5+1)
41. *Eulithis ledereri* (Bremer). 5=3+2. (A: VII 4=3+1, B: VII 1=0+1)
42. *E. convergenata* (Bremer). 2=2+0. (A: VII 1=1+0, B: VII 1=1+0)
43. *Gandaritis fixseni* (Bremer). 4=2+2. (A: VII 1=1+0, B: VII 3=1+2)
44. *G. agnes* (Butler). 46=46+0. (A: VII 3=3+0, B: VII 43=43+0)
45. *Lampropteryx minna* (Butler). 1=1+0. (A: VI 1=1+0)
46. *Ecliptopera umbrosaria* (Motschulsky). 80=47+33. (A: VI 4=3+1, VII 15=11+4, IX 2=2+0, B: VI 2=2+0, VII 57=29+28)
47. *E. capitata* (Herrich-Schäffer). 2=2+0. (A: VII 1=1+0, B: VII 1=1+0)
48. *E. pryeri* (Butler). 1=1+0. (B: IX 1=1+0)
49. *Eustroma inextricata* (Walker). 4=4+0. (A: VI 3=3+0, VII 1=1+0)
50. *E. aerosum* (Butler). 9=8+1. (A: VI 6=6+0, VII 2=2+0, B: IX 1=0+1)

51. *E. melancholicum* (Butler). 3=3+0. (A: VI 3=3+0)
52. *Lobogonodes erectaria* (Leech). 103=49+54. (A: VII 10=6+4, B: VI 2=1+1, VII 91=42+49)
53. *Plemyria rubiginata* (Denis & Schiffermüller). 4=3+1. (A: VII 1=0+1, IX 3=3+0)
54. *Dysstroma citrata* (Linnaeus). 2=2+0. (A: VI 2=2+0)
55. *Thera variata* (Denis & Schiffermüller). 41=37+4. (A: VI 5=5+0, B: VI 36=32+4)
56. *Operophtera brumata* (Linnaeus). 1=1+0. (B: X 1=1+0)
57. *O. relegata* Prout. 1=1+0. (A: X 1=1+0)
58. *Venusia cambrica* Curtis. 1=1+0. (B: VI 1=1+0)
59. *Hydrelia sylvata* (Denis & Schiffermüller). 3=3+0. (A: VI 3=3+0)
60. *H. gracilipennis* Inoue. 1=1+0. (B: VII 1=1+0)
61. *Perizoma saxeum* (Wileman). 84=47+37. (A: VI 1=0+1, VII 3=3+0, IX 11=8+3, B: VI 57=29+28, VII 10=5+5, IX 2=2+0)
62. *Eupithecia gigantea* Staudinger. 4=0+4. (B: VII 4=0+4)
63. *E.* sp.. 1=1+0. (A: IX 1=1+0)
64. *Chloroclystis v-ata* (Haworth). 27=10+17. (A: VII 14=5+9, B: VII 13=5+8)
65. *C. obscura* West. 1=0+1. (A: VII 1=0+1)

Subfamily ENNOMINAE

66. *Abraxas* spp.. 30=26+4. (A: VI 12=9+3, B: VI 18=17+1)
67. *Lomaspilis marginata* (Linnaeus). 9=8+1. (A: VI 6=5+1, B: VI 3=3+0)
68. *Lomographa bimaculata* (Fabricius). 16=14+2. (A: VI 12=11+1, B: VI 4=3+1)
69. *L. temerata* (Denis & Schiffermüller). 1=1+0. (B: VI 1=1+0)
70. *Cabera exanthemata* (Scopoli). 12=11+1. (A: VI 7=6+1, B: VI 5=5+0)
71. *C. purus* (Butler). 12=11+1. (A: VI 11=10+1, B: VII 1=1+0)
72. *C. griseolimbata* (Oberthür). 1=1+0. (A: VI 1=1+0)
73. *Parabapta aetheriata* (Graeser). 1=1+0. (A: VI 1=1+0)
74. *Semiothisa shanghaisaria* (Walker). 1=1+0. (A: VI 1=1+0)
75. *S. liturata* (Clerck). 2=1+1. (B: VI 2=1+1)
76. *S. normata* (Alphéraky). 12=11+1. (A: VI 5=4+1, VII 7=7+0)
77. *Ectephrina semilutea* (Lederer). 3=1+2. (B: VII 3=1+2)
78. *Metabraxas clerica* Butler. 9=8+1. (A: VII 2=2+0, B: VI 7=6+1)
79. *Arichanna albomacularia* Leech. 4=3+1. (A: VI 3=3+1, B: VII 1=0+1)
80. *Cleora insolita* (Butler). 16=11+5. (A: VI 2=0+2, B: VI 14=11+3)
81. *Alcis picata* (Butler). 1=0+1. (B: VI 1=0+1)
82. *Deileptenia ribeata* (Clerck). 18=6+12. (A: VII 6=3+3, B: VII 12=3+9)
83. *Hypomecis roboraria* (Denis & Schiffermüller). 5=4+1. (A: VI 2=2+0, B: VII 3=2+1)
84. *H. lunifera* (Butler). 10=8+2. (A: VII 10=8+2)
85. *H. crassestrigata* (Christoph) 2=2+0. (A: VI 1=1+0, B: VI 1=1+0)
86. *H. punctinalis* (Scopoli). 30=29+1. (A: VI 26=25+1, B: VI 4=4+0)
87. *Microcalicha fumosaria* (Leech). 1=0+1. (A: VII 1=0+1)

88. *M. sordida* (Butler). 9=9+0. (A: VI 5=5+0, B: VI 4=4+0)
89. *Calicha ornataria* (Leech). 3=3+0. (A: VI 2=2+0, B: VI 1=1+0)
90. *Phthonosema tendinosaria* (Bremer). 8=8+0. (A: VI 2=2+0, VII 1=1+0, B VI 5=5+0)
91. *Ascotis selenaria* (Denis & Schiffermüller). 2=2+0. (B: VI 2=2+0)
92. *Paradarisa consonaria* (Hübner). 1=1+0. (B: VI 1=1+0)
93. *Cusiala stipitaria* (Oberthür). 1=1+0. (A: VI 1=1+0)
94. *Ectropis bistortata* (Goeze). 8=7+1. (A: VI 7=7+0, VII 1=0+1)
95. *E. aigneri* Prout. 19=19+0. (A: VI 18=18+0, B: VI 1=1+0)
96. *Parectropis extersaria* (Hübner). 3=3+0. (A: VI 2=2+0, B: VI 1=1+0)
97. *Aethalura ignobilis* (Butler). 3=3+0. (A: VI 1=1+0, B: VI 1=1+0, VII 1=1+0)
98. *Scionomia mendica* (Butler). 6=6+0. (A: VI 3=3+0, IX 3=3+0)
99. *Larerannis orthogrammaria* (Wehrli). 1=1+0. (A: X 1=1+0)
100. *Erannis golda* Djakonov. 6=6+0. (A: X 5=5+0, B: X 1=1+0)
101. *Biston betularia* (Linnaeus). 3=3+0. (B: VI 2=2+0, VII 1=1+0)
102. *Colotois pennaria* (Linnaeus). 1=1+0. (A: X 1=1+0)
103. *Menophra atrilineata* (Butler). 11=11+0. (A: VII 10=10+0, B: VII 1=1+0)
104. *M. senilis* (Butler). 10=8+2. (A: VI 2=0+2, B: VI 8=8+0)
105. *Odontopera bidentata* (Clerck). 4=4+0. (A: VI 2=2+0, B: VI 2=2+0)
106. *Zethenia albonotaria* (Bremer). 28=22+6. (A: VI 5=4+1, VII 1=1+0, B: VI 22=17+5)
107. *Z. rufescentaria* Motschulsky. 20=14+6. (A: VI 6=6+0, B: VI 14=8+6)
108. *Auaxa cesadaria* Walker. 1=1+0. (A: VII 1=1+0)
109. *Selenia tetralunaria* (Hufnagel). 31=24+7. (A: VII 18=18+0, B: VII 13=6+7)
110. *Garaeus specularis* Moore. 1=1+0. (A: IX 1=1+0)
111. *Endropiodes abjectus* (Butler). 20=18+2. (A: VI 6=6+0, VII 13=11+2, B: VI 1=1+0)
112. *Plagodis dolabraria* (Linnaeus). 2=2+0. (A: VI 2=2+0)
113. *Cepphis advenaria* (Hübner). 8=8+0. (A: VI 4=4+0, B: VI 4=4+0)
114. *Ourapteryx maculicaudaria* (Motschulsky). 17=5+12. (B: VII 17=5+12)

Family **LASIOCAMPIDAE**

115. *Philudoria albomaculata* (Bremer). 3=2+1. (A: VII 2=2+0, B: VII 1=0+1)
116. *Somadasys brevivenis* (Butler). 10=10+0. (A: VII 6=6+0, B: VI 1=1+0, VII 3=3+0)
117. *Odonestis pruni* (Linnaeus). 3=3+0. (A: VII 1=1+0, B: VII 2=2+0)
118. *Dendrolimus superans* (Butler). 11=8+3. (A: VII 3=3+0, B: VII 8=5+3)
119. *Cyclophragma undans* (Walker). 2=2+0. (B: VII 2=2+0)
120. *Malacosoma neustria* (Linnaeus). 5=4+1. (B: VII 5=4+1)

Family **BOMBYCIDAE**

121. *Oberthueria falcigera* (Butler). 1=1+0. (B: VI 1=1+0)

Family **SATURNIIDAE**

122. *Actias artemis* (Bremer & Grey). 12=12+0. (A: VI 10=10+0, B: VI 2=2+0)

123. *Aglia tau* (Linnaeus). 4=4+0. (A: VI 4=4+0)

Family **SPHINGIDAE**

124. *Dolbina tancrei* Staudinger. 1=0+1. (B: VII 1=0+1)
125. *Mimas christophi* (Staudinger). 1=1+0. (B: VII 1=1+0)
126. *Acosmeryx naga* (Moore). 4=4+0. (A: VI 1=1+0, B: VI 3=3+0)
127. *Macroglossum saga* Butler. 1=1+0. (B: IX 1=1+0)
128. *Deilephila elpenor* (Linnaeus). 2=2+0. (B: VI 2=2+0)

Family **NOTODONTIDAE**

129. *Cerura vinula* (Linnaeus). 2=2+0. (A: VI 1=1+0, B: VI 1=1+0)
130. *Furcula infumata* (Staudinger). 1=1+0. (B: VI 1=1+0)
131. *F. lanigera* (Butler). 9=7+2. (B: VII 9=7+2)
132. *Urodonta arcuata* Alphéraky. 1=1+0. (B: VI 1=1+0)
133. *U. viridimixta* (Bremer). 1=1+0. (B: VI 1=1+0)
134. *Nerice bipartita* Butler. 1=1+0. (B: VI 1=1+0)
135. *N. davidi* Oberthür. 1=1+0. (A: VI 1=1+0)
136. *Hupodonta lignea* Matsumura. 4=3+1. (A: VII 3=2+1, B: VII 1=1+0)
137. *Zaranga permagna* (Butler). 3=3+0. (A: VI 2=2+0, B: VI 1=1+0)
138. *Shaka atrovittatus* (Bremer). 3=3+0. (B: VI 3=3+0)
139. *Pheosia fusiformis* Matsumura. 1=1+0. (B: VII 1=1+0)
140. *Notodonta dembowskii* Oberthür. 5=5+0. (B: VI 5=5+0)
141. *N. torva* (Hübner). 48=45+3. (A: VI 30=30+0, VII 4=4+0, B: VI 7=7+0, VII 7=4+3)
142. *Peridea oberthueri* (Staudinger). 2=2+0. (A: VI 2=2+0)
143. *P. graeseri* (Staudinger). 1=1+0. (B: VII 1=1+0)
144. *Suzukiana cinerea* (Butler). 2=2+0. (B: VI 1=1+0, VII 1=1+0)
145. *Semidonta biloba* (Oberthür). 1=1+0. (A: VI 1=1+0)
146. *Microphalera grisea* Butler. 4=4+0. (A: VI 1=1+0, B: VI 3=3+0)
147. *Epodonta lineata* (Oberthür). 4=3+1. (B: VI 1=1+0, VII 3=2+1)
148. *Hagapteryx admirabilis* (Staudinger). 1=1+0. (B: VII 1=1+0)
149. *Ptilodon robusta* (Matsumura). 4=4+0. (A: VI 1=1+0, VII 1=1+0, B: VI 1=1+0, VII 1=1+0)
150. *Ptilophora nohirae* (Matsumura). 19=19+0. (A: X 19=19+0)
151. *P. jezoensis* (Matsumura). 2=2+0. (A: X 2=2+0)
152. *Togepteryx velutina* (Oberthür). 1=1+0. (B: VI 1=1+0)
153. *Gluphisia crenata* (Esper). 3=3+0. (A: VI 3=3+0)
154. *Clostera anachoreta* (Denis & Schiffermüller). 4=4+0. (A: VII 1=1+0, IX 1=1+0, B: IX 2=2+0)

Family **LYMANTRIIDAE**

155. *Calliteara pudibunda* (Linnaeus). 23=22+1. (A: VI 6=6+0, B: VI 17=16+1)
156. *Cifuna locuples* Walker. 45=43+2. (A: VII 6=6+0, IX 8=8+0, B: IX 31=29+2)
157. *Orgyia thyellina* Butler. 1=1+0. (B: VII 1=1+0)
158. *Arctornis l-nigrum* (Müller). 10=10+0. (A: VII 3=3+0, B: 7=7+0)

159. *Leucoma salicis* (Linnaeus). 1=1+0. (A: VII 1=1+0)
160. *Lymantria monacha* (Linnaeus). 23=13+10. (A: VII 4=3+1, B: VII 19=10+9)
161. *Euproctis similis* (Fuessly). 1=1+0. (A: VII 1=1+0)

Family **ARCTIIDAE**

162. *Eilema griseola* (Hübner). 5=5+0. (A: VII 4=4+0, B: VII 1=1+0)
163. *E. okanoi* Inoue. 1=1+0. (B: VII 1=1+0)
164. *E. cribrata* (Staudinger). 1=1+0. (B: VII 1=1+0)
165. *E.* spp.. 119=59+60. (A: VII 15=10+5, IX 1=1+0, B: VII 103=48+55)
166. *Agylla gigantea* (Oberthür). 4=4+0. (B: VII 4=4+0)
167. *A. collitoides* (Butler). 5=5+0. (A: VI 2=2+0, B: VI 3=3+0)
168. *Lithosia quadra* (Linnaeus). 15=5+10. (A: VII 1=1+0, B: VII 14=4+10)
169. *Bizone hamata* Walker. 3=3+0. (A: VII 2=2+0, B: VII 1=1+0)
170. *Miltochrista miniata* (Forster). 43=38+5. (A: VII 4=4+0, B: 39=34+5)
171. *M. pulchra* Butler. 5=4+1. (A: VII 1=1+0, B: VII 4=3+1)
172. *Stigmatophora flava* (Bremer & Grey). 1=1+0. (A: VII 1=1+0)
173. *Phragmatobia amurensis* Seitz. 2=2+0. (B: VII 2=2+0)
174. *Spilosoma seriatopunctata* Motschulsky. 26=22+4. (A: VII 3=1+2, B: VI 19=19+0, VII 4=2+2)
175. *S. imparilis* (Butler). 4=4+0. (B: VII 4=4+0)
176. *S. punctaria* (Stoll). 16=14+2. (A: VI 14=13+1, B: VI 2=1+1)
177. *S. lubricipeda* (Linnaeus). 1=1+0. (B: VI 1=1+0)
178. *S. niveum* (Ménétriès). 51=42+9. (A: VII 6=4+2, B: VII 45=38+7)
179. *Rhyparioides amurensis* (Bremer). 2=1+1. (B: VII 2=1+1)
180. *R. nebulosus* Butler. 5=3+2. (A: VII 3=2+1, B: VII 2=1+1)
181. *Arctia caja* (Linnaeus). 2=2+0. (B: IX 2=2+0)

Family **NOCTUIDAE**

Subfamily PANTHEINAE

182. *Anacronicta nitida* (Butler). 3=2+1. (B: VI 3=2+1)
183. *Trichosea champa* (Moore). 1=0+1. (B: VI 1=0+1)
184. *Panthea coenobita* (Esper). 3=3+0. (B: VII 3=3+0)

Subfamily ACRONICTINAE

185. *Moma alpium* (Osbeck). 1=0+1. (B: VII 1=0+1)
186. *Hyboma adaucta* (Warren). 1=1+0. (A: VI 1=1+0)
187. *Triaena intermedia* (Warren). 3=3+0. (B: VI 1=1+0, VII 2=2+0)
188. *Jocheaera alni* (Linnaeus). 1=1+0. (B: VI 1=1+0)
189. *Hylonycta catocaloida* (Graeser). 2=1+1. (B: VII 2=1+1)
190. *Viminia rumicis* (Linnaeus). 35=15+20. (A: VII 6=3+3, B: VI 3=3+0, VII 25=8+17, IX 1=1+0)

Subfamily BRYOPHILINAE

191. *Stenoloba jankowskii* (Oberthür). 3=2+1. (B: VII 3=2+1)

Subfamily HELIOTHINAE

192. *Heliothis maritima* Graslin. 2=1+1. (B: VI 1=1+0, VII 1=0+1)

Subfamily NOCTUINAE

193. *Euxoa sibirica* (Boisduval). 2=1+1. (B: VII 1=1+0, IX 1=0+1)
194. *E. oberthueri* (Leech). 9=5+4. (B: VII 7=3+4, IX 2=2+0)
195. *Agrotis ipsilon* (Hufnagel). 5=3+2. (B: VI 2=2+0, IX 3=1+2)
196. *A. exclamationis* (Linnaeus). 30=26+4. (B: VI 29=25+4, IX 1=1+0)
197. *A. segetum* (Denis & Schiffermüller). 12=6+6. (B: VI 10=5+5, IX 2=1+1)
198. *Ochropleura praecox* (Linnaeus). 1=0+1. (B: VII 1=0+1)
199. *O. praecurrens* (Staudinger). 12=1+11. (B: VII 12=1+11)
200. *O. triangularis* Moore. 2=0+2. (B: VII 2=0+2)
201. *O. plecta* (Linnaeus). 10=9+1. (B: VI 10=9+1)
202. *Hermonassa arenosa* (Butler). 17=8+9. (A: VII 1=0+1, IX 3=3+0, B: VII 10=3+7, IX 3=2+1)
203. *Spaelotis lucens* Butler. 1=0+1. (A: VII 1=0+1)
204. *Sineugraphe exusta* (Butler). 61=40+21. (A: VII 2=2+0, B: VII 58=37+21, IX 1=1+0)
205. *S. disgnosta* (Boursin). 68=38+30. (A: IX 5=0+5, X 1=0+1, B: VI 5=5+0, VII 57=33+24)
206. *Diarsia canescens* (Butler). 14=11+3. (A: VI 2=2+0, B: VI 11=9+2, VII 1=0+1)
207. *D. dewitzi* (Graeser). 3=0+3. (B: VII 3=0+3)
208. *D. ruficauda* (Warren). 13=13+0. (A: VI 4=4+0, B: 9=9+0)
209. *Xestia c-nigrum* (Linnaeus). 29=20+9. (A: VI 1=1+0, VII 2=2+0, B: VI 16=10+6, VII 5=3+2, IX 5=4+1)
210. *X. ditrapezium* (Denis & Schiffermüller). 12=8+4. (B: VII 10=6+4, IX 2=2+0)
211. *X. efflorescens* (Butler). 20=13+7. (A: VII 3=3+0, IX 3=0+3, B: VII 12=8+4, IX 2=2+0)
212. *X. semiherbida* (Walker). 3=1+2. (B: VII 3=1+2)
213. *Anaplectoides virens* (Butler). 22=12+10. (A: VII 5=2+3, B: VII 17=10+7)

Subfamily HADENINAE

214. *Polia nebulosa* (Hufnagel). 1=1+0. (B: VI 1=1+0)
215. *Melanchra persicariae* (Linnaeus). 33=30+3. (A: VII 1=1+0, B: VII 32=29+3)
216. *Mamestra brassicae* (Linnaeus). 24=22+2. (B: VI 16=16+0, VII 7=6+1, IX 1=0+1)
217. *Sarcopolia illoba* (Butler). 2=2+0. (B: VII 2=2+0)
218. *Clavipalpula aurariae* (Oberthür). 1=1+0. (A: VI 1=1+0)
219. *Mythimna turca* (Linnaeus). 4=4+0. (A: VII 1=1+0, B: VII 3=3+0)
220. *M. monticola* Sugi. 1=1+0. (A: VII 1=1+0)
221. *M. divergens* Butler. 5=3+2. (A: VII 4=3+1, B: 1=0+1)
222. *Aletia conigera* (Denis & Schiffermüller). 2=1+1. (B: VII 2=1+1)
223. *A.* sp.. 2=1+1. (B: VII 2=1+1)
224. *Pseudaletia separata* (Walker). 1=1+0. (B: VI 1=1+0)
225. *Analetia postica* (Hampson). 1=1+0. (B: IX 1=1+0)

Subfamily CUCULLIINAE

226. *Cucullia artemisiae* (Hufnagel). 3=2+1. (B: VII 3=2+1)
227. *C. perforata* Bremer. 2=1+1. (B: VII 2=1+1)
228. *C. fraterna* Butler. 1=1+0. (B: VII 1=1+0)
229. *C. elongata* Butler. 1=0+1. (B: VII 1=0+1)
230. *C. ledereri* Staudinger. 3=3+0. (B: VII 3=3+0)
231. *Conistra grisescens* Draudt. 1=0+1. (B: X 1=0+1)
232. *C. fletcheri* Sugi. 4=2+2. (B: X 4=2+2)
233. *C. unimacula* Sugi. 1=1+0. (B: X 1=1+0)
234. *Dasycampa castaneofasciata* (Motschulsky). 1=1+0. (B: X 1=1+0)
235. *Blepharita bathensis* (Lutzau). 4=4+0. (B: VII 4=4+0)

Subfamily AMPHIPYRINAE

236. *Apamea crenata* (Hufnagel). 26=23+3. (B: VI 26=23+3)
237. *A. aquila* Donzel. 1=0+1. (A: VII 1=0+1)
238. *A. lateritia* (Hufnagel). 104=98+6. (A: VII 1=1+0, B: VII 103=97+6)
239. *A. sordens* (Hufnagel). 3=3+0. (B: VI 3=3+0)
240. *Leucapamea askoldis* (Oberthür). 1=1+0. (B: VII 1=1+0)
241. *Oligia rufata* Kardakoff. 1=0+1. (B: VII 1=0+1)
242. *O. fodinae* (Oberthür). 10=5+5. (B: VII 10=5+5)
243. *Mesapamea concinnata* Heinicke. 7=6+1. (B: VII 6=5+1, IX 1=1+0)
244. *Hydraecia amurensis* Staudinger. 19=19+0. (B: IX 19=19+0)
245. *Amphipoea ussuriensis* (Petersen). 285=172+113. (A: VII 2=1+1, B: VII 263=152+111, IX 20=19+1)
246. *Triphaenopsis jezoensis* Sugi. 1=1+0. (B: IX 1=1+0)
247. *T. postflava* (Leech). 5=5+0. (B: VII 5=5+0)
248. *Euplexia lucipara* (Linnaeus). 2=2+0. (B: VII 2=2+0)
249. *E. vinacea* Sugi. 6=6+0. (A: VII 2=2+0, B: VI 3=3+0, IX 1=1+0)
250. *E. illustrata* Graeser. 2=1+1. (B: VII 2=1+1)
251. *E. bella* (Butler). 1=1+0. (B: IX 1=1+0)
252. *Phlogophora beatrix* Butler. 1=1+0. (B: VI 1=1+0)
253. *Actinotia polyodon* (Clerck). 1=1+0. (B: VI 1=1+0)
254. *Dypterygia andreji* Kardakoff. 12=11+1. (A: VI 8=8+0, VII 1=1+0, B: VI 3=2+1)
255. *Axylia putris* (Linnaeus). 1=1+0. (B: VII 1=1+0)
256. *Trachea atriplicis* (Linnaeus). 1=0+1. (B: VII 1=0+1)
257. *T. lucilla* Sugi. 2=1+1. (A: VII 1=1+0, B: VII 1=0+1)
258. *T. tokiensis* (Butler). 44=35+9. (A: VI 3=2+1, VII 1=0+1, B: VI 35=29+6, VII 5=4+1)
259. *Karana laetevirens* (Oberthür). 1=1+0. (B: VII 1=1+0)
260. *Athetis albisignata* (Oberthür). 5=4+1. (B: VI 3=2+1, IX 2=2+0)
261. *A.* spp.. 6=5+1. (B: VI 6=5+1)
262. *Amphipyra pyramidea* (Linnaeus). 76=29+47. (A: VII 3=2+1, B: VII 71=25+46, IX 2=2+0)
263. *A. erebina* Butler. 1=0+1. (B: VII 1=0+1)

264. *A. schrenckii* Ménétriès. 71=41+30. (A: VII 5=5+0, IX 2=2+0, B: VII 62=33+29, IX 2=1+1)
265. *Enargia paleacea* (Esper). 3=0+3. (B: VII 3=0+3)
266. *Cosmia affinis* (Linnaeus). 2=2+0. (B: VII 2=2+0)
267. *C. unicolor* (Staudinger). 295=133+162. (A: VII 6=2+4, IX 1=1+0, B: VII 288=130+158)
268. *C. restituta* (Walker). 42=29+13. (B: VII 42=29+13)
269. *C. camptostigma* (Ménétriés). 1=1+0. (B: VII 1=1+0)
270. *C. exigua* (Butler). 25=21+4. (A: IX 4=2+2, B: VII 21=19+2)
271. *C. moderata* (Staudinger). 2=1+1. (B: VII 2=1+1)
272. *Dimorphicosmia variegata* (Oberthür). 194=79+115. (A: VII 18=6+12, IX 1=0+1, B: VII 175=73+102)
273. *Ipimorpha retusa* (Linnaeus). 1=0+1. (A: VII 1=0+1)
274. *I. subtusa* (Denis & Schiffermüller). 28=22+6. (A: 20=14+6, IX 1=1+0, B: VII 6=6+0, IX 1=1+0)
275. *Chasminodes* spp.. 443=202+241. (A: VII 7=4+3, IX 1=0+1, B: VII 433=198+235, IX 2=0+2)
276. *C. nervosa* (Butler). 399=201+198. (A: VII 2=1+1, B: VII 397=200+197)
277. *C. atrata* (Butler). 25=25+0. (A: VII 2=2+0, B: VII 23=23+0)
278. *Chytonix subalbonotata* Sugi. 2=2+0. (B: VI 2=2+0)
279. *Eucarta virgo* (Treitschke). 1=1+0. (B: VII 1=1+0)
280. *Platysenta cyclica* (Hampson). 1=1+0. (A: VI 1=1+0)
281. *Callopistria juventina* (Stoll). 2=1+1. (B: VII 2=1+1)
282. *Sphragifera sigillata* (Ménétriès). 1=1+0. (B: VII 1=1+0)

Subfamily CHLOEPHORINAE

283. *Earias pudicana* Staudinger. 1=0+1. (B: VII 1=0+1)
284. *Gelastocera exusta* Butler. 1=0+1. (B: VII 1=0+1)
285. *Sinna extrema* (Walker). 1=1+0. (B: VII 1=1+0)

Subfamily ACONTIINAE

286. *Aventiola pusilla* (Butler). 2=1+1. (A: VII 2=1+1)
287. *Trisateles emortualis* (Denis & Schiffermüller). 4=3+1. (A: VI 1=1+0, B: VI 3=2+1)
288. *Maliattha bella* (Staudinger). 1=1+0. (A: VII 1=1+0)
289. *Lithacodia pygarga* (Hufnagel). 7=7+0. (A: VI 1=1+0, VII 4=4+0, B: VI 1=1+0, VII 1=1+0)
290. *L. distinguenda* (Staudinger). 1=1+0. (B: VI 1=1+0)
291. *L. falsa* (Butler). 9=6+3. (B: VII 9=6+3)

Subfamily PLUSIINAE

292. *Macdunnoughia confusa* (Stephens). 2=2+0. (B: IX 2=2+0)
293. *Autographa gamma* (Linnaeus). 6=3+3. (B: VII 5=2+3, IX 1=1+0)
294. *A. amurica* (Staudinger). 8=4+4. (A: 1=0+1, VII 2=2+0, B: VI 2=2+0, VII 2=0+2, IX 1=0+1)
295. *Plusia festucae* (Linnaeus). 2=1+1. (B: VII 1=0+1, IX 1=1+0)

296. *Diachrysia chryson* (Esper). 2=2+0. (B: VII 2=2+0)
297. *D. stenochrysis* (Warren). 7=4+3. (A: VII 2=2+0, B: VII 5=2+3)
298. *Chrysodeixis eriosoma* (Doubleday). 1=0+1. (B: IX 1=0+1)

Subfamily CATOCALINAE

299. *Catocala lara* Bremer. 51=33+18. (B: VII 51=33+18)
300. *C. nupta* (Linnaeus). 3=0+3. (B: VII 3=0+3)
301. *C. electa* (Borkhausen). 1=1+0. (B: IX 1=1+0)
302. *C. dula* Bremer. 50=22+28. (B: VII 50=22+28)
303. *C. deuteronympha* Staudinger. 1=1+0. (B: VII 1=1+0)
304. *C. dissimlis* Bremer. 1=0+1. (B: VII 1=0+1)
305. *Mocis annetta* (Butler). 2=1+1. (A: VII 2=1+1)
306. *Lagoptera juno* (Dalman). 2=2+0. (B: IX 2=2+0)

Subfamily OPHIDERINAE

307. *Lygephila viciae* (Hübner). 1=1+0. (B: VI 1=1+0)
308. *Calyptra thalictri* (Borkhausen). 1=1+0. (A: VII 1=1+0)
309. *C. hokkaida* (Wileman). 1=1+0. (B: VII 1=1+0)
310. *Sypnoides hercules* (Butler). 20=15+5. (A: VII 1=1+0, B: VII 19=15+4)
311. *Chrysorithrum amatum* (Bremer & Grey). 1=1+0. (A: VI 1=1+0)
312. *Pangrapta umbrosa* (Leech). 1=1+0. (A: VI 1=1+0)
313. *Colobochyla salicalis* (Denis & Schiffermüller). 4=4+0. (A: VI 1=1+0, VII 2=2+0, B: VI 1=1+0)
314. *Rivula sericealis* (Scopoli). 2=2+0. (B: VII 2=2+0)

Subfamily HYPENINAE

315. *Hypena* sp.. 2=2+0. (A: VI 1=1+0, IX 1=1+0)
316. *H. whitelyi* (Butler). 1=1+0. (B: IX 1=1+0)
317. *H. tristalis* Lederer. 89=39+50. (A: VI 3=1+2, IX 4=2+2, B: VI 78=34+44, VII 1=0+1, IX 3=2+1)
318. *H. narratalis* Walker. 3=1+2. (B: IX 3=1+2)

Subfamily HERMINIINAE

319. *Hydrillodes funeralis* Warren. 42=34+8. (A: VI 16=14+2, B: VI 26=20+6)
320. *Hadennia incongruens* (Butler). 1=1+0. (A: VII 1=1+0)
321. *Paracolax albinotata* (Butler). 8=7+1. (A: VI 7=6+1, VII 1=1+0)
322. *P. fascialis* (Leech). 12=9+3. (A: VII 9=8+1, B: VII 3=2+1)
323. *Zanclognatha lunalis* (Scopoli). 1=1+0. (A: VII 1=1+0)
324. *Z. fumosa* (Butler). 4=4+0. (A: VI 2=2+0, IX 2=2+0)
325. *Z. helva* (Butler). 1=1+0. (A: VI 1=1+0)
326. *Z. tarsipennalis* (Treitschke). 4=2+2. (A: VII 1=1+0, B: VII 2=0+2, IX 1=1+0)
327. *Herminia nemoralis* (Fabricius). 15=14+1. (A: VI 12=12+0, IX 1=1+0, B: VI 2=1+1
328. *H. tarsicrinalis* (Knoch). 8=8+0. (A: VI 8=8+0)
329. *H. arenosa* Butler. 12=9+3. (A: VI 9=7+2, VII 3=2+1)

Table 1. Faunal comparison between Nopporo and Tomakomai. Number of species in each family is given, and in parentheses, percentage ratio

Family	Hokkaido[1]	Nopporo[2]	Common	Usu	Common	Tomakomai[3]
Limacodidae	9 (0.7)	5 (0.9)	2	2 (0.6)	2	4 (0.8)
Drepanidae	12 (0.9)	9 (1.5)	5	5 (1.5)	5	8 (1.5)
Thyatiridae	27 (2.1)	10 (1.7)	4	5 (1.5)	4	15 (2.8)
Geometridae	416 (32.8)	190 (32.5)	77	102 (31.0)	62	150 (29.1)
Lasiocampidae	15 (1.2)	12 (2.1)	6	6 (1.8)	6	11 (2.1)
Bombycidae	2 (0.2)	2 (0.3)	1	1 (0.3)	1	2 (0.4)
Saturniidae	9 (0.7)	7 (1.2)	2	2 (0.6)	2	6 (1.2)
Sphingidae	34 (2.7)	16 (2.7)	5	5 (1.5)	4	16 (3.1)
Notodontidae	76 (6.0)	52 (8.9)	24	26 (7.9)	20	46 (8.9)
Lymantriidae	24 (1.9)	15 (2.6)	7	7 (2.1)	7	19 (3.7)
Arctiidae	50 (3.9)	31 (5.3)	18	20 (6.1)	13	24 (4.6)
Noctuidae	596 (46.9)	236 (40.3)	115	148 (45.0)	93	215 (41.7)
Total	1,270 (100)	585 (100)	266	329 (100)	219	516 (100)
Similarity[4]			0.410		0.350	

1) Inoue *et al.* (1982). 2) Sakamoto *et al.* (1977), Sato (1985). 3) Yoshida (1976, 1981).
4) Jaccard (1902).

In total 329 species of 12 families were collected. This constituted 26% of the 1,270 species discovered in Hokkaido to date (Table 1). As in Nopporo (Sakamoto *et al.* 1977; Sato, 1985) and Tomakomai (Yoshida, 1976, 1981) which are also situated in central Hokkaido, Noctuidae, Geometridae and Notodontidae exceeded the other families in number of species. However, Jaccard's index[2], which shows the faunal similarity between two given areas, was as low as 0.410 with Nopporo and 0.350 with Tomakomai, mainly due to large numbers of uncommon species in Noctuidae and Geometridae. These indices suggest that the moth fauna of Mt. Usu is somewhat more similar to that of Nopporo than that of Tomakomai.

Figure 2 shows seasonal fluctuations of species richness and proportions of the four main families in each sampling station. As can be seen, the fluctuational trend is similar between these stations with total species richness peaking in summer and then abruptly declining towards early winter. Also similar, Geometridae, Noctuidae, Notodontidae, and Arctiidae made up the first four families in all seasons, while in contrast, the total richness was higher in the crater basin from spring to autumn and particularly remarkable, Noctuidae predominated Geometridae in summer, unlike Tomakomai (Yoshida, 1981) and Nopporo (Sato, 1985) where

2) Jaccard's similarity ratio is defined as:

$$CC = c/(a+b-c)$$

where a and b are numbers of species in the samples, and c is number of species common to both samples (Jaccard, 1902).

Noctuidae and Geometridae had similar level of richness. As a whole the species common to both stations reached 125 spp., constituting 47.5% of 263 species collected in the crater basin and 65.4% of 191 species on Yosomi Hill.

Figure 3 shows the seasonal change of sample size and dominant species in each sampling station. Total sample size in the crater basin (3,847 individuals)

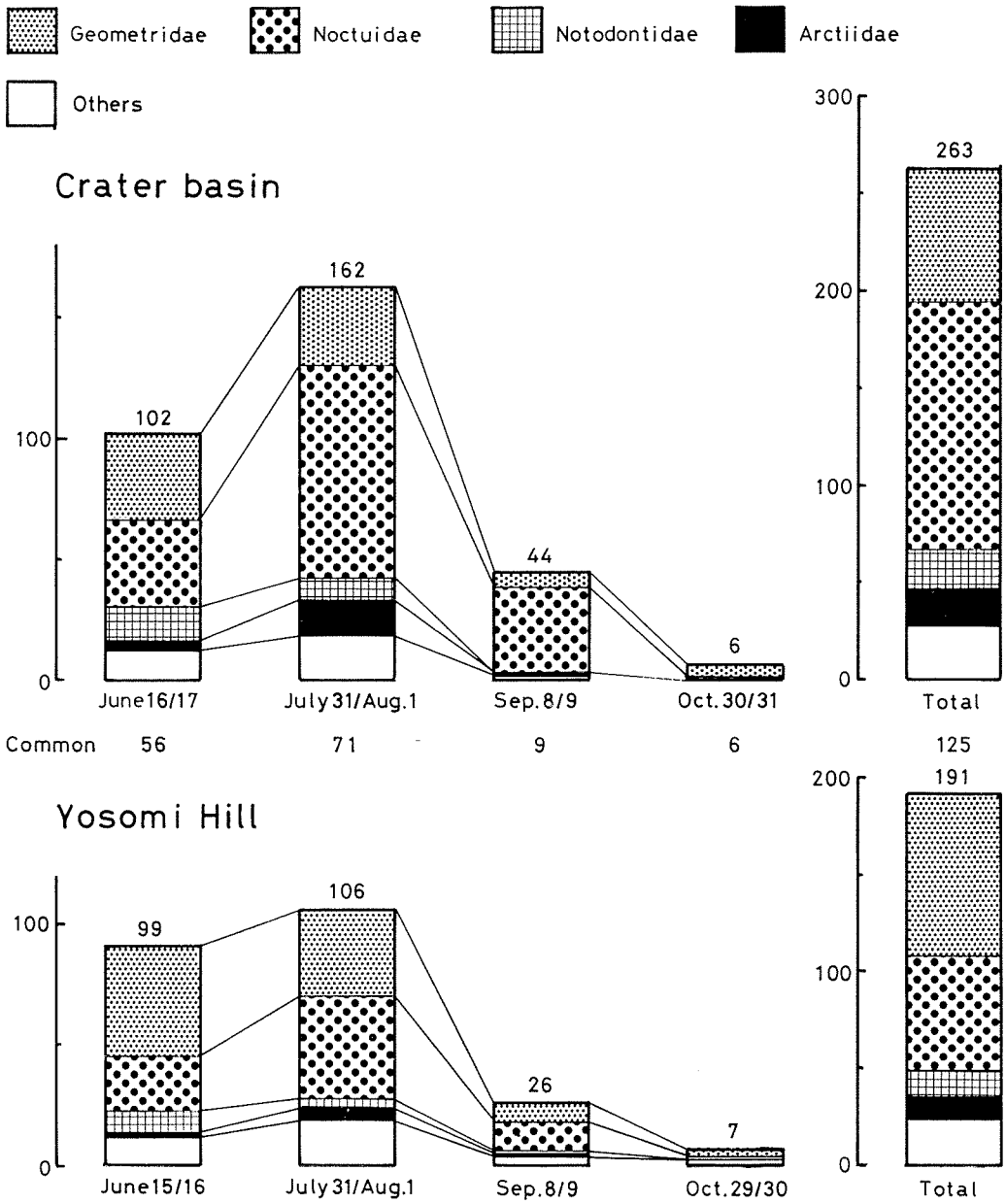

Figure 2. Seasonal fluctuations of species richness and proportions of four main families at each sampling station.

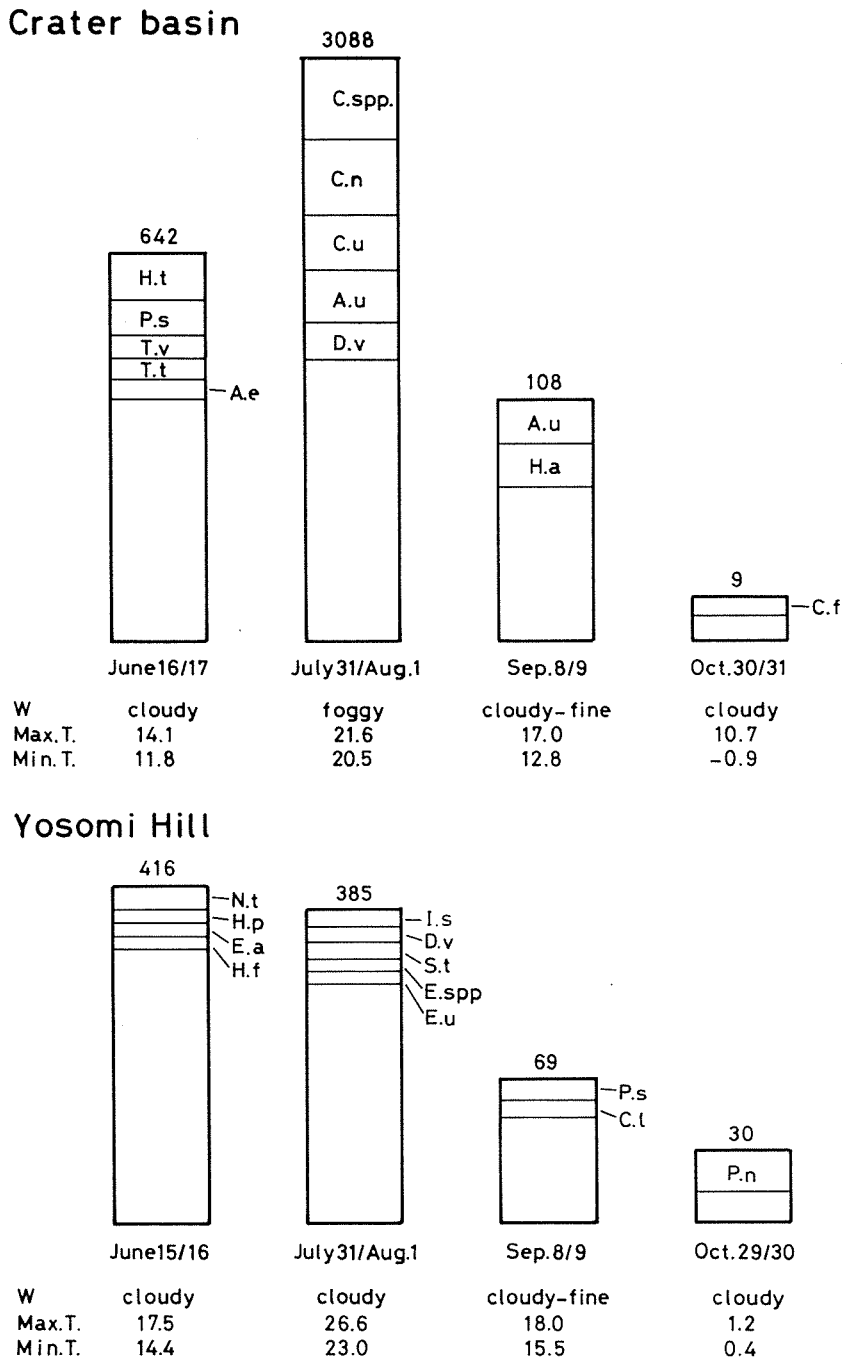

Figure 3. Seasonal change of sample size and predominat species in each sampling station. Sample size is given on the top of each bar. W: weather. Max.T. and Min.T.: maximum and minimum temperatures, respectively. H.t: *Hypena tristalis*, P.s: *Perizoma saxeum*, T.v: *Thera variata*, T.t: *Trachea tokiensis*, A.e: *Agrotis exclamationis*, C.spp.: *Chasminodes* spp., C.n: *Chasminodes nervosa*, C.u: *Cosmia unicolor*, A.u: *Amphipoea ussuriensis*, C.f: *Conistra fletcheri*, N.t: *Notodonta torva*, H.p: *Hypomecis punctinalis*, E.a: *Ectropis aigneri*, H.f: *Hydrillodes funeralis*, I.s: *Ipimorpha subtusa*, S.t: *Selenia tetralunaria*, E.spp.: *Eilema* spp., E.u: *Ecliptopera umbrosaria*, C.l: *Cifuna locuples*, P.n: *Ptilophora nohirae*.

was by far larger than that on Yosomi Hill (900), though the maximum and minimum temperatures were 1 to 5°C lower in the former than in the latter. The difference in sample size was greatest during a foggy night, July 31/August 1. According to Williams (1940) and Miyata (1984), more moths were lured to lights during warm and foggy nights than during cool and fine nights. In the present survey, the sample size seemed to be affected by the weather but not greatly by the 1 to 5°C difference in temperature. Since the emergence of most species is restricted to a given season (Yoshida, 1976, 1981), the dominant species were seasonally different as follows: On Yosomi Hill, *Hypomecis punctinalis, Ectropis aigneri* (Geometridae), *Hydrillodes funeralis* (Noctuidae) and *Notodonta torva* (Notodontidae) in the late spring; *Ipimorpha subtusa, Dimorphicosmia variegata* (Noctuidae), *Selenia tetralunaria, Ecliptopera umbrosaria* (Geometridae), and *Eilema* spp, in the summer; *Perizoma saxeum* (Geometridae), and *Cifuna locuples* (Limantriidae) in the autumn; *Ptilophora nohirae* (Notodontidae) in the early winter. In the crater basin, *Hypena tristalis, Trachea tokiensis, Agrotis exclamationis* (Noctuidae), *Perizoma saxeum,* and *Thera variata* (Geometridae) in the late spring; *Chasminodes nervosa, Chasminodes* spp., *Cosmia unicolor, Amphipoea ussuriensis,* and *Dimorphicosmia variegata* (Noctuidae) in the summer; *Amphipoea ussuriensis* and *Hydraecia amurensis* (Noctuidae) in the autumn; *Conistra fletcheri* (Noctuidae) in the early winter. The findings also show *Selenia tetralunaria, Eilema* spp., *Hypomecis punctinalis, Perizoma saxeum, Dimorphicosmia variegata, Chasminodes* spp., *Ecliptopera umbrosaria,* and *Ptilophora nohirae* were as well dominant in Nopporo or Tomakomai.

Table 2. Number of species feeding on each host type in their larval stages, in accordance with Inoue *et al.* (1982). Host type is categorized into eight: B, broad-leaved tree; C, conifer; M, moss; D, dead leaf; BC, broad-leaved tree and conifer; H, herb; BH, broad-leaved tree and herb; BCH, broad-leaved tree, conifer and herb. Host distribution is represented by: scarcely (−), intermediately (+) and densely (++). Veg.: present vegetation, Sp.: number of species, Ind.: number of individuals

	Habitat	Forest					Herb	Eurytopic		Unknown	Total
	Host type	B	C	M	D	BC	H	BH	CBH		
Crater basin	Veg.	+	−	−	−		++				
	Sp. (%)	112 (42.6)	7 (2.7)	10 (3.8)	4 (1.5)	2 (0.8)	56 (21.3)	17 (6.5)	2 (0.8)	53 (20.1)	263 (100)
	Ind. (%)	2,369 (61.6)	84 (2.2)	171 (4.4)	31 (0.8)	26 (0.7)	512 (13.3)	168 (4.4)	15 (0.4)	471 (12.2)	3,847 (100)
Yosomi Hill	Veg.	++	−	++	++		+				
	Sp. (%)	87 (45.5)	4 (2.1)	9 (4.7)	11 (5.8)	1 (0.5)	34 (17.8)	9 (4.7)	2 (1.0)	34 (17.8)	191 (100)
	Ind. (%)	465 (51.7)	15 (1.7)	33 (3.7)	74 (8.2)	4 (0.4)	107 (11.9)	49 (5.4)	8 (0.9)	145 (16.1)	900 (100)

In accordance with their hosts described by Inoue *et al.* (1982), the collected species were grouped into eight types: B, broad-leaved tree feeders; C, conifer feeders; M, moss feeders; D, dead-leaf feeders; H, herb feeders; BC, broad-leaved tree and conifer feeders; BCH, broad-leaved tree, conifer and herb feeders; BH, broad-leaved tree and herb feeders. B, C, M, D, and BC types were further clustered into a forest group; H into a grassland group; BH and BCH into a eurytopic group. As shown in Table 2, the hosts such as broad-leaved trees, conifers, and mosses were sparse in the crater basin. However, the moth species feeding on these hosts were rich, consequently representing a host-type makeup similar to that of Yosomi Hill. The high richness of the forest species in the crater basin suggests the frequent immigration of moths from the base of the mountain to the crater basin.

Species diversity H' and evenness J' are given by following formulae respectively:

$$H' = -\sum p_i \ln p_i \qquad \text{(Shannon-Wiener function index)}$$

$$J' = H'/\ln S \qquad \text{(Pielou, 1966)}$$

where p_i is a proportion of a species i in total number of individuals, and S is the total number of species. The species diversity depends not only on species

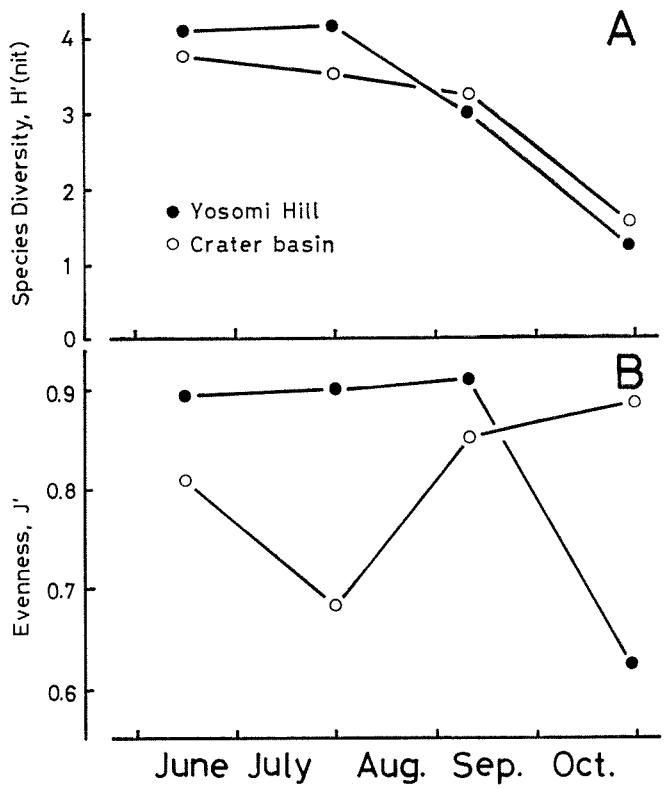

Figure 4. Seasonal fluctuations of species diversity (A) and evenness (B) at each sampling station.

richness but also on the evenness with which the individuals are apportioned among the species.

The seasonal fluctuations of species diversity were similar in trend between the crater basin and Yosomi Hill, keeping a high level of $H' \fallingdotseq 4$ in the summer and dropping to $H' \fallingdotseq 1.5$ in October (Figure 4). However, the fluctuations of evenness were dissimilar. On Yosomi Hill the evenness maintained a high level of $J' \fallingdotseq 0.9$, from June to September, and dropped to $J' \fallingdotseq 0.6$ in October. While, in the crater basin the bottom of evenness occurred in the summer, thereafter increasing to $J' \fallingdotseq 0.9$ in October. The lower occurrence in the summer was caused by a predominance of some species such as *Chasminodes nervosa*, *Chasminodes* spp., *Cosmia unicolor*, and *Dimorphicosmia variegata*, feeding on *Tilia japonica*, *Quercus mongolica* var. *grosseserrata* and *Ulmus davidiana* which were less dominant around the top of this mountain. The predominance of these moths was undoubtedly due to the frequent immigration from the forests around this mountain.

4. Conclusion

Compared with a control station located in a broad leaved-forest of Yosomi Hill, which did not suffer serious damages vegetationally by the 1977–78 eruptions of a volcano Mt. Usu, the mountaintop area of this volcano was almost completely deforested and the vegetational recovery is far from the situation of the control station. However, the fauna of macrolepidopterous moths is richer around the mountaintop (263 species) than in the control station (191 species). When these species are grouped by the host plants during their larval stages, forest species constitute 51.4% of the 263 species discovered around the mountaintop while the openland species comprise only 21.3%. *Chasminodes nervosa*, *Chasminodes* spp., *Cosmia unicolor*, and *Eilema* spp. which are predominant around the mountaintop belong to a group of forest species. These facts doubtless mean that many moth species are already immigrating into the deforested areas before the recovery of the vegetation.

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